Project Manual for:

GOVERNMENT OF CANADA
COALDALE GOVERNMENT BUILDING

PROJECT NO: 9031

VOLUME 2 OF 2
DIVISIONS 20-33

Issued for Tender
January 9, 2019

STEPHENS KOZAK ACI
ARCHITECTS AND PLANNERS

Government of Canada
Gouvernement du Canada
Canada

VOLUME 1

Document 00 - Procurement and Contracting Requirements

Division 01 - General Requirements

Division 02 - Existing Conditions

Division 03 - Concrete

Division 04 - Masonry

Division 05 - Metals

Division 06 - Wood, Plastics and Composites

Division 07 - Thermal and Moisture Protection

Division 08 - Openings

VOLUME 2

Division 21 - Fire Protection

Division 22 – Plumbing

Division 23 - Heating, Ventilating and Air Conditioning (HVAC)

Division 26 – Electrical

Division 33 – Utilities

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

.3 Shop drawings to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances.

.4 Shop drawings and product data accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Acoustical sound power data, where applicable.
- .3 Points of operation on performance curves.
- .4 Manufacturer to certify current model production.
- .5 Certification of compliance to applicable codes.

.5 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

.6 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
- .3 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for systems and component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .5 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Equipment performance verification test results.

.3 Special performance data as specified.

.4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.6 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make changes as required and re-submit as directed by Departmental Representative.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.9 As-built drawings:

.1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.

.2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.3 Submit to Departmental Representative for approval and make corrections as directed.

.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.

.5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

.10 Submit copies of as-built drawings for inclusion in final TAB report.

1.2 QUALITY ASSURANCE

.1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.

1.3 MAINTENANCE

.1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One head gasket set for each heat exchanger.

.4 One glass for each gauge glass.

.5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

.3 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Waste Management and Disposal:

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

Part 2 Products

2.1 MATERIALS

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

.2 Do verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 23 - Interior Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 Restore to new condition, finishes which have been damaged.

3.2 CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and air handling units.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

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

3.4 DEMONSTRATION

.1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Trial usage to apply to following equipment and systems:

.1 Chiller

.2 Boiler

.3 Fan Coil

.4 AHU

.5 Building Automation System

.3 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.4 Use operation and maintenance manual, as-built drawings, and audio-visual aids as part of instruction materials.

.5 Instruction duration time requirements as specified in appropriate sections.

.6 Departmental Representative will record these demonstrations on video tape for future reference.

3.5 PROTECTION

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

.2 All piping to be installed inside walls or concealed in shafts for protection of piping and occupants.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 National Fire Prevention Association (NFPA)

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

.2 NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.

.2 Underwriter's Laboratories of Canada (ULC)

.1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta.

.2 Indicate:

.1 Materials.

.2 Finishes.

.3 Method of anchorage

.4 Number of anchors.

.5 Supports.

.6 Reinforcement.

.7 Assembly details.

.8 Accessories.

.4 Samples:

.1 Submit samples of following:

.1 Each type of sprinkler head.

.2 Signs.

.5 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.7 Field Quality Control Submittals:

.1 Manufacturer's Field Reports: manufacturer's field reports specified.

.8 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals in accordance with NFPA 13.

.9 Manufacturer's Catalog Data, including specific model, type, and size for:

.1 Pipe and fittings.
.2 Valves, including gate, check, and globe.
.3 Water motor alarms.
.4 Sprinkler heads.
.5 Pipe hangers and supports.
.6 Pressure or flow switch.
.7 Fire department connections.
.8 Excess pressure pump.
.9 Mechanical couplings.

.10 Drawings:

.1 Sprinkler heads and piping system layout.

.1 Prepare mm detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
.2 Show data essential for proper installation of each system.
.3 Show details, plan view, elevations, and sections of systems supply and piping.
.4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.

.2 Electrical wiring diagrams.

.11 Design Data:

.1 Calculations of sprinkler system design.
.2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than [18] months.

.12 Field Test Reports:

.1 Preliminary tests on piping system.

.13 Records:

.1 As-built drawings of each system.

.1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.

.14 Operation and Maintenance Manuals:

.1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground piping and other documentation for incorporation into manual in accordance with NFPA 13.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: company or person specializing in wet sprinkler systems with documented experience.

.2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Provide spare sprinklers and tools in accordance with NFPA 13.

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

.3 Storage and Protection:

.1 Store materials in dry location.

.2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

.4 Packaging Waste Management: remove for reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, by hydraulic calculations for uniform distribution of water over design area.

.2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.

.3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.

.4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers. Center sprinkler heads in ceiling tiles.

.5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.

.6 Location of Sprinkler Heads:

.1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13.

.2 Uniformly space sprinklers on branch.

.7 Water Distribution:

.1 Make distribution uniform throughout the area in which sprinkler heads will open.

.2 Discharge from individual heads in hydraulically most remote area to be 100 % of specified density.

.8 Density of Application of Water:

.1 Size pipe to provide specified density when system is discharging specified total maximum required flow.

.9 Sprinkler Discharge Area:

.1 Area: calculate hydraulically most remote ² area as defined in NFPA 13.

.10 Outside Hose Allowances:

.1 Include allowance in hydraulic calculations of for outside hose streams as per NFPA.

.11 Friction Losses:

.1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.

.12 Water Supply:

.1 Base hydraulic calculations on static pressure, available flow, and residual pressure of based upon results of a hydrant flow test at the nearest fire hydrant

.2 Contractor is responsible for conducting hydrant flow test.

2.2 ABOVE GROUND PIPING SYSTEMS

.1 Provide fittings for changes in direction of piping and for connections.

.1 Make changes in piping sizes through tapered reducing pipe fittings, bushings will not be permitted.

.2 Conceal piping in areas with ceilings.

2.3 PIPE, FITTINGS AND VALVES

.1 Pipe:

.1 Ferrous: to NFPA 13.

.2 Copper tube: to NFPA 13.

.2 Fittings and joints to NFPA 13:

.1 Ferrous: screwed, welded, flanged or roll grooved.

.1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.

.2 Copper tube: screwed, soldered, brazed, grooved.

.3 Provide grooved-end type fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.

.4 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.

.5 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32 mm and larger.

.6 Fittings: ULC approved for use in wet pipe sprinkler systems.

.7 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.

.8 Side outlet tees using rubber gasketed fittings are not permitted.

.9 Sprinkler pipe and fittings: metal.

.3 Valves:

.1 ULC listed for fire protection service.

.2 Gate valves: open by counter clockwise rotation.

.3 Provide rising stem OS&Y gate valves.

.4 Pipe hangers:

.1 ULC listed for fire protection services in accordance with NFPA.

2.4 SPRINKLER HEADS

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

.2 Sprinkler Head Type:

.1 Exposed Non-Secure Areas: upright bronze.

.2 Non-Secure Areas with Ceilings: flush with white cover plate.

.3 Secure Areas: Approved Security type sprinkler head

.3 Provide nominal 1.2 cm orifice sprinkler heads.

.1 Release element of each head to be of temperature rating suitable for specific application.

.2 Provide fully recessed sprinkler heads with white cover plate for suspended/drywall ceilings in non-secure areas.

.3 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.

.4 Deflector: not more than 75 mm below suspended ceilings.

.5 Ceiling plates: not more than 25 mm deep.

.6 Ceiling cups: not permitted.

2.5 ALARM CHECK VALVE

.1 Alarm check valve to NFPA 13 and ULC listed for fire service.

.2 Provide variable pressure type alarm valve complete with retarding chamber, alarm test valve, alarm shutoff valve, drain valve, pressure gages, accessories, and appurtenances for proper operation of system.

.3 Provide valve complete with internal components that are replaceable without removing the valve from the installed position.

2.6 WATER MOTOR ALARMS

.1 Provide alarms approved weatherproof and guarded type, to sound locally on flow of water in each corresponding sprinkler system.

.2 Mount alarms on outside of outer walls of each building at location as directed.

.3 Provide separate drain piping directly to exterior of building.

2.7 SUPERVISORY SWITCHES

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

.2 Valves:

.1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.

.3 Pressure or flow switch type:

.1 With normally open and normally closed contacts and supervisory capability.

.2 Provide switch with circuit opener or closer for automatic transmittal of alarm over facility fire alarm system.

.3 Connect into building fire alarm system.

.4 Connection of switch: Section 28 31 00 - Fire Alarm System.

.5 Alarm actuating device: mechanical diaphragm-controlled retard device adjustable from 10 to 60 seconds and instantly recycle.

.4 Pressure alarm switch:

.1 With normally open and normally closed contacts and supervisory capability.

2.8 FIRE DEPARTMENT CONNECTION

.1 Provide connections approximately 1.5 m above finish grade, location as indicated.

.2 To NFPA 13 and ULC S543 listed.

.3 Polished chrome plated exposed of approved two-way type with 2.5-inch National Standard female hose threads with plug, chain, and identifying fire department connection escutcheon plate.

.4 Thread specifications: compatible with local fire department.

.5 Install a 90-degree elbow with drain connection at the low-point near each fire department connection to allow for system drainage to prevent freezing.

2.9 PRESSURE GAUGES

.1 ULC listed and to Section 23 05 19.01 - Thermometers and Pressure Gauges - Piping Systems.

.2 Maximum limit of not less than twice normal working pressure at point where installed.

2.10 PIPE SLEEVES

.1 Provide pipe sleeves where piping passes through walls and concrete ceiling

.2 Secure sleeves in position and location during construction.

.3 Provide sleeves of sufficient length to pass through entire thickness of walls and concrete ceilings.

.4 Provide 2.5 cm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.

.1 Firmly pack space with mineral wool insulation.

.2 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass, provide mechanically adjustable segmented elastomeric seal.

.3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.

.4 In acoustic rated walls, sealed both ends of pipe sleeves or core-drilled holes with acoustic caulking.

.5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:

.1 Provide ductile-iron cast-iron sleeves.

.2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.

.6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:

.1 Provide 0.6 mm thick galvanized steel sheet.

2.11 ESCUTCHEON PLATES

.1 Provide one-piece type metal plates for piping passing through walls and ceilings in exposed spaces.

.2 Provide polished chromium-plated finish on copper alloy plates in finished spaces.

.3 Provide paint finish on metal plates in unfinished spaces.

2.12 INSPECTOR'S TEST CONNECTION

.1 Locate inspector's test connection at hydraulically most remote part of each system or at riser manifold.

.2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.

.3 Provide discharge orifice of same size as corresponding sprinkler orifice.

2.13 SIGNS

.1 Attach properly lettered and approved metal signs to each valve and alarm device to NFPA 13.

.2 Permanently fix hydraulic design data nameplates to riser of each system.

2.14 SPARE PARTS CABINET

.1 Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each alarm valve. Number and types of extra sprinkler heads as specified in NFPA 13.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

3.3 PIPE INSTALLATION

.1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.

.2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.

.3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.

.4 Inspect piping before placing into position.

3.4 ELECTRICAL CONNECTIONS

.1 Electrical connections to the sprinkler system are by Division 26. Sprinkler contractor is to coordinate all work with electrical contractor.

3.5 FIELD PAINTING

.1 Clean, pre-treat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.

.2 Apply coatings to clean, dry surfaces, using clean brushes.

.3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.

.4 Immediately after cleaning, provide metal surfaces with 1 coat of pre-treatment primer applied to minimum dry film thickness of 0.3 ml, and one coat of zinc chromate primer applied to minimum dry film thickness of 1.0 ml.

.5 Shield sprinkler heads with protective covering while painting is in progress.

.6 Upon completion of painting, remove protective covering from sprinkler heads.

.7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.

.8 Provide primed surfaces with following:

.1 Piping in Finished Areas:

.1 Provide primed surfaces with 2 coats of paint to match adjacent surfaces.

.2 Provide valves and operating accessories with 1 coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil.

.3 Provide piping with self-adhering red plastic bands 50 mm wide red enamel bands spaced at maximum of 6 m intervals throughout piping systems and on each side of walls.

.2 Piping in Unfinished Areas:

.1 Provide primed surfaces with one coat of red alkyd gloss enamel applied to minimum dry film thickness of 1.0 mil in spaces above suspended ceilings, pipe chases, mechanical equipment rooms, spaces where walls or ceiling are not painted or not constructed of a prefinished material.

3.6 FIELD QUALITY CONTROL

.1 Site Test, Inspection:

.1 Perform test to determine compliance with specified requirements.

.2 Test, inspect, and approve piping before covering or concealing.

.3 Preliminary Tests:

.1 Hydrostatically test each system at 200 psig for a 2-hour period with no leakage or reduction in pressure.

.2 Flush piping with potable water in accordance with NFPA 13.

.3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.

.4 Test alarms and other devices.

.5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.

.4 Formal Tests and Inspections:

.1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.

.2 Submit written request for formal inspection at least 15 days prior to inspection date.

.3 Repeat required tests as directed.

.4 Correct defects and make additional tests until systems comply with contract requirements.

.5 Furnish appliances, equipment, instruments, connecting devices, personnel for tests.

.6 Authority of Jurisdiction may witness formal tests and approve systems before they are accepted. Notify consultant and authority having jurisdiction prior to testing

.2 Manufacturer's Field Services:

.1 Provide manufacturer's field services consisting of product use recommendations.

.2 Testing to be witnessed by Fire Commissioner of Canada.

3.7 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

.1 NFPA 10, Standard for Portable Fire Extinguishers.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.

.3 Provide shop drawings.

.4 Closeout Submittals:

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Waste Management and Disposal:

.1 Separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MULTI-PURPOSE DRY CHEMICAL EXTINGUISHERS (All locations unless otherwise indicated)

.1 Stored pressure rechargeable type with hose and shut-off nozzle, ULC labelled for A, B and C class protection.

.1 Size 4.5kg.

2.2 CARBON DIOXIDE (Where indicated)

.1 Extinguishers Insulated handle, hose and horn discharge assembly, self-closing lever or squeeze-grip operation, fully charged, ULC labelled for B and C class protection.

.1 Sizes 2.25 kg.

2.3 EXTINGUISHER BRACKETS

.1 Type recommended by extinguisher manufacturer.

2.4 CABINETS

.1 Semi-recessed type as indicated, constructed of 1.6 mm thick steel, 180 degrees opening door of 2.5 mm thick steel with latching device.

.2 Cabinet to maintain fire resistive rating of construction in which they occur.

.3 Cabinet door:

.1 With 5 mm full glass panel

.2 Solid metal where indicated for secure area c/w/ door.

.4 Finish:

.1 Tub: prime coated.

.2 Door and frame: No.4 satin finish stainless steel.

2.5 IDENTIFICATION

.1 Identify extinguishers in accordance with recommendations of NFPA 10 and CAN/ULC-S508.

.2 Label to extinguishers, indicating month and year of installation. Provide space for service dates.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install or mount extinguishers in cabinets or on brackets as indicated NFPA 10.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Provide manufacturer's field services consisting of product use recommendations in accordance with manufacturer's instructions.

END OF SECTION

1. General

1.1 SCOPE

.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 Operating and Maintenance Manuals

.3 Record Drawings

1.2 QUALITY ASSURANCE

.1 Work specified in this section shall be performed by an Independent Agency specializing in this type of work.

1.3 REFERENCES

.1 Division 00

.2 Division 01

.3 Division 21

.4 Division 23

2. Products

2.1 OPERATING AND MAINTENANCE MANUALS

.1 Refer to Section 01 78 00, Close Out Procedures.

2.2 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 216 mm x 280 mm, three (3) post, expanding spine type, with metal piano hinges and bound with heavy fabric.

.4 Maximum binder thickness when filled shall not exceed 100 mm, including a space allowance for 10% additional data.

.5 Binder colour shall be blue, Ontario buckram fabric, colour #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.

.8 Contractor to submit proof of cover layout for review prior to ordering binders.

2.3 **TABS**

.1 The divider tabs shall be laminated Mylar plastic and coloured 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 colouring for tabs for individual sections is as follows:

.1 Yellow Miscellaneous Systems

.2 Purple Plumbing Systems

2.4 **MANUAL DIVISIONS**

.1 Organize each manual into the following divisions.

.1 Operation Division

.2 Maintenance Division

.3 Contract Documentation Division

2.5 **OPERATIONS DIVISIONS**

.1 The operations division shall have all data organized into sections according to the system category with individual divider tabs as follows:

.1 MIS Miscellaneous Systems

.2 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 Future load allowances

.2 Standby capabilities

.3 Calculated load and design capacity of domestic water supply mains.

.4 Calculated load and design capacity of drainage mains.

.2 System Schematic - Provide a system schematic showing all components comprising the domestic hot/cold/recirculation water systems, fuel oil system, compressed air system.

.3 Operating Instructions - Provide, in "operator" layman language, the specific instructions for start-up, shutdown and seasonal changeover 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 Equipment Identification - Provide data for each system component on equipment identification forms equal to the standard forms obtained from the design consultant.

The consultant shall provide one sample reproducible copy of a form for use by the contractor. New forms produced by the contractor shall follow the same format as the sample form and contain all required information.

.5 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 Tags and 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 manufacturer’s maintenance brochures, for each component of each system in the following format:

.1 Daily.
.2 Weekly.
.3 Monthly.
.4 Semi-annually.
.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.

.6 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.

.7 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

.4 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.

.5 The second copy shall be returned to the contractor with review comments.

.6 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.

2.6 **RECORD DRAWINGS**

.1 Refer to Section 01 77 19, Contract Close-Out Requirements.

.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.

.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.

3. Execution

3.1 **GENERAL**

.1 Submit documents to the Engineer for approval prior to transmitting to the Owner.

3.2 **RECORD DRAWINGS**

.1 Enter dimensions from building line to all buried services, including coordinates of manholes, catch basins, tanks, outside shut-off valves, and other similar elements.

.2 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.

.3 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.

.4 At substantial completion, transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, to a set of disks to AutoCAD. Drafting quality layers, symbols, etc. shall be identical to original drawings. Prior to substantial performance, turn over a completed set of disks.

.5 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.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Coordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.

.3 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet for fixtures and equipment.

.2 Submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.

.4 Shop Drawings.

.1 Submit shop drawings to indicate:

.1 Equipment, including connections, fittings, control assemblies and ancillaries. Identify whether factory or field assembled.

.2 Wiring and schematic diagrams.

.3 Dimensions and recommended installation.

.4 Pump performance and efficiency curves.

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

.6 Instructions: submit manufacturer's installation instructions.

.7 Manufacturers' Field Reports: manufacturers' field reports specified.

.8 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, include:

.1 Manufacturers name, type, model year, capacity and serial number.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list with names and addresses.

1.3 QUALITY ASSURANCE

.1 Pre-Installation Meeting:

.1 Convene pre-installation meeting prior to beginning on-site installations in accordance with Section 01 32 16.06 - Construction Progress Schedule

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

.2 Health and Safety:

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section01 47 19 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Unused sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 MATERIALS

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

2.2 DOMESTIC HOT WATER CIRCULATING PUMPS

.1 Capacity: as indicated.

.2 Construction: closed-coupled, in-line centrifugal, all bronze construction shaft, stainless steel or bronze shaft sleeve, two oil lubricated bronze sleeves or ball bearings. Design for 1375 kPa and 105 degrees C continuous service.

.3 Motor: drip-proof, with thermal overload protection.

.4 Supports: provide as recommended by manufacturer.

2.3 SUMP PUMP SUBMERSIBLE

.1 Capacity: as indicated.

.2 Construction: CSA approved, housing epoxy coated cast iron, stainless steel shaft, non-clog bronze impeller, mechanical shaft seal.

.3 Motor: hermetically sealed, with automatic overload protection.

.4 Control: mercury switches and control box.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.2 INSTALLATION

.1 Make piping and electrical connections to pump and motor assembly and controls as indicated.

.2 Ensure pump and motor assembly do not support piping.

.3 Align vertical pit mounted pump assembly after mounting and securing cover plate.

.4 Place 150 mm sand under sump pit tank.

3.3 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Check power supply.

.2 Check starter protective devices.

.2 Start-up, check for proper and safe operation.

.3 Check settings and operation of hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.

.4 Adjust flow from water-cooled bearings.

.5 Adjust impeller shaft stuffing boxes, packing glands.

.6 Verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification, include:

.1 Materials and resources.

.2 Storage and collection of recyclables.

.3 Construction waste management.

.4 Resource reuse.

.5 Recycled content.

.6 Local/regional materials.

.7 Certified wood.

.8 Low-emitting materials.

3.4 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Procedures:

.1 Check power supply.

.2 Check starter O/L heater sizes.

.3 Start pumps, check impeller rotation.

.4 Check for safe and proper operation.

.5 Check settings, operation of operating, limit, safety controls, over-temperature, audible/visual alarms, other protective devices.

.6 Test operation of hands-on-auto switch.

.7 Test operation of alternator.

.8 Adjust leakage through water-cooled bearings.

.9 Adjust shaft stuffing boxes.

.10 Adjust leakage flow rate from pump shaft stuffing boxes to manufacturer's recommendations.

.11 Check base for free-floating, no obstructions under base.

.12 Run-in pumps for 12 continuous hours.

.13 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.14 Adjust alignment of piping and conduit to ensure full flexibility.

.15 Eliminate causes of cavitation, flashing, air entrainment.

.16 Measure pressure drop across strainer when clean and with flow rates as finally set.

.17 Replace seals if pump used to degrease system or if pump used for temporary heat.

.18 Verify lubricating oil levels.

3.5 REPORTS

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.

.2 Include:

.1 PV results on approved PV Report Forms.

.2 Product Information report forms.

.3 Pump performance curves (family of curves) with final point of actual performance.

3.6 TRAINING

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

- .1 ANSI/ASME B16.15-[06], Cast Bronze Threaded Fittings, Classes 125 and 250.
- .2 ANSI/ASME B16.18-[01], Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ANSI/ASME B16.22-[01], Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .4 ANSI/ASME B16.24-[01], Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.

.2 ASTM International Inc.

- .1 ASTM A307-[07b], Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM A536-[84(2004)e1], Standard Specification for Ductile Iron Castings.
- .3 ASTM B88M-[05], Standard Specification for Seamless Copper Water Tube (Metric).

.3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA)

- .1 ANSI/AWWA C111/A21.11, 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 Department of Justice Canada (Jus)

- .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

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

- .1 Material Safety Data Sheets (MSDS).

.7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).

- .1 MSS-SP-67 Butterfly Valves.
- .2 MSS-SP-70 Gray Iron Gate Valves, Flanged and Threaded Ends.
- .3 MSS-SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
- .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

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

- .1 NRCC 38728, National Plumbing Code of Canada (NPC) - 2015

.9 Transport Canada (TC)

- .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Closeout Submittals:

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with Section 02 81 01.

.2 Packaging Waste Management: remove for reuse and in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

Part 2 Products

2.1 PIPING

.1 Domestic hot, cold and recirculation systems, within building.

.1 Above ground: copper tube, hard drawn, type K to ASTM B88M.

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

2.2 FITTINGS

.1 Bronze pipe flanges and flanged fittings, Class 300: to ANSI/ASME B16.24.

.2 Cast bronze threaded fittings, Class 250: to ANSI/ASME B16.15.

.3 Cast copper, solder type: to ANSI/ASME B16.18.

.4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.

.5 NPS 2 and larger: ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.

.6 NPS 1 and smaller: wrought copper to ANSI/ASME B16.22 cast copper to ANSI/ASME B16.18; with 301stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.

2.3 JOINTS

.1 Solder: 95/5

.2 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.

2.4 GATE VALVES

.1 NPS 2 1/2 and over, in mechanical rooms, flanged:

.1 Rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, OS Y bronze trim specified Section 23 05 23.02 - Valves - Cast Iron.

.2 NPS 2 1/2 and over, other than mechanical rooms, flanged:

.1 Non-rising stem: to MSS-SP-70, Class 125, 860 kPa, flat flange faces, cast-iron body, bronze trim, bolted bonnet specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.5 GLOBE VALVES

.1 NPS2 and under, soldered:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 23.01 - Valves - Bronze.

.2 Lock shield handles:

2.6 SWING CHECK VALVES

.1 NPS 2 and under, soldered:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.

.2 NPS 2 and under, screwed:

.1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.

.3 NPS 2 1/2 and over, flanged:

.1 To MSS-SP-71, Class 125, 860 kPa, cast iron body, flat flange faces, renewable seat, bronze disc, bolted cap specified Section 23 05 23.02 - Valves - Cast Iron: Gate, Globe, Check.

2.7 BALL VALVES

.1 NPS 2 and under, screwed:

.1 Class 150.

.2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland, seat, steel lever handle as specified Section 23 05 23.01 - Valves - Bronze

.2 NPS 2 and under, soldered:

.1 To ANSI/ASME B16.18, Class 150.

.2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland, seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23.01 - Valves - Bronze.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install in accordance with NPC 2015 AND local authority having jurisdiction.

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

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.

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

.6 Buried tubing:

.1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.

.2 Bend tubing without crimping or constriction. Minimize use of fittings.

3.3 VALVES

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

.2 Balance recirculation system using lock shield globe valves. Mark settings and record on as-built drawings on completion.

3.4 PRESSURE TESTS

.1 Conform to requirements of Section 21 05 01 - Common Work Results for Mechanical.

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

3.5 FLUSHING AND CLEANING

.1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean to Provincial potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

3.6 PRE-START-UP INSPECTIONS

.1 Systems to be complete, prior to flushing, testing and start-up.

.2 Verify that system can be completely drained.

.3 Ensure that pressure booster systems are operating properly.

.4 Ensure that air chambers, expansion compensators are installed properly.

3.7 DISINFECTION

.1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction.

.2 Coordinate with Section 33 11 16- Irrigation and Section 33 11 00 - Water Utility Distribution Piping.

.3 Upon completion, provide laboratory test reports on water quality Consultant approval.

3.8 START-UP

.1 Timing: start up after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

.3 Start-up procedures:

.1 Establish circulation and ensure that air is eliminated.

.2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.

.3 Bring HWS storage tank up to design temperature slowly.

.4 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.

.5 Check control, limit, safety devices for normal and safe operation.

.4 Rectify start-up deficiencies.

3.9 PERFORMANCE VERIFICATION

.1 Scheduling:

.1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.

.2 Procedures:

.1 Verify that flow rate and pressure meet Design Criteria.

.2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.

.4 Sterilize HWS and HWC systems for Legionella control.

.5 Verify performance of temperature controls.

.6 Verify compliance with safety and health requirements.

.7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.

.8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.

.3 Reports:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning (Cx) Requirements]: Report Forms and Schematics.

.2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.10 OPERATION REQUIREMENTS

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

3.11 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials for recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM B32, Standard Specification for Solder Metal.

.2 ASTM B306, Standard Specification for Copper Drainage Tube (DWV).

.3 ASTM C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.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-B125.3, Plumbing Fittings.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-36, Commercial Adhesives.

.4 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

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

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

.3 Packaging Waste Management: remove in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 COPPER TUBE AND FITTINGS

.1 Above ground sanitary, storm, and vent Type DWV to: ASTM B306.

.1 Fittings.

.1 Cast brass: to CAN/CSA-B125.3.

.2 Wrought copper: to CAN/CSA-B125.3.

.2 Solder: lead free to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

.1 Above ground storm to CAN/CSA-B70.

.1 Joints:

.1 Hub and spigot:

.1 Caulking lead: to CSA B67.

.2 Mechanical joints:

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

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 In accordance with Section 23 05 01 - Use of HVAC Systems During Construction.

.2 Install in accordance with National Plumbing Code.

3.3 TESTING

.1 Pressure test buried systems before backfilling.

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

3.4 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil and re-seal.

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

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

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

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

.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International Inc.

.1 ASTM D2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

.2 ASTM D2564, Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International)

.1 CAN/CSA-Series B1800-, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-36, Commercial Adhesives.

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

.1 Material Safety Data Sheets (MSDS).

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

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

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

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: remove in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIAL

.1 Adhesives and Sealants: in accordance with Section 07 92 00 - Joint Sealants.

2.2 PIPING AND FITTINGS

.1 For buried Sanitary, Storm, and DWV piping:

.1 PVC-DWV :CAN/CSA B1800.

.2 For above ground Sanitary and DWV piping to:

.1 PVC-XFR

2.3 JOINTS

.1 Solvent weld for PVC: to ASTM D2564.

.2 Solvent weld for ABS: to ASTM D2235.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

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

.2 Install in accordance with National Plumbing Code.

3.3 TESTING

.1 Pressure test buried systems before backfilling.

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

3.4 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure accessible and that access doors are correctly located.

.2 Open, cover with linseed oil and re-seal.

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

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

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Ensure weirs are correctly sized and installed correctly.

.3 Verify provisions for movement of roof system.

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

.5 Affix applicable label storm, sanitary, vent, pump discharge c/w directional arrows every floor or 4.5 m whichever is less.

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials] in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute/Canadian Standards Association (ANSI/CSA)

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

.2 Canadian Standards Association (CSA International)

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

.2 CAN/CSA-B149.1, Natural Gas and Propane Installation Code.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for domestic water heater, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate:

.1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

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

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

.3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 WARRANTY

.1 For the Work of this Section 22 30 05 - Domestic Water Heaters, 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to number of years specified for each product.

Part 2 Products

2.1 GAS (POWER BURNER) WATER HEATER

.1 As indicated on drawings.

.2 Gas burner: complete with high limit control, gas valve, gas pressure regulator, 100% safety shut-off, firepower gas burner with air distribution ring.

.3 3-year warranty certificate.

2.2 TRIM AND INSTRUMENTATION

.1 Drain valve: NPS 1 with hose end.

.2 Thermometer: 100 mm dial type with red pointer and thermowell filled with conductive paste.

.3 Pressure gauge: 75 mm dial type with red pointer and shut-off cock.

.4 Thermowell filled with conductive paste for control valve temperature sensor.

.5 ASME rated temperature and pressure relief valve sized for full capacity of heater having discharge terminating over floor drain and visible to operators.

.6 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

2.3 ANCHOR BOLTS AND TEMPLATES

.1 Supply anchor bolts and templates for installation in concrete support pad in accordance with Section 03 30 00 - Cast-in-Place Concrete

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.

.2 Provide insulation between tank and supports.

.3 Install natural gas fired domestic water heaters in accordance with CAN/CSA-B149.1.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.

3.4 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Plumbing fixtures and trim

.2 Thermostatic 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 of 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.

1.4 SUBMITTALS

.1 Submit shop drawings for review.

Part 2 Products

2.1 WATER CLOSET (WC-1)

.1 Bowl: **American Standard Madera** floor mount flushometer valve toilet, 381mm height, vitreous china, elongated bowl, low consumption 4.2LPF, EverClean surface, fully glazed 54mm trapway, 38mm IOF spud inlet, 2 bolt caps, direct-fed siphon jet action, condensation channel. 1000gram MaP score, Provide floor flange, flange bolts and gasket. ADA compliant.

.2 Seat: Heavy duty, open front, less cover w/ slow close hinges. American Standard #5901.100

.3 Flush Valve: **Sloan Royal 111-1.6-CP Royal Exposed Manual Flushometer For Top Spud Toilet,** polished chrome finish, 6 L (1.6 US Gal) factory set flow, quiet action 'PERMEX' diaphragm type with dual filter by-pass, non-hold open feature, A.D.A triple seal oscillating handle, V.P. Smooth design stop cap on bak-chek angle stop (screwdriver operated), high pressure vacuum breaker.

2.2 WATER CLOSET (WC-2)

.1 Bowl: **American Standard Madera** floor mount flushometer valve toilet, 419mm height, vitreous china, elongated bowl, low consumption 4.2LPF, EverClean surface, fully glazed 54mm trapway, 38mm top spud inlet, 2 bolt caps, direct-fed siphon jet action, condensation channel. 1000gram MaP score, Provide floor flange, flange bolts and gasket. ADA compliant.

.2 Seat: Heavy duty, open front, less cover w/ slow close hinges. American Standard #5901.100

.3 Flush Valve: **Sloan Royal 111-1.6-CP Royal Exposed Manual Flushometer For Top Spud Toilet,** polished chrome finish, 6 L (1.6 US Gal) factory set flow, quiet action 'PERMEX' diaphragm type with dual filter by-pass, non-hold open feature, A.D.A triple seal oscillating handle, V.P. Smooth design stop cap on bak-chek angle stop (screwdriver operated), high pressure vacuum breaker.

2.3 WATER CLOSET (WC-3)

.1 Base: **Acorn LR1440 Series**, Floor mounted, Ligature-resistant 450mm combination LAV/Toilet, Suicide Resistant Combination Fixture, serviceable from accessible pipe chase, wall sleeve, 14gauge type 304 stainless steel, seamless welded construction, polished satin finish, sound-deadened with fire resistant material, hemispherical cabinet, 190mm wall thickness, wall waste outlet. Toilet is concealed blowjet type with elongated bowl, self-draining rim and integral seat with high polish finish, trap has 89mm seal and will pass 54mm ball, provide 1.28 GPF flush valve. Lavatory is 380x330x140mm lavatory “D” bowl w/ standard 40mm waste outlet. Lavatory Valve: Dual temperature, pneumatic metering, push button valve requiring less than 35kPa to activate, and comply with NSF61. Provide hemispherical penal bubbler BPH with hemispherical penal pushbutton. Wall Template. Toilet Overflow Preventer. Provide additional lead-free thermostatic mixing valve to meet ASSE 1070, Bradley S59-4008. **CONFIRM ORIENTATION PRIOR TO ORDERING.**

2.4 URINAL (UR-1)

.1 Urinal: Vitreous china, wash out, wall hung urinal with flushing rim, extended shields, integral trap, stainless steel strainer, 20 mm back spud and steel support hangers. **American Standard “Washbrook #6590.525**.

.2 Flush Valve: **Sloan #186-0.125 HEU-SG** Exposed, high efficiency urinal flush valve unit for 200m top spud urinal, low consumption (0.5 Lpf), factory set flow, quiet action, dual linear filtered bypass diaphragm, adjustable tailpiece, vacuum breaker, ADA compliant, non-hold-open handle extended. Saniguard antimicrobial coating on handle

2.5 LAVATORY (LAV-1)

.1 Lavatory: Vitreous china, wall hung lavatory with recessed self-draining deck, integral back, rectangular basin, rear overflow, chrome plated supplies and stops, chrome adjustable "P-trap" with extension, Vitreous china shroud/knee contact guard model 0059.020EC, **American Standard Model “Murro” No. 0954.004EC**, complete with concealed arm carrier, Watts Model CA-411.

.2 Trim: **American Standard Model 5500.170.002 Monterrey Two handles Faucet,** Polished Chrome finish, Cast brass body, Aerator outlet, Cast brass spout, 95 mm (3-3/4") projection, 4" (102 mm) long vandal resistant red and blue indexed wrist blade handles, 13 mm (1/2") male threaded inlet shanks with brass coupling nuts.

2.6 LAVATORY (LAV-2)

.1 Lavatory: Vitreous china, white, self-rimming, counter-top lavatory, two rear overflow holes, faucet deck, faucet holes 102mm on center, 441mm x 279mmx 133mm, ADA compliant, 32mm trap, chrome adjustable "P-trap" with extension, P-Trap to be insulated and cladded. **American Standard Cadet Universal Counter-Top Sink**

.2 Trim: ADA Complaint, **American Standard Model 5500.170.002 Monterrey Two handles Faucet,** Polished Chrome finish, Cast brass body, Aerator outlet, Cast brass spout, 95 mm (3-3/4") projection, 4" (102 mm) long vandal resistant red and blue indexed wrist blade handles, 13 mm (1/2") male threaded inlet shanks with brass coupling nuts.

2.7 STAINLESS STEEL SINGLE COMPARTMENT SINK (SK-1)

.1 Bowl: Compartment size of 355mm x 410mm x 175mm, Overall size 460mm x 475mm x 175mm ., Type 302 stainless steel self-rimming bowl single compartment with under coating, 90 mm. crumb cup, 3 holes drilled in ledgeback complete with under deck clamps. **Kindred LBS4607-1/3.**

.2 Trim: Sink supply faucet, heavy duty cast brass, 203mm center two handle, polished chrome plated finish, brass swing spout, metal hold-down package, 5.7L/min vandal resistant flow control aerator, 76mm hooded lever handles (with temperature indicator). ADA compliant **DELTA 26C3142-TI-LS**

2.8 STAINLESS STEEL DOUBLE COMPARTMENT SINK (SK-2)

.1 Bowl: Compartment size of 410mm x 360mm x 200mm, Overall size 520mm x 790mm x 200mm ., Type 302 stainless steel self-rimming bowl double compartment with under coating, 90 mm. crumb cup, 4 holes drilled in ledge back complete with under deck clamps. **Kindred LBS6408-4.**

.2 Trim: Sink handle kitchen deck faucets for exposed mounting on three-hole sink, metal fabricated body, 221mm long spout w/ 180-degree swing, 5.7L/min vandal resistant aerator, lever handle shall return to neutral position when faucet is off, red/blue indicator on handle, diamond coated ceramic cartridge for control mechanism, adjustable handle limit stop, 1143mm hose and spray attachment w/ anti-siphon device. ADA compliant **DELTA 400LF-HDF**

2.9 STAINLESS STEEL SINK (SK-3)

.1 Bowl: Compartment size of 410mm x 460mm x 200mm, Overall size 520mm x 510mm x 200mm ., Type 302 stainless steel self-rimming bowl single compartment with under coating, 3 holes drilled in ledge back complete with under deck clamps. **Kindred LBS6808-3**.

.2 Trim: Sink supply faucet, heavy duty cast brass, 203mm center two handle, polished chrome plated finish, brass swing spout, metal hold-down package, 5.7L/min vandal

resistant flow control aerator, 76mm hooded lever handles (with temperature indicator). ADA compliant **DELTA 26C3142-TI-LS**

2.10 STAINLESS STEEL SINK (SK-4)

.1 Bowl: Single compartment size of 580mm x 430mm x 200mm, Overall size 640mm x 560mm x 200mm, Type 18-8 stainless steel self-rimming bowl single compartment with under coating, 3 holes drilled in ledge back complete with under deck clamps. **Kindred QSLY2225/8**.

.2 Trim: Sink supply faucet, heavy duty cast brass, 203mm center two handle, polished chrome plated finish, brass swing spout, metal hold-down package, 5.7L/min vandal resistant flow control aerator, 76mm hooded lever handles (with temperature indicator). ADA compliant **DELTA 26C3942-TI-LS**

.3 **Accessories**: Provide point of use acid neutralization molded cartridge tank below sink SK-4 located in room 155. Tank to be constructed from chemical resistant Polypropylene. Piping and waste assembly to acid neutralization tank to be meet the requirements of ASTM D410, ASTm F1412, ASTM D635. Provide sampling port on the outlet of the side downstream of neutralization tank. Cartridge Neutralization Tank: **Zurn model Z9A** complete with manufacturer's support bracket, bucket, siphon pump and hose, and prescribed media package. Provide a 6-month supply of media and litmus sample strips from manufacturer. Provide owner with local supplier information. Confirm media type with manufacturer based on owner requirements.

2.11 STAINLESS STEEL SINK (SK-5)

.1 Bowl: single compartment with drain board, self-rimming, faucet ledge, 1.2mm type 304 stainless steel, #4 stain finish on exposed surfaces, undercoated to reduce condensation, rim seal, cut out template, crumb cup strainer, centre back waste, **FRANKE LBSDBR6408P-1** (or equivalent). Confirm which side drain board should be on.

.2 Trim: T & S Brass and Bronze Works model B-0507 single pedal valve and B-0524 gosseneck spout. See attached. Waste fitting: integral stainless steel basket strainer/stopper, tailpiece, cast brass P-trap with cleanout. Provide and install below deck thermostatic mixing valve **Watts LFMMV**.

2.12 STAINLESS STEEL SINK (SK-6)

.1 Bowl: 1500mm x 1638mm x 640mm self standing, Fully welded one piece tub, built in 1" slope, 1.9mm type 304 stainless steel, Swinging door, swivel ramp, high backsplash, tie-down rail located on backsplash, Fully welded tubing underframe stand with adjustable feet, HDPE elevated / floor grates incased in 304 stainless steel frame, basket drain, hair trap, stainless steel SRQ1 quart shampoo rack, 100mm center set faucet with 1800mm stainless steel hose and sprayer, **Tristar Vet Swival Ramp Tub Model 800-10**. Confirm which side drain board should be on.

2.13 SHOWER (SH-1)

.1 Trim: Pressure balancing thermostatic shower mixing valve with integral volume control, 9.5 lpm (2.5 gpm) #4-151 single mode shower head mounting bracket with ball joint shower head, complete with integral service stops, single blade style lever handle with

adjustable stop screw, chrome plated brass escutcheon, chrome plated brass dome cover, anchor plate for mounting of showerhead on ceramic tile, 30 spray shower head spray angle. Symmons Shower System No. C-96-1-151-X-B. Note: Specify reverse core (-REV) in valve for back to back installations, refer to drawings for instances where this occurs.

.2 Drain: Refer to FD-3

.3 Enclosure: Built in place tiled surround, refer to architectural dwgs and specifications. Curtain rod, rings and curtain by architectural.

2.14 SHOWER (SH-2)

.1 Trim: ADA Compliant, hand shower system with lever handle consisting of; pressure balancing thermostatic shower mixing valve with integral volume control, integral service stops, single blade style lever handle with adjustable stop screw, chrome plated brass escutcheon, chrome plated brass dome cover, T-300-V, 9.5 lpm (2.5 gpm) wall/hand shower with 1500mm flexible metal hose, in line vacuum breaker, wall connection and cradle for hand shower mounting, 760mm (30") slide bar, vandal resistant escutcheon screws. Symmons Hand Shower System No. C-96-300-B30-V-X-VP.

.2 Drain: Refer to FD-3

.3 Enclosure: Built in place tiled surround, refer to architectural dwgs and specifications. Curtain rod, rings and curtain by architectural

2.15 SHOWER (SH-3)

.1 Trim: **ACORN Penal-Ware 1741 Series**, type 304 stainless steel components with exterior polished to stain finish. 50mm projecting chrome plated brass vandal-resistant showerhead, tapered end to prevent suicide, wall sleeve, pneumatically operated push-button valve using atmospheric air, 9.5L/min, push-button control (located on adjacent side of wall). All tubing, connector hoses, nuts, and support plates which support shower head and the pushbutton control ate to e located inside the galvanized wall sleeve. The only visible items on the "Chase Side" (back of the wall sleeve) will be the secure mounting screws, securing a contractor is provided with a stainless-steel cover over the top of the wall sleeve. Cover to be a minimum 3.4MM (10 gauge 304 stainless)

.2 Thermostatic Mixing Valve, copper encapsulated thermostatic assembly with Teflon coated shuttle, combination checkstops, unions on inlets, wall support, locking temperature regulating handle, tempered outlet ball valves, colour coded dial thermometer, 32-60C temperature adjustment range, top inlets, top outlet, wall bracket, factory assembled and tested, **LEONARD XL-32a-LF-BDT-TOP-VP.**

2.16 MOP SINK (MS-1)

.1 Bowl: 600 mm x 600 mm x 250 mm deep white molded stone, floor mounted sink with 25 mm wide shoulders and stainless-steel strainer. **Fiat Model No. MSB-2424**.

.2 Trim: Exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose end spout, aerator, pail hook, vinyl bumper guards, stainless steel wall guards, eccentric adjustable inlets, integral screw drivers stops with covering caps and adjustable

threaded wall flanges, 1500 mm of 15 mm. plain end reinforced rubber hose, hose clamp, mop hanger. Trim to be mounted 900 mm up off the floor. **Fiat 830-AA**.

2.17 EMERGENCY SHOWER & EYEWASH STATION (ESH-1)

.1 Standard, plumbed emergency barrier free shower with eyewash combination unit. Eyewash: 5.1 gpm (0.321 L/s) with type 316 stainless steel spray head, bowl and dust cover. Showerhead: 22 gpm (1.38 L/s) flow rate, type 316 stainless steel head with stainless steel shroud. 25mm shower ball valve and 12mm stay-open eye and eye/face wash valve manufactured of type 316 stainless steel. Barrier free pull rod handle made of type 316 stainless steel. **Bradley S19314BFSS**.

.2 Thermostatic Mixing Valve: meets ANSI Z358.1, liquid filled thermostat w/ 10year warranty, checkstops on inlet, vandal resistant temperature adjustable set point, built-in cold-water bypass, positive shut-off of hot when cold supply is lost, dial thermometer, factory assembled and tested, located inside manufacturers surface mounted stainless-steel cabinet. **Bradley S19-2100EFX**.

2.18 EMERGENCY EYEWASH STATIONS (EW-1)

.1 Barrier-free cabinet concealed swing down eye/face wash. Meets ANSI Z358.1, concealed fixture, activated with opening of stainless-steel door, corrosion resistant stainless-steel cabinet, internal drain, chrome-plated brass pipe and fittings, universal sign and inspection tag, spring softened opening, flush mounting in wall, bottom fed thermostatic mixing valve, maintenance compartment below fixture, 30mm drain with tailpiece, **Bradley S19-294HBT.**

.2 Thermostatic Mixing Valve: meets ANSI Z358.1, liquid filled thermostat w/ 10year warranty, checkstops on inlet, vandal resistant temperature adjustable set point, built-in cold-water bypass, positive shut-off of hot when cold supply is lost, dial thermometer, factory assembled and tested. **Bradley S19-2000EFX.**

2.19 DRINKING FOUNTAIN: DF-1

.1 Fountain: Self-contained, wall mounted, refrigerated water cooler with bottle filling station, mechanically activated pushbar operation, electronic sensor for touchless bottle filler, laminar flow 5.7 lpm bottle filler, 11000L filter with visual monitor to indicate replacement, ADA certified, lead free design, stainless steel basin with integral drain and bubbler, light gray granite. Cooling system: hermetically-sealed single-phase compressor, fan-cooled, permanent lubricated fan motor, fully insulated, adjustable thermostat. **ELKAY EZH2O MODEL LMABF8WS** (Supply unit with 51300C_3PK replacement filters)

2.20 HOSE BIBB (NFHB) – EXTERIOR NON-FREEZE

.1 **Watts HY-725 Non-Freeze** Wall Hydrant, concealed non-freeze key operated wall hydrant with nickel bronze box and door, chrome plated hydrant face, self-draining integral vacuum breaker, 19 mm hose connection, all bronze head, loose key

2.21 HOSE BIBB – INTERIOR

.1 **Acorn #8121CP 'NEPTUNE'** Hose Valve, heavy duty polished chrome cast brass body with integral cast flange, vandal-resistant lock shield bonnet with removable wheel handle, 19mm NPT female inlet and hose end vacuum breaker.

2.22 FLOOR DRAIN (FD-1)

.1 **Watts FD-100-A** Floor Drain, epoxy coated cast iron body with anchor flange, reversible clamping collar with primary & secondary weep holes, adjustable 127 mm round nickel bronze strainer, no hub outlet, trap primer connection.

2.23 FLOOR DRAIN (FD-2)

.1 **Watts Model FS-740** Floor Sink, Floor drains in water meter / sprinkler tree rooms shall be 300x300x200deep floor sink with a porcelain enamel coated iron grate, aluminum dome strainer, trap primer connection, trap primer connection

2.24 FLOOR DRAIN (FD-3)

.1 **Watts FD-100-C (Factory Modified)** Floor / Shower Drain with Heavy Duty Adjustable Strainer Head, cast iron body with anchor flange, no hub outlet and trap primer connection. **Factory Modification:** Remove standard nickel bronze strainer and replace with Watts R5G-1 nickel bronze clean out cover custom drilled from factory as per the attached drawing (R-1-Perf) located at the end of this specification. Secure cover in place with Torx Centre Pin security screws c/w Locktite Series 262 Mil-Spec S-46163a Type 2, grade 0 for secure installation, trap primer connection.

2.25 FLOOR DRAIN (FD-4)

.1 **Watts FD-100-EG** Modular trench drain system shall be 100mm wide See drawings for lengths. Drain shall be 75mm deep. Drain shall be made of 0% absorbent polypropylene, positive mechanical connection between sections, mechanical locking. No hub end outlet. Drain shall have stainless steel slotted grate. Funnel Floor Drain, epoxy coated cast iron body with anchor flange, reversible clamping collar with primary & secondary weepholes, adjustable nickel bronze strainer with 102 mm x 229 mm oval nickel bronze funnel, no hub outlet, trap primer connection.

2.26 TRENCH DRAIN (TD-1)

.1 **WATTS DEAD LEVEL P:** 150mm wide by 1220mm long modular trench drain. No hub bottom outlet. Frame anchored. System shall include frame connectors, grate lockdowns, construction covers. Stainless steel perforated grate.

2.27 ROOF DRAIN (RD-1)

.1 **Zurn Z121** Roof Drain, Dura-coated cast iron roof drain with combination membrane flashing clamp/gravel guard and low silhouette cast iron dome. No hub outlet, non-roof membrane penetrating installation, vandal-proof top, roof sump receiver.

2.28 ROOF DRAIN (RD-2)

.1 **Zurn Z121** Roof Drain, Dura-coated cast iron roof drain with combination membrane flashing clamp/gravel guard and low silhouette cast iron dome. No hub outlet, non-roof membrane penetrating installation, vandal-proof top, roof sump receiver, 89mm external water dam.

.2 **Zurn Z199** downspout nozzle. Nickel Bronze body, decorative wall flange and outlet nozzle, removable stainless steel screen

2.29 ROOF DRAIN (RD-3)

.1 **Zurn Z130** Roof Drain, Dura-coated cast iron roof drain with combination membrane flashing clamp/gravel guard and aluminum dome. No hub outlet, non-roof membrane penetrating installation, vandal-proof top, roof sump receiver.

Part 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 Install wall mounted lavatories and urinals and water closets with approved wall carriers.

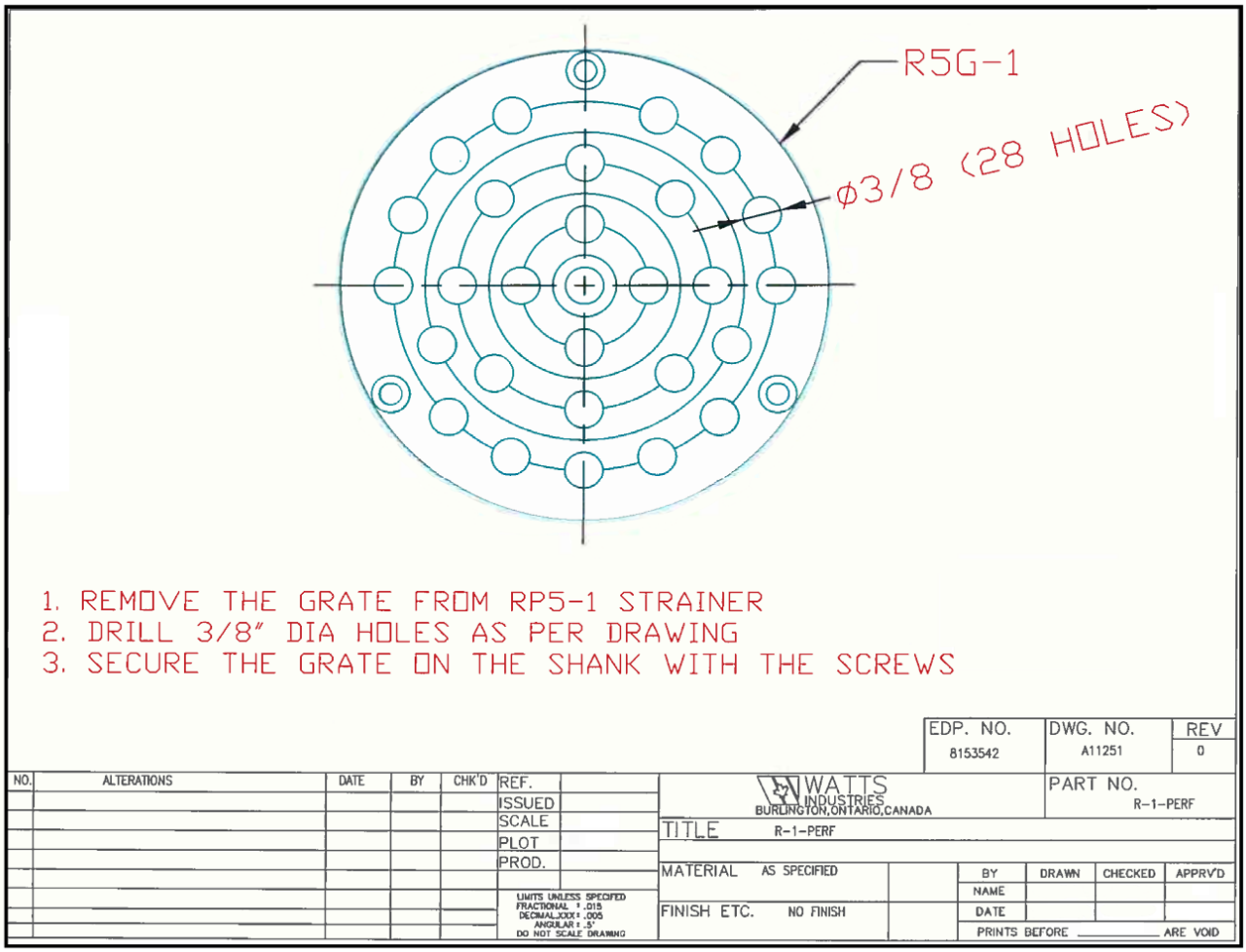
.4 Caulk gap between mop sink and wall with silicone sealant.

3.2 FIXTURES ROUGH-IN SCHEDULE

.1 Rough-in fixture piping connections in accordance with the following table of minimum sizes.

	Hot Water		**Cold Water**		**Waste**		**Vent**	
Lavatories	*15 mm*	***½ in.***	*15 mm*	***½ in.***	*40 mm*	***1½ in.***	*30 mm*	***1¼ in.***
Service Sink	*15 mm*	***½ in.***	*15 mm*	***½ in.***	*50 mm*	***2 in.***	*40 mm*	***1½ in.***
Kitchen Sink	*15 mm*	***½ in.***	*15 mm*	***½ in.***	*40 mm*	***1½ in.***	*30 mm*	***1¼ in.***
Drinking Fountain	--		*15 mm*	***½ in.***	*30 mm*	***1¼ in.***	*30 mm*	***1¼ in.***
Water Closet (Flush Valve)	--		*25 mm*	***1 in.***	*100 mm*	***4 in.***	*50 mm*	***2 in.***
Urinals (Flush Valve)	--		*20 mm*	***¾ in.***	*50 mm*	***2 in.***	*40 mm*	***1½ in.***
Floor Drains	--		--		*100 mm*	***4 in.***	*40 mm*	***1½ in.***
Water Closet (Tank Type)	--		*15 mm*	***½ in.***	*100 mm*	***4 in.***	*50 mm*	***2 in.***
Bath Tub	*15 mm*	***½ in.***	*15 mm*	***½ in.***	*40 mm*	***1½ in.***	*30 mm*	***1¼ in.***
Shower (Single Stall)	*15 mm*	***½ in.***	*15 mm*	***½ in.***	*50 mm*	***2 in.***	*40 mm*	***1½ in.***

	Hot Water		Cold Water		Waste		Vent	
Eyewash	*15 mm*	***½ in.***	*15 mm*	***½ in.***	*30 mm*	***1¼ in***	*30 mm*	***1¼ in.***



END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

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

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

.2 American Water Works Association (AWWA)

.1 ANSI/AWWA C700, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.

.2 ANSI/AWWA C701, Standard for Cold Water Meters-Turbine Type for Customer Service.

.3 ANSI/AWWA C702, Standard for Cold Water Meters-Compound Type.

.3 CSA International

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

.2 CSA B79, Commercial and Residential Drains and Cleanouts.

.3 CAN/CSA-B356, Water Pressure Reducing Valves for Domestic Water Supply Systems.

.4 Efficiency Valuation Organization (EVO)

.1 International Performance Measurement and Verification Protocol (IPMVP).

.5 Plumbing and Drainage Institute (PDI)

.1 PDI-G101, Testing and Rating Procedure for Grease Interceptors with Appendix of Installation and Maintenance.

.2 PDI-WH201, Water Hammer Arresters Standard.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting prior to beginning on-site installation, with in accordance with Section 01 31 19 - Project Meetings to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

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 plumbing products and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements:

.3 Shop Drawings:

.1 Indicate on drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions, construction and assembly details, and accessories.

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

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturers' Field Reports: manufacturers' field reports specified.

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 plumbing specialties and accessories for incorporation into manual.

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

1.5 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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect plumbing materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan.

Part 2 Products

2.1 CLEANOUTS

.1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.

.2 Access Covers:

.1 Wall Access: face or wall type, polished nickel bronze, square, cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.

.2 Floor Access: round cast iron body and frame with adjustable secured nickel bronze top cast box with anchor lugs and:

.1 Plugs: bolted bronze with neoprene gasket.

.2 Cover for Unfinished Concrete Floors nickel bronze, round, gasket, vandal-proof screws.

.3 Cover for Terrazzo Finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.

.4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.

.5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

2.2 NON-FREEZE WALL HYDRANTS

.1 Non-Freeze Hose Bib NFHB:

.1 Non-freeze wall hydrant with nickel bronze box and door, integral vacuum breaker, concealed, key operated, chrome plated hydrant face, 20mm hose connection, 20mm female x 25mm male pipe connection, all bronze head/seat casting/internal parts. **WATTS HY-725 (or equivalent)**

2.3 WATER HAMMER ARRESTORS

.1 Stainless steel construction, bellows type: to PDI-WH201.

2.4 BACK FLOW PREVENTERS

.1 Preventers: to CSA-B64 Series, application as indicated.

2.5 VACUUM BREAKERS

.1 Breakers: to CSA-B64 Series, vacuum breaker hose connection.

2.6 BACKWATER VALVES

.1 Coated extra heavy cast iron body with bronze seat, revolving bronze flapper and threaded cover.

.2 Access:

.1 Surface access.

.2 Access pipe with cover: maximum 300 mm depth.

.3 Steel housing with gasketed steel cover.

.4 Concrete access pit with cover, as indicated.

2.7 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

2.8 WATER MAKE-UP ASSEMBLY

.1 Complete with backflow preventer pressure gauge on outlet, pressure reducing valve to CAN/CSA-B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.

2.9 STRAINERS

.1 860 kPa, Y type with 20 mesh, bronze or stainless steel removable screen.

.2 NPS 2 and under, bronze body, screwed ends, with brass cap.

.3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing specialities and accessories installation in accordance with manufacturer's written instructions.

.1 Inform Consultant of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheet.

3.3 INSTALLATION

.1 Install in accordance with National Plumbing Code of Canada and local authority having jurisdiction.

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

3.4 CLEANOUTS

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

.2 Bring cleanouts to wall or finished floor unless serviceable from below floor.

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

.4 Coordinate floor cleanout location with architectural floor layout.

3.5 NON-FREEZE WALL HYDRANTS

.1 Install 600 mm above finished grade.

3.6 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures and where indicated.

3.7 BACK FLOW PREVENTERS

.1 Install in accordance with CSA-B64 Series, where indicated on drawings and elsewhere as required by code.

.2 Pipe discharge to terminate over nearest drain.

3.8 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Install at bottom of risers, at low points to drain systems, and as indicated.

3.9 TRAP SEAL PRIMERS

.1 Install where indicated on all floor drains.

.2 Install plastic tubing to floor drain.

3.10 STRAINERS

.1 Install with sufficient room to remove basket for maintenance.

3.11 WATER METERS

.1 Install water meter provided by local water authority as per municipal guidelines.

3.12 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

3.13 TESTING AND ADJUSTING

.1 General:

.1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13- General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.3 Application tolerances:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

.4 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.5 Floor drains:

.1 Verify operation of trap seal primer.

.2 Prime, using trap primer. Adjust flow rate to suit site conditions.

.3 Check operations of flushing features.

.4 Check security, accessibility, removability of strainer.

.5 Clean out baskets.

.6 Vacuum breakers, backflow preventers, backwater valves:

.1 Test tightness, accessibility for O M of cover and of valve.

.2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.

.3 Verify visibility of discharge from open ports.

.7 Roof drains:

.1 Check location at low points in roof.

.2 Check security, removability of dome.

.3 Adjust weirs to suit actual roof slopes, meet requirements of design.

.4 Clean out sumps.

.5 Verify provisions for movement of roof systems.

.8 Access doors:

.1 Verify size and location relative to items to be accessed.

.9 Cleanouts:

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

.10 Water hammer arrestors:

.1 Verify proper installation of correct type of water hammer arrester.

.11 Wall, ground hydrants:

.1 Verify complete drainage, freeze protection.

.2 Verify operation of vacuum breakers.

.12 Pressure regulators, PRV assemblies:

.1 Adjust settings to suit locations, flow rates, pressure conditions.

.13 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.14 Hose bibbs, sediment faucets:

.1 Verify that flow and pressure meet design criteria.

.2 Check for leaks, replace compression washer if required.

.15 Hydronic system water Make-up Assembly:

.1 Verify flow, pressure, and connection.

.16 Water meters:

.1 Verify location and accessibility.

.2 Test meter reading accuracy.

3.14 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.

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

3.15 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 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.16 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by plumbing specialties and accessories installation.

END OF SECTION

Part 1 General

1.1 PAYMENT PROCEDURES FOR TESTING LABORATORY SERVICES

.1 Engage and pay for services of independent testing laboratory in accordance with Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

1.2 REFERENCES

.1 Definitions:

.1 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:

.1 Rigid supply and return ductwork;

.2 Flexible ductwork;

.3 Air handling units

.4 Return air plenums including ceiling plenums;

.5 Cooling and heating coils and compartments;

.6 Condensate drain pans and humidifiers;

.7 Fans, fan blades and fan housing;

.8 Filter housing and frames;

.9 Acoustically insulated duct linings;

.10 Diffusers, registers and terminal units;

.11 Dampers and controls;

.2 Reference Standards:

.1 National Air Duct Cleaners Association (NADCA)

.1 ACR Standard, 2006 edition: Assessment, Cleaning and Restoration of HVAC Systems.

.2 North American Insulation Manufacturers Association (NAIMA)

.1 NAIMA 2005, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Site Evaluation: conduct site visit a minimum of 2 weeks before start of work to establish specific co-ordinated video survey and cleaning plan to establish specific co-ordinated video survey and cleaning plan determining how areas of facility and HVAC systems will be protected during cleaning operations.

.1 Organize and lay out plan for video survey and identify camera and cleaning apparatus insertion points.

.2 Ensure plan identifies sequence and schedule of survey and cleaning operations for each individual HVAC system and for complete facility.

.1 Take account of elbows, bends, turning vanes, dampers, transitions, take-offs, and other internal features.

.3 Consultant to review video survey and cleaning plan 1 week minimum prior to start of work.

.2 Damaged or broken equipment and components found during initial testing and inspection are to be repaired or replaced by contractor.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit video survey and cleaning plan developed during site evaluation.

.1 Ensure plan includes sequence of operation, identification of camera and cleaning apparatus insertion points and schedule for work.

.3 Product Data:

.1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.

.2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 43 – Environment Procedures.

.4 Testing Laboratory Services: submit name and address of laboratory engaged for work of this Section.

.1 Submit laboratory analysis report of particulate collection indicating:

.1 Location of collection;

.2 Particulate grade;

.3 Particulate size;

.4 Percentage concentration of individual particulates in each sample.

1.5 CLOSEOUT SUBMITTALS

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

.2 Post Cleaning Inspection Report: submit 4 copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:

.1 Name and address of facility;

.2 Name and address of HVAC cleaning contractor;

.3 Description of HVAC systems with sketches identifying systems cleaned;

.4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;

.5 Identification of points where samples were collected, and type of analysis used for each collection;

.6 Identification of each sample collected;

.7 Comments complete with photographs of each sampling location and other observed system features;

.8 Identify systems tested, observations, actions taken and recommendations for future maintenance.

.3 Record post cleaning video survey: submit 2 copies of video memory card, and include on video survey following:

.1 Areas tested for particulate analysis or microbial growth evaluation;

.2 Areas of special interest and location;

.3 Special internal features;

.4 Problems such as broken or damaged controls or components;

.5 Ensure system tested, locations, observations, actions taken, and recommendations are clearly identified in English on video using text or voice over.

1.6 QUALITY ASSURANCE

.1 Contractor: verification of membership in NADCA, verification of 5 years minimum experience in work similar to or exceeding work of this Section.

Part 2 Products

2.1 ACCESS DOORS AND PANELS

.1 Equipment Access Doors and Panels: construct from same materials as equipment panelling complete with sealing gasket and positive locking device.

.1 Size access doors and panels in equipment to allow for inspection and cleaning.

.2 Ductwork Access Doors: construct access doors from 1.27 mm minimum galvanized sheet steel with gasketed seal.

.1 Ensure access door is 25 mm greater in every dimension than access opening.

.2 Access door size 200mm x 200 mm minimum.

.3 Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure 3 screws per side minimum.

.3 Access Doors and Panels Acoustic Lining:

.1 Install acoustic lining to match existing.

.2 Self-adhesive glass fibre tape capable of adhering to both acoustic lining and metal access door or panel materials.

.3 Water-based duct sealer for repairing cut acoustic lining.

2.2 SYSTEM FILTERS

.1 Supply and install new filters for each HVAC System cleaned.

2.3 AIR DUCT CLEANING EQUIPMENT

.1 Manually propelled full contact brushes:

.1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.

.1 Ensure brushes are sized to fit various duct sizes in HVAC system.

.2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.

.2 Brushes: manually propelled with integrally-mounted motor and nylon or other non-metallic material bristles.

.1 Ensure motor has capacity to continue to push brush after bristles are distorted.

.2 Replace worn and ineffective brushes when required.

2.4 MULTI-FUNCTIONAL ROBOTIC CLEANING SYSTEM

.1 Self-propelled remote-controlled wheel-drive equipped with: camera, lights: rotating brushes, air supply nozzle, and vacuum.

.1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, acoustic lined ducts, equipment and components of HVAC system.

.2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces.

.3 Replace worn and ineffective brushes when required.

.2 Camera: remote control focus and dustproof video capable of storing 4 hours of recorded media.

.1 Camera Light: 2 x 20-watt Halogen with dimmer

2.5 HEPA FILTER EVACUATION FAN

.1 Evacuation Fan: includes fan, HEPA filter, flexible hose and motor capable of maintaining debris and particulates airborne in airstream until they reach evacuation fan and maintaining system under negative pressure.

.1 Ensure HEPA filters are clean and maintain evacuation fan and HEPA filter to run efficiently.

2.6 HEPA VACUUM UNIT

.1 Vacuum Unit: includes vacuum fan, integral HEPA filter, suction hose and vacuum head, capable of maintaining HVAC System debris and particulates airborne in air stream until they reach vacuum unit and maintaining system under negative pressure.

.1 Ensure HEPA filters are clean and maintain vacuum unit and HEPA filter to run efficiently.

Part 3 Execution

3.1 PREPARATION

.1 Close down HVAC system.

.2 Locate and identify externally visible HVAC system features which may affect cleaning process including:

.1 Control devices;

.2 Fire and smoke control dampers;

.3 Balancing dampers: indicate and record positions for resetting;

.4 Air volume control boxes: indicate and record positions for resetting;

.5 Fire alarm devices;

.6 Monitoring devices and controls;

.3 Cut openings in equipment panels and ductwork for access to system interior.

.1 Square or rectangular opening sizes: 200 mm minimum each side.

.2 Circular opening sizes: 200]mm minimum diameter.

.4 Installation of Access Doors and Panels: install access doors and panels for equipment where required to facilitate system inspection and cleaning.

.1 Install access doors and panels for inspection and cleaning of equipment as follows:

.1 Heating and cooling coils;

.2 Fan units;

.3 Filters;

.4 Dampers;

.5 Sensors;

.5 Installation of Access Doors in Ductwork: install access doors in ductwork where required to facilitate system inspection and cleaning.

.1 Access door installation is not permitted in flexible ductwork.

.1 Inspect flexible ductwork only by disconnecting from main duct and inspecting from open end.

.6 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibre glass tape and water-based duct sealer.

.1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.

.7 Remove and reinstall ceiling tiles to gain access to HVAC system as required.

.1 Replace ceiling tiles damaged or soiled by air duct cleaning procedures.

3.2 EXAMINATION / PRE-CLEANING INSPECTION

.1 Verification of Conditions:

.1 Make visual inspection of interior of HVAC system using remote controlled robotic camera.

.2 Insert camera at pre-established strategic locations to evaluate condition and cleanliness of HVAC systems and components.

.2 Evaluation and Assessment:

.1 Identify location and type of internal components.

.2 Identify extent of potential problems.

3.3 DUCT CLEANING

.1 Do duct cleaning in accordance with NADCA ACR Standard.

.2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zone that has already been cleaned.

.1 Isolate zone of duct using closed-cell polyurethane foam before cleaning.

.3 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.

.4 Install HEPA filter evacuation fan at one end of zone section and insert full contact brushes at the other end.

.5 Clean HVAC supply air duct system and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.

.6 Clean exhaust, return, transfer ductwork and plenums, equipment and components where particulate sample collected from surfaces is greater than 75 mg of particulate per 0.01 square metres.

.7 Energize brushes to travel from insertion point to HEPA filter evacuation fan.

.1 Pass brushes through sections as often as necessary to achieve required cleanliness.

.2 Change brush sizes as required to ensure positive contact with duct and component interiors.

.3 Clean corners and pockets where dirt and debris can accumulate.

.8 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.

.9 Clean diffusers, registers, louvers, and other terminal units.

3.4 ACOUSTICALLY LINED DUCTWORK CLEANING

.1 Clean glass fibre acoustically insulated ducts to NAIMA recommended practices.

.1 Use specifically designed robotic apparatus that has been demonstrated not to damage acoustic glass fibre lining.

.2 Monitor cleaning process progress by onboard camera.

3.5 COMPONENTS AND EQUIPMENT CLEANING

.1 Brush and vacuum coils, humidifiers, air handling unit enclosures, and heat exchanger surfaces to achieve required cleanliness.

.2 Compressed air and manual cleaning is acceptable only for cleaning individual components and small areas as follows:

.1 Fan blades;

.2 Dampers;

.3 Turning vanes;

.4 Controls;

.5 Sensor bulbs;

.6 Fire alarms;

.7 Smoke detectors;

3.6 FIELD QUALITY CONTROL/FINAL INSPECTIONS

.1 Post Cleaning Inspection: carry out final inspection using robotic camera and other visual inspection methods after final cleaning has been completed.

.1 Carry out video survey as directed Consultant.

.2 Identify on HVAC system record drawings access points used for inspection and cleaning.

.3 Re-collect and analyze particulates collected at same locations where original samples were collected before cleaning.

.4 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

3.7 SYSTEM STARTUP

.1 Install new system filters after cleaning operations are completed.

.2 Cover each inspection opening with access door or panel and secure in place after inspection and cleaning are completed.

.3 Restart each HVAC system.

3.8 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

1. General

1.1 REFERENCES

.1 Division 00.

.2 Division 01.

.3 Divisions 21/22/23.

1.2 INTENT

.1 Provide complete, fully tested, and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

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

.3 Follow manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Engineer at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test.

.7 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by Controls Contractor.

.8 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. The Contractor shall, at his own expense, repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing such work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on work not otherwise covered.

.9 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.10 'Provide' shall mean; supply and install'.

1.3 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 filters, grease, and belts.

1.4 **COORDINATION OF WORK**

.1 Cooperate and coordinate with other trades on the project.

.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. Jointly work out all conflicts on site before fabricating or installing any materials or equipment.

.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 Any areas indicted as space for future materials or equipment shall be left clear.

1.5 **PERMITS**

.1 All work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the work.

.3 Contractor shall arrange for inspections of the work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.6 **TENDER PRICE BREAKDOWN**

.1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format required by the engineer.

.2 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.

.3 Progress claims shall be submitted using this contract price breakdown.

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		
	• Water - On Site		
	• Sanitary - On Site		
	• Gas Service		
10.	Pre-operational Cleaning and Chemical Treatment		
11.	Water Softening Equipment		
12.	Plumbing		
	• Fixtures		
	• Piping & Valves		
	• Domestic Water Heaters		
	• Pumps		
	• Miscellaneous Equipment (List)		

CONTRACT PRICE BREAKDOWN			
		MATERIAL	**LABOUR**
13.	Heating		
	• Tanks		
	• Boilers		
	• Pumps		
	• Terminal Heating Units (Radiation)		
	• Piping & Valves		
	• Unit Heaters/Force Flows		
	• Miscellaneous Equipment (List)		
14.	Cooling		
	• Chillers		
	• Pumps		
	• Piping & Valves		
	• Dry Coolers		
	• Miscellaneous Equipment (List)		
15.	Ventilation & Air Conditioning		
	• Make-up Air Units		
	• Energy Recovery Units		
	• Fans		
	• Grilles / Diffusers / Louvres		
	• Fan Coil Units		
	• Ducts and Dampers		
	• Miscellaneous Equipment (List)		
16.	Fire Protection		
	• Sprinklers		
	• Fire Extinguishers		
17.	Insulation		
	• Piping Insulation		
	• Duct Insulation		
	• Equipment Insulation		
18.	Meters and Gauges		
19.	Duct Cleaning		

CONTRACT PRICE BREAKDOWN			
		MATERIAL	**LABOUR**
20.	Breeching & Chimneys		
	TOTAL (TO EQUAL CONTRACT PRICE)		

1.7 **PROGRESS CLAIMS**

.1 Submit a Progress Summary and a Detailed Price Breakdown with each Progress Claim. The Summary and Breakdown shall include all Change Orders issued.

.2 Progress claims shall not be processed past 90% of the overall Mechanical Contract until the final commissioning and prove-out has been completed. This will allow for sufficient deficiency holdbacks for problems identified during commissioning.

1.8 **EXAMINATION OF SITE**

.1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. 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 is visible or known to exist at the time of tender.

1.9 **QUALITY OF WORK**

.1 All work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates.

.2 Work which does not conform to standards accepted by the Consultant and the trade may be rejected by the Consultant. The Contractor shall redo rejected work to the accepted standard at no cost to the Owner.

1.10 **METRIC CONVERSION**

.1 All units in this division are expressed in SI units.

.2 Submit all shop drawings and maintenance manuals in SI units.

.3 On all submittals (shop drawings etc.) use the same SI units as stated in the specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.5 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.6 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

EQUIVALENT NOMINAL DIAMETER OF PIPES					
mm	***Inches (NPS)***	***mm***	***Inches (NPS)***	***mm***	***Inches (NPS)***
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*				

1.11 **METRIC DUCT SIZES**

.1 The Metric duct sizes are expressed as 25 mm = 1 inch.

.2 Not applicable.

1.12 **ALTERNATE MATERIALS AND EQUIPMENT**

.1 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

.2 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted in duplicate, to the Engineer no later than seven (7) 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.

.3 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 "Alternate Only", this shall be stated in the quotation.

.4 Approved equivalents and/or alternatives to specified products shall be equal to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined.

.5 The Contractor shall be fully responsible for any additional work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such work.

1.13 **DRAWINGS AND SPECIFICATION**

.1 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.

.2 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, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work is satisfactorily carried out without changes to building.

1.14 **SHOP DRAWINGS**

.1 Provide 1 electronic copy for review. Provide 3 printed copies for insertion into manuals

.2 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 Engineer's office. Maintenance and operating manuals are not suitable submittal material.

.3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.

.4 Include dimensional and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes.

.5 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.

.6 Do not order equipment or material until the Engineer has reviewed and returned shop drawings.

.7 Prior to submission to the Engineer, the Contractor shall review all shop drawings.

.1 By this review, the Contractor certifies that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and certifies that he has checked and coordinated each shop drawings with the requirements of the work of the contract documents.

.2 The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a responsible person.

.8 Retain one copy of shop drawings on site for review.

1.15 **SALVAGE**

.1 Remove from site all equipment, ducting or piping which is no longer required because of work under this Contract.

.2 Turnover to and deliver to the Owner's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.16 **CUTTING, PATCHING AND CORING**

.1 Provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

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

.3 Obtain written approval from the Engineer before cutting or burning structural members.

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

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.17 **EXCAVATION AND BACKFILL**

.1 Refer to requirements of Division 2.

.2 Provide all excavating to facilitate installation of the mechanical work, including shoring, pumping, 150 mm compacted sand bedding under and first 300 mm of compacted sand over piping and ducting.

1.18 **INSTALLATION OF EQUIPMENT**

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.19 **FIRE-STOPPING**

.1 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations.

.2 Fire-stopping materials to meet ULC CAN 2S115. Acceptable Materials: by "Tremco" or "National Firestopping".

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer's instructions.

1.20 **CONNECTIONS TO EXISTING SERVICES**

.1 Maintain liaison with the Owner and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory work is completed and all required materials are on site.

.3 Interruptions and shutdowns of existing services shall be by the maintenance staff.

1.21 **EQUIPMENT AND MATERIALS**

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear manufacturer's name, address, catalogue and serial number in a conspicuous place.

.3 Where two or more products of the same type are required, products shall be of the same manufacturer.

.4 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.

1.22 **EQUIPMENT PROTECTIONS AND CLEAN-UP**

.1 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.

.2 Protect equipment with polyethylene covers and crates.

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

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

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

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

1.23 **ELECTRICAL MOTORS**

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: NEMA, EEMAC, CSA, CEC Part 1, IEEE and ANSI. All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch.

.3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.5 Motors less than 1 hp shall be 120 V, 60 Hz, 1-phase. Motors 1 hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm where indicated.\

.7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.9 Refer to electrical specifications, Division 26, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 21/22/23.

.10 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.

.11 Minimum certified motor efficiency shall be as outlined below;

MINIMUM CERTIFIED MOTOR EFFICIENCY (%) *				
HP	**3600 RPM**	**1800 RPM**	**1200 RPM**	**900 RPM**
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.6
30	90.8	91.9	91.4	90.7
40	91.4	92.5	92.3	90.6
50	91.9	92.7	92.3	91.3
60	92.4	93.2	92.9	91.6
75	92.5	93.5	93.1	92.8
100	93.0	93.7	93.5	92.7
125	93.6	93.9	93.6	93.4
150	93.8	94.3	94.2	93.4
200	94.3	94.5	94.6	93.9
250	95.0	95.0	95.0	95.0
300	95.0	95.0	95.0	95.0
400	95.0	95.0	95.0	95.0
500	95.0	95.0	95.0	95.0

(*) As defined in CSA C390 or IEEE 112B Nominal Standards

1.24 **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 Cleanouts and traps;

.5 Controls, coils and terminal units;

.6 Expansion joints.

.7 Filters

.8 Strainers

.2 Non-Fire Rate Access Doors: Aluminum frame with gypsum board inlay and structural nylon corners. The door shall be tapped and finished consistent with the surrounding surface. Recess aluminum frame provides edge similar to drywall bead against which ceiling surface can be finished. Materials: Extruded Aluminum Alloy 6063-T6, gypsum board inlay, fiberglass re-enforced nylon, zinc plated screws, stainless steel springs and retaining wire. Concealed hinge for 120degree door opening and door removal. Paint as per surrounding

.3 Fire Rated Access Doors: Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.4 Mark removable ceiling tiles used for access with colour coded dots.

.5 Sizes to be 200 mm x 200 mm. for cleanout, 300 mm x 300 mm. for hand 600 mm x 600 mm^2 for body access minimum.

.6 Provide UL-listed fire rated access doors installed in rated wall and ceilings.

1.25 MISCELLANEOUS METALS

.1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for work under this contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

.3 Access platforms and catwalks.

1.26 PIPE SLEEVES

.1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum 0.61 mm galvanized sheet metal. Sleeves shall extend 25 mm. on either side of the wall.

.2 .Schedule 40 steel pipe shall be used as floor pipe sleeves in wet areas with up-stand.

.3 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

1.27 ESCUTCHEON AND PLATES

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors, and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.28 PAINTING AND IDENTIFICATION

.1 Coordinate colour coding of piping and equipment with work of Division 9.

.2 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour schedule at end of this section.

.3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm. high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.4 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m. maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.5 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this section.

.6 Provide 20 mm. diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.7 Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to Owner. Include copies in O & M Manuals.

.8 Tag automatic controls, instruments and relays and match/key to control shop drawing identification numbers. Tag all equipment and control panels.

.9 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this division with lamacoid plates having 6 mm. minimum letter size. Identification to state equipment controlled.

.10 Identify the usage of duct access panels with self-adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

Usage	Colour	Letters
Cleaning and service access	Yellow	C.A.
Controls, including heat sensors	Black	C.
Dampers (backdraft, balance & control)	Blue	D.
Fire dampers	Red	F.D.
Smoke dampers and detectors	Red	S.D.

*Note: Provide black lettering for yellow or white background, white for all other colours.

.11 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots." Place identification dots (12mm. diameter) on the access panel. The colours shall conform to the following schedule:

.1 Concealed equipment and cleaning access:

.1 Yellow

.2 Control equipment, including control dampers and valves, and heat sensors:

.1 Black

.3 Fire, smoke, and sprinkler equipment including dampers:

.1 Red

.4 Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment:
.1 Green

.5 Balancing Dampers:
.1 Blue

.12 When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.29 **COLOUR CODING SCHEDULE**

.1 Colour numbers are called for in Canadian Government Specification No. 5-GP-1a. Colours assigned from CGSB 1-GP-12c for colour code identification.

.2 Mechanical Primary Colours for Pipe Lines/Equipment.

MECHANICAL PRIMARY COLOURS FOR PIPE LINES/EQUIPMENT	
Colour	**Pipe Lines/ Equipment**
Yellow	505-102
Light Blue	502-106
Green	503-107
Orange	508-102
Brown	504-103
Red	509-102
White	513-101
Aluminum	515-101
Purple	501-101
Grey	501-107

.3 Secondary Colours for Bands.

SECONDARY COLOURS FOR BANDS	
Colour	**Bands**
Red	509-102
Orange	508-102
Blue	502-106

.4 Banding.

BANDING	
Colour	**Banding**
Red	To indicate extremely hazardous material
Orange	To indicate mildly hazardous material
Blue	To indicate non-hazardous material

.5 Identification Symbols and Colour for Piping

IDENTIFICATION SYMBOLS AND COLOUR FOR PIPING			
Type	**Pipe Colour**	**Stripe Colour**	**Symbol**
Chilled Glycol Return	Green	Orange	CH.GLYR
Chilled Glycol Supply.	Green	Orange	CH.GLYS
Compressed Air	White	None	kPa Air
Condensate	Green	Orange	COND
Domestic Cold Water	Light Blue	None	DCW
Domestic Hot Water	Green	Orange	DHW
Domestic Hot Water	Green	Blue	DHWR.
Engine Exhaust	Aluminum	Orange	EXH
Heating Glycol Return	Yellow	Orange	HGLYR
Natural Gas	Orange	Red	Nat.Gas
Sprinkler	Red	None	Sprinkler
Vacuum	Aluminum	None	Vac.
Vent	Aluminum	Red/Orange	Vent
Water Softened	Blue	None	Soft Wat.

.6 Identification Symbols and Colours for Equipment

IDENTIFICATION SYMBOLS AND COLOURS FOR EQUIPMENT			
	Pipe Colour	**Stripe Colour**	**Symbol**
Boilers	Green	Red	None *25 mm1 in.* Length
Fan Guards - Motor Guards	Red Machinery Enamel		
Hangers, Brackets, Hanger Rods	Black Machinery Enamel		
Heat Exchangers	Green	Orange	None
Hot Water Storage (Uninsulated)	Aluminum	Red	None
Pumps - Fire	Red	None	None
Pumps - Regular	Aluminum	None	None
Supports	Black	None	None
Tanks - Chilled Glycol	Green	Orange	None

IDENTIFICATION SYMBOLS AND COLOURS FOR EQUIPMENT			
	Pipe Colour	**Stripe Colour**	**Symbol**
Tanks - Hot Water (Insulated)	Green	Orange	None
Valves Uninsulated	High Heat Aluminum		
Water Chiller Units	Green	Orange	Ch. Water

.7 Mechanical Control Systems

.1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black `C'.

.2 Main and secondary control panels, factory finish acceptable - control Contractor to install company label to identify.

.8 Ductwork

.1 All ductwork in mechanical rooms to be identified as follows, complete with directional arrows:

DUCTWORK IDENTIFICATION	
Return Air	R.A.
Supply Air	S.A.
Mixed Air	M.A.
Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

.9 Provide Lamacoid labels for all equipment

1.30 **PERFORMANCE VERIFICATION OF INSTALLED EQUIPMENT**

.1 Installed mechanical equipment whose performance is questioned by the Consultant, may be subject to performance verification as specified herein.

.2 When performance verification is requested, equipment shall be tested to determine compliance with specified performance requirements.

.3 The Consultant will determine by whom testing shall be carried out. When requested, the contractor shall arrange for services of an independent testing agency.

.4 Testing procedures shall be reviewed by the Consultant.

.5 Maintain building comfort conditions when equipment is removed from service for testing purposes.

.6 Promptly provide the Consultant with all test reports.

.7 Should test results reveal that originally installed equipment meets specified performance requirements. Owner will pay all costs resulting from performance verification procedure.

.8 Should test results reveal that equipment does not meet specified performance requirements, equipment will be rejected and the following shall apply:

.1 Remove rejected equipment. Replace with equipment which meets requirements of Contract Documents including specified performance requirements.

.2 Replacement equipment will be subject to performance verification as well, using same testing procedures on originally installed equipment.

.3 Contractor shall pay all costs resulting from performance verification procedure.

1.31 **TEMPORARY HEAT**

.1 Do not use the permanent system for temporary heating purposes without written permission from the Engineer.

.2 Thoroughly clean and overhaul permanent equipment used during the construction period, replace worn or damaged parts before final inspection.

.3 Use of permanent systems for temporary heat shall not modify terms of warranty.

.4 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

.5 Air systems shall 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 system.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.32 **TEMPORARY OR TRIAL USAGE**

.1 Temporary or trial usage by the Owner or Engineer of mechanical equipment supplied under contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.4 Avoid thermal shock to heating system by coordination with the Owner during planning, construction and operation of temporary heating system.

.5 Return condensate to the heating plant. Meter equipment is not required.

1.33 **SUBSTANTIAL AND TOTAL PERFORMANCE**

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 A certificate of Substantial Performance will not be granted unless the following items are completed:

.3 Heating air conditioning, plumbing and fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation.

.4 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.5 Air and water systems have been balanced with draft report submitted to Engineer.

.6 Valve tagging and equipment identification is complete.

.7 Warranty forms have been mailed to the manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.

.8 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from manufacturer's representative to confirm status of treatment.

.9 Draft Operating/Maintenance Manuals have been submitted.

.10 Operating and Maintenance demonstrations have been provided to the Owner.

.11 Written inspection report by manufacturer's representative has been submitted for noise and vibration control devices and flexible connections.

.12 Record drawings have been submitted.

.13 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.14 All seismic restraint devices have been installed.

.15 All previously identified deficiencies have been corrected.

.16 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of substantial performance inspection have been corrected and the following items completed prior to the total performance inspection:

.17 Submit find air and water balance reports.

.18 Submit final operating and maintenance manuals.

.19 Complete final calibration.

.20 The Engineer shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required, shall be at the expense of the Contractor.

.21 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.34 **LIABILITY**

.1 Assume full responsibility for laying out the work and for any damage caused to the Owner or other Sub-Contractors by improper location, or carrying out of the work.

.2 Be responsible for prompt installation of this work in advance of concrete pouring or similar work.

.3 Provide and set sleeves where required. Should any cutting or repairing of either unfinished or finished work be required, this Sub-Contractor shall direct the particular Sub-Contractor whose work is involved to do such cutting and repairing without expense to the Owner. Before being undertaken, such work shall be laid out for the Consultant's review.

.4 Examine the site and the local conditions affecting work under this Contract.

.1 Examine carefully the mechanical, electrical, structural and architectural drawings and confirm that the work under this Sub-Contract can be satisfactorily carried out without changes to the building as shown on these plans.

.2 Before commencing the work, examine the work of the other Trades and report at once any defect of interference affecting the work or warranties of this section.

.3 No extras will be subsequently allowed for such error, omission or oversight on the thorough inspection of the grounds, building, conditions, etc.

.5 Arrange work in co-operation with other trades in the building in such a manner as not to interfere with other work being carried on in the building and places where other pipes, ducts, conduits, cable and equipment are to be installed along with the pipes and ducts pertaining to this trade.

.1 Cooperate with the other trades to get all the pipes, ducts, conduit, etc., installed to the best advantage.

.2 When open web structural joists are used, obtain structural shop drawings to ensure adequate space is available for installation of pipes and ductwork.

.6 Where any pipes, ducts and equipment supplied by this Sub-trade must be built into the work of other trades such as masonry, structural, or plastering, be responsible for supplying the equipment to be built in or for measurements to allow the necessary openings to be left.

.1 All pipes and ducts which are to be concealed shall be installed neatly and close to the building structure so that the necessary furring can be kept as small as possible.

.2 Any pipes, ducts, or other work which are not, in the opinion of the Consultant, installed as they should be, shall be taken out and replaced without cost to the Owner.

.7 Protect finished and unfinished work from damage due to the carrying out of his work, giving special attention to the protection of building vapour barriers, waterproof membranes, etc.

.1 Cover floors and other parts of the building with tarpaulins, etc., and repair all damage to the satisfaction of the Owner and the Consultant.

.2 During freezing weather, protect all his materials in such a manner that no harm can be done to installations already in place and/or to materials and equipment on the job.

.8 Be responsible for the condition of all materials and equipment supplied and for providing all necessary protection for same.

.9 Be responsible for the protection and maintenance of the work of this Section until the work has been completed and accepted by the Owner for storing materials inside and out of the way, and for cleaning up all refuse caused by this work to the Consultant's approval.

.10 On completion of the work, all tools and surplus and waste materials shall be removed and the work left in a clean and perfect condition.

1.35 **LIABILITY INSURANCE**

.1 This Sub-Contractor shall maintain such insurance as will fully protect both the Owner and himself from any and all claims, all as noted within the General Conditions as amended under Supplementary Conditions.

1.36 **LAWS, PERMITS, PERMITS AND FEE**

.1 Give all necessary notices, obtain all necessary permits and pay all fees in order that the work hereinafter specified may be carried out. Furnish all certificates necessary to evidence that the work installed conforms with all applicable laws and regulations of all authorities having jurisdiction.

.2 All work shall be in accordance with the regulations of the following authoritative bodies, the codes in effect at the time of tender, and any other authorities having jurisdiction:

.1 Fire Marshall.

.2 Canadian Electrical Code.

.3 Local Building By-Laws.

.4 Worker's Compensation Board.

.5 Canadian Standards Association.

.6 Refrigeration Code and CSA Codes governing refrigeration plants.

.7 Canadian Gas Code B-149.1

.8 National Plumbing Code.

.9 Alberta Building Code.

.10 Boiler and Pressure Vessel Act.

.11 National Fire Protection Association.

.12 Insurers Assurance Organization.

.13 National Building Code

.14 Underwriters' Laboratories of Canada.

1.37 **ACCEPTABLE MANUFACTURERS**

.1 All equipment outputs shall be selected for high altitude where applicable.

.2 Requests for changes to the specification in standards, materials, equipment or installation techniques shall be submitted for review five (5) working days prior to close of tenders, and if applicable will be incorporated in an Addendum to the Specification.

.1 Equipment used shall not exceed space limitations in any dimension. Replace any equipment or apparatus which does not meet this Specification at no cost.

.2 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.

.3 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.

.3 Submit samples, in addition to drawings, of all items which in the Consultant's judgement, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.

.4 Provide equipment from the following manufacturers. Those manufacturers not listed are considered as alternatives. All mechanical equipment shall have the manufacturers name permanently affixed to it. It is the responsibility of both the 'named' product/supplier as well as the following listed "acceptable" products/suppliers to ensure that they meet or exceed the scheduled performance and are suitable for the intended use.

.5 Alternate manufacturers may be shown along with savings if so desired, however these alternatives must be shown in addition to a manufacturer from the acceptable list.

.6 Within ten (10) days of Award of Contract, give proof of placement of orders for all major pieces of mechanical equipment and materials. Proof must be submitted in the form of a purchase order or an invoice from the supplying vendor indicating quantity, delivery date and date when manufacture of item is to commence.

.7 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.

.8 Equipment on acceptable manufacturers list must be equal or better in quality and performance of the model specified. Equipment which is not equal will be replaced with the specified equipment at no cost to the Owner.

.9 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.

.10 The equipment manufacturer shall ensure that the strength and anchorage of the internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

Item	Acceptable products/ Suppliers/Manufacturers
Access Doors	Fire-Rated: Acudor, E.H. Price, Maxam, Steel Brothers, Milcor, Mifab, Bauco Non-Fire Rated: Bauco
Air Handling Units	Engineered Air, Trane, Johnson Controls
Air Measuring Stations	Cambridge, Sentinel, Ebtron
Air Separators	Trane, Engineered Air, Pace, Haakon, Scott Springfield
Automatic Air Vent	Hoffman, Braukman, Sarco, Armstrong, Maid-OMist, Voss
Balancing	Chalet Balancing, R.A. Bruce & Associates, Thermo Mechanical, Aztech
Balancing Dampers	Maxam, Ruskin
Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison
Backflow Protection Watts	Febco, Clayton, Beeco, Wilkins, Ames, Conbraco
Boilers (Condensing)	Weil McLain, Lochinvar, Viessman
Bypass Filter	Sumco, GESL, Pace Chemicals, Specified Technical
Carbon Monoxide Detectors	MSA, Denco, Acme, Armstrong
Chillers (Air-Cooled Modular)	ClimaCool, Multistack, Arctic Chill, Tandem
Chimneys	Selkirk, Van Packer, Belvent, Ecco
Coils - Heating and Cooling	Trane, Aerofin, Engineered Air, Colmac
Damper - Backdraft	Tamco, Ruskin
Dampers - Motorized	Tamco, Ventex
Domestic Hot Water Heaters	A.O. Smith, Lochinvar, PVI
Duct Cleaning Company	Power Suction Service, Enviro-vac, Ace Mobile Power Service Ltd., Clean Air Services Ltd.
Expansion Joints	Flexonics, Hyspan, Uniroyal, Keflex, Mason, Goodall, Metraflex, Hydro Flow
Fan Coil Units	Trane, Airtherm, Engineered Air, Enviro-Tec, Johnson Controls
Fans	Jenn-Air, Greenheck, Delhi, Acme, Cook, LAU, Carnes, Nederman, Twin City, Pennbarry, Twin City
Filter Gauges	Dwyer, Cambridge
Filters	Farr, Continental, Cambridge, AAF, Viledon, Tridec
Fire Dampers	Canadian Advanced Air, Maxam, Ruskin, Controlled Air, Nailor
Fire Protection - Cabinets &	Wilson & Cousins, National, Viking, General, Grinnell, NFE,

Item	Acceptable products/ Suppliers/Manufacturers
Extinguishers	CEB, Automatic
Fire Protection - Sprinklers	Grinnell, Viking, Vipond
Flexible Air Duct	Thermoflex, Wiremold, Flexmaster
Flow Meters	Western Meter, Annubar, PSE, Bell & Gossett, Armstrong
Flush Valves	Zurn, Crane, Sloan, Cambridge Brass
Force Flow Units/Unit Heaters (Hot Water)	Trane, Rosemex, McQuay, Engineered Air, Sigma, Modine
Grilles, Diffusers and Registers (Non-Secure)	E.H. Price, Krueger, Titus, Hart & Cooley, Nailor, Carnes
Grilles (Secure)	Chubb, Virtucom, Simpson, Eneround
Heat Exchangers (Plate)	Alpha Laval, Armstrong, APV, Tranter, Taco
Humidifiers	Dri-Steem, Nortec
Insulation - Duct	Fiberglas, Knauf, Manville, Atlas, PPG, Manson, Certainteed
Insulation - Flexible Duct	Flexmaster
Insulation - Flexible Piping	Armstrong, PPG, Knauf, Manville, Manson
Insulation - Piping	Fiberglas, Knauf, Manville, Manson, Atlas, PPG, Certainteed
Jacketing Material	Childers, Fiberglas, Manville, Flamex FR Canvas
Louvers	Greenheck, Airolite, Ventex, Ruskin
Mixing Valves	Leonard, Bradley, Powers, Symmons
Motors, Electric	Century Electric "E Plus iii", Baldor "Super-E", Toshiba "EQP 34", Teco "Max-E1"
Pipe Fittings and Flanges	Crane, Grinnell, Jenkins, Victaulic, Mech-Line, Shurjoint
Pipe Flexible Connection	Flexonics, Metraflex, Hyspan, Hydro Flo
Pipe Supports and Hangers	Crane, Unistrut, Myatt, L.E. Taylor, Grinnell, Sarco
Plumbing Drainage Accessories	J.R. Smith, Enpoco, Zurn, Ancon, Mifab, Roto-Tech-Smith, Watts
Plumbing Brass (All to be CSA approved)	American Standard, Crane, Waltec, Moen, Kohler, Zurn, Cambridge, Chicago, Grohe
Plumbing Trim (All to be CSA approved)	American Standard, Crane, Cambridge, Kohler, Eljer, Alsons, Bradley, Powers, Symmons, Moen, Delta, Brasscraft, T & S Brass, Emco, Acorn, Leonard, Briggs, Chicago
Plumbing Fixtures (All to be CSA approved)	Crane, K.I.L., Fiat, Kohler, Eljer, American Standard, Williams, Arista Haws, Elkay, Aquarius, Jacuzzi, Sunroc, Western, Swan, Bradley, Speakman, Valley, Hytec, Watrous, Briggs, Kindred, Waltec, A.M.I., Chicago
Secure Area Plumbing Fixtures (All to be CSA approved)	Acorn, Willoughby

Item	Acceptable products/ Suppliers/Manufacturers
Pressure Gauges	Weiss, Ametek, Trerice, Winters, Wika
Pressure Reducing Valves	Fisher, Masoneilon, Singer
Pumps - In-Line	Bell & Gossett, Armstrong, Grundfos, Taco, Wilo
Radiation	Sigma, Engineered Air (for bare fin only)
Relief B.D.O.B. Dampers, Penthouses	Titus, Vent Air
Relief Valves	Crosby, Sarco, Watts
Sound Attenuation - Ducts	I.A.C., Vibron, Vibro Acoustics, Wisp Air
Split System AC Units	Mitsubishi, Liebert
Strainers – Pipe	Red & White, Crane, Sarco, Armstrong, Kitz, Mueller, Plenty, Metraflex
Tanks (Expansion)	Anthes, Leitch, Armstrong, Enermax Clemmer, Westeel-Rosco, Bell & Gossett, Ferro, Expanflex, Flexcon Industries, Taco
Thermometers	Trerice, Weiss, Weksler, Winters, Wika
Valves – Ball	Red & White, Grinnell, Jenkins, Watts, Hills, Crane, McCanna, Kitz, Milwaukee, Nibco, American, Apollo, MAS
Valves – Gate & Globe	Red & White, Crane, Jenkins, Kitz Grinnell, Vogt, Milwaukee, Nibco, DeZurik, Watts, Sarco, Lunkenheimer, Keystone, Norriseal, Braukman, Demco, Victaulic
Valves - Butterfly	Red & White, Centerline, Keystone, Grinnell, Milwaukee, Nibco, Crane, Jenkins, Norriseal, Demco, Victaulic, Lunkenheimer, Watts, Kitz and Apollo
Valves - Balancing	DeZurik, Millcentric, Grinnell, T/A, Armstrong, CBV, Sarco, Kitz and Apollo, Oventrop
Valves - Balancing/Flow Meter	T/A, Bell & Gossett, Armstrong, Grinnell
Valves - Check Spring Loaded	Duo-Check II, Moyes & Groves, Grinnell, Crane, Conbraco
Valves – Radiation	Globe Toyo, Dahl
Valves – Spring Loaded Check	Duo-Check II, Moyes & Groves, Check Rite, Conbraco
Variable Air Volume Boxes	Krueger, Price, Trane, Titus
Variable Frequency Drives	ABB, Hitachi, Mitsubishi
Vibration Control Equipment	Vibro-Acoustics, Lo-Rez, Vibron, Korfund, Mason, Vibron
Water Closet Seats	Beneke, Bemis, Olsonite, Moldex, Sperzel, Centoco

1.38 **NON-SPECIFIC DATE/TIME COMPLIANCE**

.1 All equipment, hardware, software and firmware (for the purposes of this clause #, the "Product") delivered or deliverables resulting from any services provided are fully Date

Compliant and the Product will not adversely or materially affect the daily business operations as a result of a date related computer problem (for the purposes of this clause #, the "Warranty").

.1 Date Compliant means that the Product accurately and correctly processes and stores date/time data (including, but not limited to, calculating, comparing, displaying, recording and sequencing operations) including:

.1 Year

.2 Century

.3 Leap year calculations.

.2 Provide documentary proof of Date Compliance prior to substantial completion listing all equipment and certifying their compliance.

.3 Notwithstanding any other remedy available under this agreement or at law for breach of the Warranty, any Product that is not Date Compliant shall, within twenty-four (24) hours of receipt of notice of the breach, be repaired or replaced at the Contractors sole cost and expense, including parts, labour, transportation and insurance, so as to correct any failure to meet the Warranty.

2. Products

Not applicable.

3. Execution

Not applicable.

END OF SECTION

Part 1 General

1.1 USE OF SYSTEMS

.1 Use of new permanent heating and/or ventilating systems for supplying temporary heat and or ventilation is permitted only under following conditions:

- .1 Entire system is complete, pressure tested, cleaned, flushed out.
- .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
- .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
- .4 There is no possibility of damage.
- .5 Supply ventilation systems are protected by 60 % filters, inspected daily, changed every week or more frequently as required.
- .6 Return systems have approved filters over openings, inlets, outlets.
- .7 Systems will be:
  - .1 Operated as per manufacturer's recommendations and instructions.
  - .2 Operated by Contractor.
  - .3 Monitored continuously by Contractor.
- .8 Warranties and guarantees are not relaxed.
- .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Consultant.
- .10 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

.2 Filters specified in this Section are over and above those specified in other Sections of this project.

.3 Exhaust systems are not included in approvals for temporary heating ventilation.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.

.2 Canadian Standards Association (CSA International)

.1 CSA B139-[04], Installation Code for Oil Burning Equipment.

.3 Green Seal Environmental Standards (GSES)

.1 Standard GS-11Environmental Standard for Paints and Coatings.

.4 National Fire Code of Canada (NFCC 2005)

.5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2007, Architectural Coatings.

.2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

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:

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

.3 Packaging Waste Management: remove for reuse in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.1 Primers, Paints, Coating: In accordance with manufacturer's recommendations for surface conditions.

.2 Primer: maximum VOC limit 250 g/L to Standard GS-11.

.3 Paints: maximum VOC limit 150 g/L to Standard GS-11.

.2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.

.1 Sealants: maximum VOC limit to SCAQMD Rule 1168.

.3 Sealants: maximum VOC limit to SCAQMD Rule 1168.

.4 Adhesives: maximum VOC limit to SCAQMD Rule 1168.

.5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

Part 3 Execution

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

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

.2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.

.3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

.1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.

.2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer and as indicated without interrupting operation of other system, equipment, components.

3.4 DRAINS

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

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

.3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

.1 Install manual air vents to CSA B139 at high points in piping systems.

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

3.6 DIELECTRIC COUPLINGS

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

.1 Install pipework to CSA B139.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed ceiling piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines. All piping drops to be located in concealed partitions, walls or equipment rooms/chases.

.8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible and as indicated.

.12 Ream pipes, remove scale and other foreign material before assembly.

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

.14 Provide for thermal expansion as indicated.

.15 Valves:

.1 Install in accessible locations.

.2 Remove interior parts before soldering.

.3 Install with stems above horizontal position unless indicated.

.4 Valves accessible for maintenance without removing adjacent piping.

.5 Install globe valves in bypass around control valves.

.6 Use ball valves at branch take-offs for isolating purposes except where specified.

.7 Install ball valves for glycol service.

.8 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.

.16 Check Valves:

.1 Install silent check valves on discharge of pumps and as indicated.

3.8 SLEEVES

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

.2 Material: schedule 40 black steel pipe.

.3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.

.4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.5 Installation:

.1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.

.2 Other floors: terminate 25 mm above finished floor.

.3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.

.6 Sealing:

.1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.

.2 Elsewhere:

.1 Provide space for firestopping.

.2 Maintain fire rating integrity.

.3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.

.4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

.1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.

.2 Construction: one-piece type with set screws.

.1 Chrome or nickel-plated brass or type 302 stainless steel..

.3 Sizes: outside diameter to cover opening or sleeve.

.1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRE STOPPING

.1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.

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

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

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

3.11 FLUSHING OUT OF PIPING SYSTEMS

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

.2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.

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

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

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

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

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

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Pay costs for repairs or replacement, retesting, and making good. Consultant to determine whether repair or replacement is appropriate.

.6 Insulate or conceal work only after approval and certification of tests by Consultant.

3.13 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

1. General

1.1 SCOPE

.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 Operating and Maintenance Manuals

.3 Record Drawings

1.2 QUALITY ASSURANCE

.1 Work specified in this section shall be performed by an Independent Agency specializing in this type of work.

1.3 RELATED WORK IN OTHER SECTIONS

.1 Documentation for Plumbing Section 22 05 05

2. Products

2.1 OPERATING AND MAINTENANCE MANUALS

.1 Close out Procedures Section 01 78 00

2.2 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 216 mm x 280 mm, three (3) post, expanding s pine type, with metal piano hinges and bound with heavy fabric.

.4 Maximum binder thickness when filled shall not exceed 100 mm, including a space allowance for 10% additional data.

.5 Binder colour shall be blue, Ontario buckram fabric, colour #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 and Facility location.

.8 Contractor to submit proof of cover layout for review prior to ordering binders.

2.3 TABS

.1 The divider tabs shall be laminated mylar plastic and coloured 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 colouring for tabs for individual sections is as follows:

Green	Air Systems
Brown	Control Systems
Blue	Cooling Systems
Orange	Heating Systems
Yellow	Miscellaneous Systems

2.4 MANUAL DIVISIONS

.1 Organize each manual into the following divisions.

.1 Operation Division.

.2 Maintenance Division.

.3 Contract Documentation Division.

2.5 OPERATIONS DIVISIONS

.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	HTG	Heating Systems
.5	MIS	Miscellaneous 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 Future load allowances.

.8 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: hot water heating system, chilled water cooling system, ventilation systems, heat recovery 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 Equipment Identification - Provide data for each system component on equipment identification forms equal to the standard forms obtained from the design consultant.

.1 The consultant shall provide one sample reproducible copy of a form for use by the contractor. New forms produced by the contractor shall follow the same format as the sample form and contain all required information.

.5 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 Tags and 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 manufacturer’s 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.

.6 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.

.7 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

2.6 **RECORD DRAWINGS**

.1 Refer to Section 01 78 00, Contract Close-Out Procedures.

.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.

.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.

3. Execution

3.1 **GENERAL**

.1 Submit documents to the Engineer for approval prior to transmitting to the Owner.

3.2 **RECORD DRAWINGS**

.1 At substantial completion, transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, to a set of disks to AutoCAD. Drafting quality layers, symbols, etc. shall be identical to original drawings. Prior to substantial performance, turn over a completed set of disks and a complete set of mylar sepia record drawings.

.2 Each “record” mylar 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.

END OF SECTION

1. General

1.1 SCOPE

.1 Test heating glycol piping.

.2 Test chilled glycol piping.

.3 Test ductwork.

1.2 QUALITY ASSURANCE

.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.

.4 Piping, fixtures 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.

1.3 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.

1.4 LIABILTY

.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.

1.5 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1 Testing, adjusting and Balancing for HVAC Systems Section 23 05 93

2. Products

Not Applicable.

3. Execution

3.1 PRESSURE TESTS

.1 Provide equipment, materials and labour 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 Closed Loop Piping Systems: Test to 1-1/2 times maximum working pressure or 1035 kPa, whichever is greater, water pressure measured at system low point.

.4 Ducts: Check for audible leaks at 500 Pa above associated fan external static pressure.

.5 Medium Pressure Ductwork: Check for audible leaks. Test for tightness as specified by the SMACNA Manuals with maximum leakage of 1/2% at any branch or main duct at 3.0 kPa static pressure for round ductwork and 2.0 kPa static pressure for rectangular ductwork.

.6 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.7 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.8 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of work.

.9 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubbler test for air or nitrogen test medium and halide torch for refrigerant medium.

.10 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

3.2 TESTING OF SOLDERED COPPER JOINTS

.1 Submit two (2) sample soldered copper pipe joints prepared by each tradesmen to be used on the project, to the engineer within two (2) months of contract award. These samples may be subjected to radiographic testing to verify quality of workmanship.

.2 Remove ten (10) samples of soldered copper pipe joints on heating system during construction as selected by the engineer and remake joints removed. Arrange and pay for radiographic testing of removed joints 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.

END OF SECTION

1. General

1.1 SCOPE

.1 Performance testing of equipment.

.2 Manufacturer's startup of equipment.

1.2 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.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1	Testing, Adjusting and Balancing for HVAC Systems	Section 23 05 93
.2	Documentation and Training	Section 01 79 00
.3	General Commissioning	Section 01 91 13

2. Products

Not Applicable.

3. Execution

3.1 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 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.4 Confirm voltages and operating amperages at full load.

.5 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 procedures.

3.2 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.

3.3 **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 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.

.2 Terminal Boxes

.1 Measure air flow and inlet static pressure.

.2 Verify box installation duct inlet.

.3 Measure discharge sound power level at 3 m downstream.

.4 Verify DDC box control volume read outs by traverse.

.5 Measure box temperature profile.

.6 Verify box access acceptability.

.3 Air Outlets

.1 Take sound readings at specified air flows at outlets.

.2 Test each damper to ensure proper blade movement and damper closure.

.3 Verify damper accessibility for changing of the fusible links.

.4 Ductwork

.1 Low pressure supply, return and exhaust ductwork is to be tested by sound and feel for leakage.

.2 Medium and High pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Sections 23 05 07 and 23 3113.

.5 Unit Heater, Fan Coil Units

.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.

.2 Hydronic Heating System

.1 Boilers

.1 Start-up boilers as per manufacturers recommendations.

.2 Set up and adjust burner operation through all firing rates, and record efficiencies.

.2 Control Valves

.1 Record pressure drops across each valve.

.3 Pumps

.1 Run for 12 hours. (Ensure parallel pumps are equally balanced).
.2 Record motor power consumption.
.3 Calculate pump efficiency.
.4 Measure specific gravity of fluid.

.4 Tanks
.1 Verify expansion tank level at 20°C and 93°C.

.5 Piping
.1 Test to 1½ times the working pressure, minimum 1035 kPa, for eight (8) hours.

.6 Glycol System
.1 All tests to be the same as for the hot water system.
.2 Verify glycol concentration levels.

.7 Chemical Treatment System
.1 Acceptance tests by independent lab to provide performance guarantee.

.3 Cooling System

.1 Chillers
.1 Conduct chiller operational system test.
.2 Verify chiller installation requirements for venting of rupture discs.
.3 Verify piping for oil coolers.
.4 Prior to chiller operation verify that strainers are in place.

.2 Pumps & Piping
.1 All tests shall be the same as the hydronic heating system

.3 Chemical Treatment System
.1 Acceptance tests by independent lab to provide performance guarantee

.4 DDC Control System

.1 General
.1 Conduct system 7-day performance test to prove communication, loop tuning and control sequences

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).

.2 Electrical Equipment Manufacturers' Association Council (EEMAC)

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

.1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Quality Control: in accordance with Section 01 45 00 - Quality Control.

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

.2 Instructions: submit manufacturer's installation instructions.

.4 Closeout Submittals

.1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.3 QUALITY ASSURANCE

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

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

.1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

.1 Provide motors for mechanical equipment as specified.

.2 Motors under 560 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.

.3 Motors 560 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 208 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

.1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.

.2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.

.3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.

.4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.

.5 Correct size of sheave determined during commissioning.

.6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.

.7 Motor slide rail adjustment plates to allow for centre line adjustment.

.8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00 - Closeout Submittals.

2.5 DRIVE GUARDS

.1 Provide guards for unprotected drives.

.2 Guards for belt drives;

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

.3 Provide means to permit lubrication and use of test instruments with guards in place.

.4 Install belt guards to allow movement of motors for adjusting belt tension.

.1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
.2 Securely fasten in place.
.3 Removable for servicing.

.5 Unprotected fan inlets or outlets:

.1 Wire or expanded metal screen, galvanized, 19 mm mesh.
.2 Net free area of guard: not less than 80% of fan openings.
.3 Securely fasten in place.
.4 Removable for servicing.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Fasten securely in place.

.2 Make removable for servicing, easily returned into, and positively in position.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
.3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Provide infinitely variable speed drive package equipment as specified.

.2 Submit complete service and maintenance manuals including wiring and connection diagrams for review and inclusion in Maintenance Manuals.

1.2 SUBMITTALS

.1 Submit shop drawing information including, but not limited to the following:

.1 CSA approval

.2 Unit tag number and equipment number it serves

.3 Voltage, horsepower

.4 Wiring schematic

.5 Physical dimensions

.6 Copy of start-up and commissioning report

.7 Operation procedures and maintenance

1.3 REFERENCES

.1 IEEE 519-1992, Recommended Practices and Requirements for Harmonic control in Electrical Power System.

.2 FCC Part 15, Class A.

.3 UL 508, ETL.

.4 NEC.

Part 2 Products

2.1 GENERAL

.1 Furnish complete variable frequency drives as specified herein for the pumps designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD enclosure shall be NEMA 1 with inlet air filters.

.2 The VFD shall convert three-phase, 60 Hz utility power to adjustable voltage and frequency, three phase power for step-less motor speed control from 10% to 100% of the motor’s 60 Hz speed. Input voltage shall be as specified on the drawing schedules.

.3 The VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage. All VFDs shall include input line reactors.

.4 The inverter section of the VFD shall invert the DC voltage into a quality output waveform, with adjustable voltage and frequency for step-less motor speed control. The VFD shall maintain a constant V/Hz ratio.

.5 The VFD and options shall be tested to ANSI/UL Standard 508. The complete drive, including all specified options, shall be listed by a nationally recognized testing agency such as UL, ETL or CSA.

.6 Power line noise shall be limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1981, Guide for Harmonic Control and Reactive Compensation of Static Power Converters. The total voltage distortion shall not exceed 5%.

.7 The VFD shall not emit radiated RFI in excess of the limitations set forth in the FCC Rules and Regulations, Part 15 for Class A computing devices. The VFD shall carry an FCC compliance label. PWM type drives shall include RFI filters.

.8 Motor noise as a result of the VFD shall be limited to three dB over across the line operation, measured at three feet from the motor's centre line.

.9 The VFD's full load amp rating shall meet or exceed NEC Table 430-150.

.10 Protective Features:

.1 Individual motor overload protection for each motor controlled.

.2 Protection against input power undervoltage, overvoltage, and phase loss.

.3 Protection against output current overload and instantaneous over current.

.4 Protection against over-temperature within the VFD enclosure.

.5 Protection against over-voltage on the DC bus.

.6 Protect VFD from sustained power or phase loss. Under-voltage trip activates automatically when line voltage drops more than 10% below rated input voltage.

.7 Automatically reset faults due to under-voltage, over-voltage, phase loss, or over temperature.

.8 Protection against output short circuit and motor winding shorting to case faults, as defined by UL508.

.9 Status lights or digital display for indication of individual fault conditions.

.10 Controller capable of operating without a motor or any other equipment connected to the drive output to facilitate start-up and troubleshooting.

.11 Input line reactors shall be provided to minimize harmonics introduced to the AC line, and to provide additional protection to AC line transients.

.11 Interface Features:

.1 Door mounted Hand/Off/Auto selector switch to start and stop the VFD. In the auto position, the VFD will start/stop from a remote contact closure. In the HAND Position, the VFD will run regardless of the remote contact position.

.2 Manual speed control capability.

.3 Local/Remote selector switch. In the remote position, motor speed is determined by the follower signal. In the local position, motor speed is determined by the manual speed control.

.4 Power/on light to indicate that the VFD is receiving utility power.

.5 Fault light to indicate that the VFD has tripped on a fault condition.

.6 Digital meter with selector switch to indicate percent speed and percent load.

.7 A set of form-C, dry contacts to indicate when the VFD is in the fun mode.

.8 A set of form-C, dry contacts to indicate when the VFD is in the fault mode.

.9 A 0 to 10Vdc output signal to vary in direct proportion to the controller's speed.

.10 VFD to have terminal strip to accept N.C. safety contacts such as freezestats, smoke alarms, etc. VFD to safely shut down in drive or bypass mode when contacts open.

.11 VFD to accept an additional N.C. contact to interface with the Hand-Off-Auto switch for remote Stop/Start control.

.12 VFD shall accept a4 to 20 mA, 0 to 5Vdc, 0 to 10Vdc or a 3 to 15 psi pneumatic signal (if required).

.12 Adjustments:

.1 Maximum speed, adjustable 50 to 100% base speed.

.2 Minimum speed, adjustable 0 to 50% base speed.

.3 Acceleration time, adjustable 3 to 60 seconds.

.4 Deceleration time, adjustable 3to 60 seconds with override circuit to prevent nuisance trips if decel time is set too short.

.5 Current limit, adjustable 0 to 105%.

.6 Overload trip setpoint.

.7 Offset and gain to condition the input speed signal.

.13 Service Conditions:

.1 Ambient temperature, 32° to 104°F (0 to 40°C).

.2 0 to 95% relative humidity, non-condensing.

.3 Elevation to 3,300 feet (1,000 metres) without de-rating.

.4 AC line voltage variation, -10 to +10% of nominal.

.14 Special Features:

.1 The following special features shall be included in the VFD enclosure. The unit shall maintain its UL, ETL Listing and CSA certification.

.2 Motor overload protection shall be provided in both drive and bypass modes.

.3 A door interlocked, pad lockable drive disconnect switch shall be provided to disconnect power from the VFD only.

.4 A second fused disconnect switch or circuit breaker shall be provided as a means of disconnecting all power to both the VFD and bypass circuits, as well as providing short circuit and locked rotor protection to the motor while in the bypass mode.

.5 The disconnect and bypass functions may be accomplished via disconnects, contactors and overloads, or with a four-position drive/off/line/test switch with motor starter and bypass fuses.

.6 ***VFDS that serve fans shall have a terminal strip to accept dampers end-switch contact. VFD is to be disabled when damper end-switch is not closed.***

.15 Quality Assurance:

.1 To ensure quality and minimize infantile failures at the jobsite, the complete VFD shall be tested by the manufacturer. The VFD shall operate a dynamometer at full load and the load and speed shall be cycled during the test.

.2 All optional features shall be functionally tested at the factory for proper operation.

.16 Submittals:

.1 Submit manufacturer's performance data including dimensional drawings, customer connection drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFD's FLA rating, certification agency file numbers and catalogue information.

.2 The specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

Part 3 Execution

3.1 START-UP SERVICE

.1 The manufacturer shall provide start-up commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at

the customer's site. Sales personnel and other agents who are not factory certified technicians for drive field repair shall not be acceptable as commissioning agents.

.2 Start-up services shall include checking for verification of proper operation and installation for the VFD, its options and its interface wiring to the building automation system. Included in this service shall be (as a minimum):

.1 Verification of contractor wire terminations to the VFD and its optional circuitry

.2 Installation verification for proper operation and reliability of the VFD, the motor being driven, and the building automation system

.3 Up to one hour of customer operator training on operation and service diagnostics at the time of the equipment commissioning

.4 Measurement for verification of proper operation on each of the following items:

.5 Motor voltage and frequency. Verification of proper motor operation

.6 Control input for proper building automation system interface and control calibration.

.7 Calibration check for the following set points (and adjustment as necessary):

.1 Minimum speed,

.2 Maximum speed,

.3 Acceleration and deceleration rates

3.2 WARRANTY

.1 The VFD shall be warranted by the manufacturer for a period of 36 or 18 months from date of shipment. The warranty shall include parts, labour, travel costs and living expenses incurred by the manufacturer to provide factory authorized on-site service.

.2 The motor(s) which are directly connected to the VFD shall be warranted by the VFD manufacturer against insulation breakdown which is directly attributed to the VFD. The length of the motor insulation warranty shall be the same as the VFD warranty. The motor must never have been driven by another VFD.

3.3 EXAMINATION

.1 Contractor to verify that jobsite conditions for installation meet factory recommended and code required conditions for VFD installation prior to start-up. These shall include as a minimum:

.1 Clearance spacing

.2 Temperature, contamination, dust, and moisture of the environment

.3 Separate conduit installation of the motor wiring, power wiring, and control wiring

.4 Installation per the manufacturer's recommendations

.2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.

END OF SECTION

1. General

1.1 SCOPE

.1 Expansion tanks.

.2 Glycol fill tanks.

.3 Accessories and connection to piping system.

.4 Saddles and structural supports.

1.2 STANDARDS

.1 Construct pressure tanks to ASME Code for Unfired Pressure Vessels.

.2 Comply with Provincial Government Regulations.

1.3 SUBMITTALS

.1 Submit shop drawings; comply with Section 01 33 00, Submittal Procedures.

1.4 INSPECTIONS

.1 Obtain inspection certificates for pressure vessels from Provincial Authorities

2. Products

2.1 EXPANSION TANKS

.1 Tank shall be closed type, welded steel rated for working pressure, cleaned, prime coated and supplied with steel support saddles.

.2 Construct tank with necessary tappings for installation of accessories.

.3 Provide gauge glass set consisting of brass compression stops and guard. Glass shall be long enough to cover the tank from 50 mm above the bottom to 50 mm below the top. Maximum length of each glass shall be 600 mm.

.4 Provide quick connect air inlet of automotive tire valve type, pipe from top of tank to accessible location on wall, and tank drain hose bibb on bottom of tank.

.5 Provide pressure relief valve.

.6 Provide pressure relief valve, and automatic cold water fill assembly complete with positive displacement meter, pressure reducing valve, reduced pressure back flow preventer valve with test cocks, strainer, pressure gauge, and valved bypass around reducing valve only, as shown on drawings, for chilled water and heating water expansion tanks.

2.2 EXPANSION TANKS, DIAPHRAGM TYPE

.1 Welded steel, rated for working pressure, supplied with steel support structure.

.2 Pre-charged air chamber, heavy duty butyl diaphragm bonded with polypropylene liner to steel shell separating air chamber from water.

.3 Provide with air side charge connection and water side inlet connection.

.4 Include items listed in 2.2.4, 2.2.5 and 2.2.6 above.

2.3 **GLYCOL CHARGING TANKS**

.1 Pressure Vessel Type

.1 Closed type ASME rated pressure vessel, welded steel.

.2 Red zinc rich primer coating, inside and out.

.3 Steel skirt for vertical floor support.

.4 Maximum 600 mm long gauge glass sections from top of tank to bottom, brass try cocks, ball check stops and guards.

.5 Accessories:

.1 Pressure gauge

.2 Funnel with valve on top of tank

.3 Pressure reducing valve with bypass

.4 Gauge glass assembly

.5 Pressure relief valve

.6 Inlet, discharge, drain, gauge glass, pressure relief valve tappings.

3. Execution

3.1 **INSTALLATION**

3.2 Support tanks inside building from building structure as indicated on drawings. Provide 100 mm high housekeeping bases on floor mounted tanks.

3.3 Provide 12 mm compressed air line with flexible coiled hose at each expansion tank and charging tank complete with fitting compatible with quick connect on the tank. Extend line and hose down to 1200 mm above floor level.

3.4 **PERFORMANCE**

.1 Provide tanks of dimensions and capacities indicated on the drawings and/or tank schedule.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

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

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

.1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit copy of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

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

.1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.

.3 Submittals to include:

.1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.

.2 Service conditions.

.3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.

.4 Accuracy statements for each component at specified flow rates and other conditions.

.5 Flow and temperature ranges.

.6 Signal processor calibration data.

.7 Minimum turndown ratio.

.4 Samples:

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

.2 Samples to include:

.1 Full size samples of recorder charts, integrator readings.

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

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

.2 Instructions: submit manufacturer's installation instructions.

.6 Closeout Submittals:

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

1.3 QUALITY ASSURANCE

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 ACCURACY

.1 Calculate overall accuracy of each installation using following expression: Overall accuracy = (E (accuracy of individual components of system)^2)1/2.

.2 Components to include:

.1 Primary flow measuring elements.

.2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.

.3 RTD's.

.4 Signal processors, recorders.

.5 Calibration of signal processors: assume 0.20% per processor.

.6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.

.3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.

.4 Indicate minimum measurable flow rate.

2.2 CHILLED/HOT WATER METERING

.1 Type of metering:

.1 Wide range

.2 Design data:

.1 Flow rates:
  .1 100% Design.
  .2 Normal design flow rate: 70% of 100% design flow rate.
  .3 Minimum flow rate: 20% of maximum.
.2 Supply temperature: 5 degrees C.
.3 Return temperature: 13degrees C.

.3 State in proposal:
  .1 Point of change-over.
  .2 How change-over will be achieved.

.4 Design differential pressure at normal design flow rate: 25 kPa.

.5 Maximum accuracy of complete meter installation at normal design flow and design temperatures to be plus or minus 1%.

.6 Flow transmitters may form an integral part of primary flow measuring element.

.7 Standard of design for venture primary flow measuring elements: ASME Fluid Meter Handbook.

.8 State in proposal maximum irrecoverable head loss (IHL).

.9 Available lengths of straight pipe to first fitting, and intrusion: as indicated.

.10 State in proposal minimum lengths of straight pipe required upstream and downstream of primary element to meet specified accuracy requirements.

.11 If meter to be smaller than main size, state in proposal size of pipe required.

.12 Temperature sensors:
  .1 100-ohm RTD.
  .2 Thermowells to NPS 3/4 stainless steel thermowell filled with conductive paste with following insertion lengths:
    .1 Up to NPS 6: 75 mm.
    .2 NPS 8 and over: 150 mm.
  .3 Sensors for temperature difference measurements to be matched pairs.

.13 Signal transmission between primary measuring element and signal conditioners:
  .1 Power: 24 VDC.
  .2 Signal: 0-10 VDC.
  .3 Cable: colour coded, twisted and shielded pair with grounding wire.

.14 Connection to Building Automation System (BAS):
  .1 Refer to Controls specifications.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PREPARATION

.1 Before final calculations for orifice diameter, and before purchase of venturi, measure:

.1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.

.2 For concentricity of pipe.

3.3 INSTALLATION OF PRIMARY ELEMENT

.1 Follow manufacturer's instructions.

3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING

.1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.

.2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

3.5 INSTALLATION OF SIGNAL TRANSMISSION CABLE

.1 Ground shielding at one point only.

.2 Protect against RF interference.

.3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

3.6 START-UP

.1 Follow manufacturer's recommendations.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

- .1 ASME B40.100, Pressure Gauges and Gauge Attachments.
- .2 ASME B40.200, Thermometers, Direct Reading and Remote Reading.

.2 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-14.4, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.
- .2 CAN/CGSB-14.5, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.

.3 Efficiency Valuation Organization (EVO)

- .1 International Performance Measurement and Verification Protocol (IPMVP)

.4 Green Seal Environmental Standards (GS)

- .1 GS-11, Standard for Paints and Coatings.
- .2 GS-36, Standard for Commercial Adhesives.

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 thermometers and pressure gauges and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Certificates:

- .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.4 Test and Evaluation Reports:

- .1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

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 thermometers and pressure gauges in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect thermometers and pressure gauges from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

Part 2 Products

2.1 GENERAL

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

.2 Ranges: as indicated.

2.2 DIRECT READING THERMOMETERS

.1 Industrial, mercury-free, liquid filled, 125 mm scale length: to CAN/CGSB-14.4

.1 Resistance to shock and vibration.

2.3 REMOTE READING THERMOMETERS

.1 100 mm diameter mercury-free liquid filled activated dial type: to CAN/CGSB-14.5 accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless-steel case for wall mounting.

2.4 THERMOMETER WELLS

.1 Copper pipe: copper or bronze.

.2 Steel pipe: brass

2.5 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Siphon for steam service.

.2 Snubber for pulsating operation.

.3 Diaphragm assembly for corrosive service.

.4 Gasketed pressure relief back with solid front.

.5 Bronze stop cock.

.6 Oil filled for high vibration applications.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 GENERAL

.1 Install thermometers and gauges so they can be easily read from floor or platform.

.1 If this cannot be accomplished, install remote reading units.

.2 Install between equipment and first fitting or valve.

3.3 THERMOMETERS

.1 Install in wells on piping. Include heat conductive material inside well.

.2 Install in locations as indicated and on inlet and outlet of:

.1 Heat exchangers.

.2 Water heating and cooling coils.

.3 Water boilers.

.4 Chillers.

.5 Cooling towers.

.6 DHW tanks.

.3 Install wells as indicated and as required for balancing purposes.

.4 Use extensions where thermometers are installed through insulation.

3.4 PRESSURE GAUGES

.1 Install in locations as follows:

.1 Suction and discharge of pumps.

.2 Upstream and downstream of PRV's.

.3 Upstream and downstream of control valves.

.4 Inlet and outlet of coils.

.5 Inlet and outlet of liquid side of heat exchangers.

.6 Outlet of boilers.

.7 Inlet and Outlet of Chillers

.8 In other locations as indicated.

.2 Install gauge cocks for balancing purposes and elsewhere as indicated.

.3 Use extensions where pressure gauges are installed through insulation.

3.5 NAMEPLATES

.1 Install engraved lamacoid nameplates in accordance with Section 23 05 53 – Painting and Identification for HVAC Systems.

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 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by thermometer and gauge installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).

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

.2 ASTM International

.1 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes.

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

.3 ASTM B283, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).

.4 ASTM B505/B505M, Standard Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1 MSS-SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.

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

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.

.3 Shop Drawings:

.1 Submit data for valves specified in this Section.

1.3 CLOSEOUT SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.1 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.
.2 Discs: one for every 10 valves, each size. Minimum 1.
.3 Stem packing: one for every 10 valves, each size. Minimum 1.
.4 Valve handles: 2 of each size.
.5 Gaskets for flanges: one for every 10 flanged joints.

.2 Tools:
.1 Furnish special tools for maintenance of systems and equipment.
.2 Include following:
.1 Lubricant gun for expansion joints.

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

.3 Packaging Waste Management in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Valves:

.1 Except for specialty valves, to be single manufacturer.
.2 Products to have CRN registration numbers.

.2 End Connections:

.1 Connection into adjacent piping/tubing:
.1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
.2 Copper tube systems: solder ends] to ANSI/ASME B16.18.

.3 Lock shield Keys:

.1 Where lock shield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

.4 Globe Valves:

.1 Requirements common to globe valves, unless specified otherwise:
.1 Standard specification: MSS SP-80.
.2 Bonnet: union with hexagonal shoulders.
.3 Connections: screwed with hexagonal shoulders.
.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.

.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.

.6 Handwheel: non-ferrous.

.7 Handwheel Nut: bronze to ASTM B62.

.2 NPS 2 and under, composition disc, Class 125:

.1 Body and bonnet: screwed bonnet.

.2 Disc and seat: renewable rotating disc composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: lock shield.

.3 NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: lock shield.

.4 NPS 2 and under, plug disc, Class 150, screwed ends:

.1 Body and bonnet: union bonnet.

.2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.

.3 Operator: handwheel.

.5 Angle valve, NPS 2 and under, composition disc, Class 150:

.1 Body and bonnet: union bonnet.

.2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.

.3 Operator: lock shield.

.5 Check Valves:

.1 Requirements common to check valves, unless specified otherwise:

.1 Standard specification: MSS SP-80.

.2 Connections: screwed with hexagonal shoulders.

.2 NPS 2 and under, swing type, bronze disc, Class 125:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.3 NPS 2 and under, swing type, bronze disc:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.4 NPS 2 and under, swing type, composition disc, Class 200:

.1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.

.2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.

.5 NPS 2 and under, horizontal lift type, composition disc, Class 150:

.1 Body: with integral seat, union bonnet ring with hex shoulders, cap.

.2 Disc: renewable rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.

.6 NPS 2 and under, vertical lift type, bronze disc, Class 125:

.1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

.6 Silent Check Valves:

.1 NPS 2 and under:

.1 Body: cast high tensile bronze to ASTM B62 with integral seat.

.2 Pressure rating: Class 125.

.3 Connections: screwed ends to ANSI B1.20.1 and with hex. shoulders.

.4 Disc and seat: renewable rotating disc.

.5 Stainless steel spring, heavy duty.

.6 Seat: regrindable.

.7 Ball Valves:

.1 NPS 2 and under:

.1 Body and cap: cast high tensile bronze to ASTM B62.

.2 Pressure rating: Class125.

.3 Connections: solder ends to ANSI.

.4 Stem: tamperproof ball drive.

.5 Stem packing nut: external to body.

.6 Ball and seat: replaceable stainless-steel solid ball and Teflon seats.

.7 Stem seal: TFE with external packing nut.

.8 Operator: removable lever handle.

Part 3 Execution

3.1 INSTALLATION

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

.2 Remove internal parts before soldering.

.3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.2 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.2 ASTM International Inc.

.1 ASTM A49, Standard Specification for Heat-Treated Carbon Steel Joint Bars.

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

.3 ASTM A536, Standard Specification for Ductile Iron Castings.

.4 ASTM B61, Standard Specification for Steam or Valve Bronze Castings.

.5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 ASTM B85/B85M, Standard Specification for Aluminum-Alloy Die Castings.

.7 ASTM B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1 MSS SP-61, Pressure Testing of Steel Valves.

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

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

.4 MSS SP-82-, Valve Pressure Testing Methods.

.5 MSS SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:

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

.3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials/Spare Parts:

.2 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size, minimum 1.

.3 Stem packing: one for every 10 valves, each size, minimum 1.

.4 Valve handles: 2 of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

.3 Tools:

.1 Furnish special tools for maintenance of systems and equipment.

.2 Include following:

.1 Lubricant gun for expansion joints.

Part 2 Products

2.1 MATERIAL

.1 Valves:

.1 Except for specialty valves, to be of single manufacturer.

.2 Standard specifications:

.1 Gate valves: MSS SP-70.

.2 Globe valves: MSS SP-85.

.3 Check valves: MSS SP-71.

.3 Requirements common to valves, unless specified otherwise:

.1 Body, bonnet: cast iron to ASTM B209 Class B ductile iron to ASTM A536 Grade 65-45-12.

.2 Connections: flanged ends with 2 mm raised face with serrated finish to ANSI B16.1.

.3 Inspection and pressure testing: to MSS SP-82.

.4 Bonnet gasket: non-asbestos.

.5 Stem: to have precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.

.6 Stuffing box: non-galling two-piece ball-jointed packing gland, gland bolts and nuts.

.7 Gland packing: non-asbestos.

.8 Handwheel: die-cast aluminum alloy to ASTM B85/B85M or malleable iron to ASTM A49. Nut of bronze to ASTM B62.

.9 Identification tag: with catalogue number, size, other pertinent data.

.4 All products to have CRN registration numbers.

2.2 GATE VALVES

.1 NPS 2 1/2-8, outside screw and yoke (OS Y), bronze trim, solid wedge disc:

.1 Body and multiple-bolted bonnet: with bosses in body and bonnet for taps and drains, full length disc guides designed to ensure correct re-assembly, yoke, yoke hub, yoke sleeve and nut. Class 125.

.2 Disc: solid offset taper wedge, bronze to ASTM B62 up to NPS 3, cast iron with bronze disc rings on other sizes, secured to stem through integral forged T-head disc-stem connection.

.3 Seat rings: renewable bronze screwed into body.

.4 Stem: manganese-bronze.

.5 Disc: solid offset taper all-cast iron, secured to stem through integral forged T-head disc-stem connection.

.6 Seat rings: integral with body.

.7 Stem: nickel-plated steel.

.8 Pressure-lubricated operating mechanism.

.9 Operator: handwheel.

2.3 UNDERWRITERS APPROVED GATE VALVE

.1 NPS 2 1/2 - 14, OS Y:

.1 Approvals: UL and FM approved for fire service.

.2 UL and FM Label: on valve yoke.

.3 Body, Bonnet: cast iron to ASTM A126 Class B. Wall thicknesses to ANSI B16.1 and ULC C-262 (B), ductile iron to ASTM A536 Grade 65-45-12.

.4 Bonnet bushing, yoke sleeve: bronze, to FM requirements.

.5 Packing gland: bronze.

.6 Stem: manganese bronze. Diameter to ULC C-262 (B). Brass, ASTM B16.

.7 Stuffing box dimensions, gland bolt diameter: to ULC C-262 (B).

.8 Bosses for bypass valve, drain: on NPS 4 and over.

.9 Disc: solid taper wedge. Up to NPS 3: bronze. NPS 4 and over: EPDM coated cast iron with bronze disc rings.

.10 Disc seat ring: self-aligning, Millwood undercut on NPS 3 - 12.

.11 Pressure rating:

.1 NPS 2-1/2 - 12: 1.7 Mpa CWP.

.2 NPS 14-1.2: 1.2 MPa CWP.

.12 Operator: handwheel.

2.4 GLOBE VALVES

.1 NPS 2 1/2 - 10, OSY:

.1 Body: with multiple-bolted bonnet.

.2 WP: 860 kPa steam, 1.4 MPa CWP.

.3 Bonnet-yoke gasket: non-asbestos.

.4 Disc: bronze to ASTM B62, fully guided from bottom, securely yet freely connected to stem for swivel action and accurate engagement with disc.

.5 Seat ring: renewable, regrindable, screwed into body.

.6 Stem: bronze to ASTM B62.

.7 Operator: handwheel.

2.5 VALVE OPERATORS

.1 Install valve operators as follows:

.1 Handwheel: on valves except as specified.

.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.6 CHECK VALVES

.1 Swing check valves, Class 125:

.1 Body and bolted cover: with tapped and plugged opening on each side for hinge pin. Flanged ends: plain faced with smooth finish.

.1 Up to NPS 16: cast iron to ASTM A126 Class B, ductile iron ASTM A536 Grade 65-45-12.

.2 Ratings:

.1 NPS 2 1/2 - 12: 860 kPa steam; 1.4 MPa CWP.

.2 NPS 14 - 16: 860 kPa steam; 1.03 MPa CWP.

.3 NPS 18 and over: 1.03 MPa CWP.

.3 Disc: rotating for extended life.

.1 Up to NPS 6: stainless steel type 316.

.2 NPS 8 and over: bronze-faced cast iron.

.4 Seat rings: renewable bronze to ASTM B62 screwed into body.

.5 Hinge pin, bushings: stainless steel.

.6 Disc: A126 Class B, secured to stem, rotating for extended life.

.7 Seat: cast iron, integral with body.

.8 Hinge pin: exelloy; bushings: malleable iron.

.9 Identification tag: fastened to cover.

.10 Hinge: stainless steel.

.2 Swing check valves, NPS 2 1/2 - 8 Class 250:

.1 Body and bolted cover: cast iron to ASTM A126 Class B with tapped and plugged opening on each side for hinge pin.

.2 Flanged ends: 2 mm raised face with serrated finish.

.3 Rating: 250 psi steam; 500 psi CWP.

.4 Disc: rotating for extended life.

.1 Up to NPS 3: bronze to ASTM B61.

.2 NPS 4 - 8: iron faced with ASTM B61 bronze.

.5 Seat rings: renewable bronze to ASTM B61, screwed into body.

.6 Hinge pin, bushings: renewable, bronze to ASTM B61.

.7 Hinge: galvanized malleable iron.

.8 Identification tag: fastened to cover.

2.7 SILENT CHECK VALVES

.1 Construction:

.1 Body: ductile iron with integral seat.

.2 Pressure rating: Class 125, WP = 860 kPa.

.3 Connections: flanged.

.4 Disc: bronze renewable rotating disc.

.5 Seat: renewable, EPDM.

.6 Stainless steel spring, heavy duty.

Part 3 Execution

3.1 INSTALLATION

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

3.2 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.2 Clean installed products in accordance to manufacturer's recommendation.

.3 Waste Management: separate waste in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

- .1 ASME B16, Fittings and Valves Package.
- .2 ASME B16.5Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
- .3 ANSI/ASME B16.10 Face-to-Face and End-to-End Dimensions Valves.
- .4 ANSI/ASME B16.25 Buttwelding Ends.
- .5 ANSI/ASME B16.34, Valves Flanged, Threaded and Welding End. Includes Supplement (2010).

.2 American Petroleum Institute (API)

- .1 API STD 598, Valve Inspection and Testing.

.3 ASTM International

- .1 ASTM A49, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
- .2 ASTM A182/A182M, Standard Specification for Specification for Forged or Rolled Alloy and Stainless-Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
- .3 ASTM A193/A193M, Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature or High-Pressure Service and Other Special Purpose Applications.
- .4 ASTM A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
- .5 ASTM A216/A216M, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
- .6 ASTM B85/B85M, Standard Specification for Aluminum-Alloy Die Castings.

.4 Efficiency Valuation Organization (EVO)

- .1 International Performance Measurement and Verification Protocol (IPMVP)

.5 Green Seal Environmental Standards (GS)

- .1 GS-11, Standard for Paints and Coatings.
- .2 GS-36, Standard for Commercial Adhesives.

.6 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

- .1 MSS SP-25, Standard Marking System for Valves, Fittings, Flanges and Unions.
- .2 MSS SP-61, Pressure Testing of Valves.

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 and include product characteristics, performance criteria, physical size, finish and limitations.

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

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for valves for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect valves from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section.

.5 Packaging Waste Management: remove for reuse as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Extra Stock Materials:

.3 Furnish following spare parts:

.1 Valve seats: one for every 10 valves each size, minimum 1.

.2 Discs: one for every 10 valves, each size, minimum 1.

.3 Stem packing: one for every 10 valves, each size. Minimum 1.

.4 Valve handles: 2]of each size.

.5 Gaskets for flanges: one for every 10 flanged joints.

Part 2 Products

2.1 MATERIAL

.1 Valves:

.1 To be of single manufacturer.

.2 Test valves individually.

.2 Requirements common to valves, unless specified otherwise:

.1 Pressure-temperature ratings: to ANSI B16.34.

.2 Inspections and tests: to API 598.

.3 Pressure testing: to MSS SP-61.

.4 Flanged valves:

.1 Face-to-face dimensions: to ANSI B16.10.

.2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.

.5 Butt-weld valves:

.1 End-to-end dimensions: to ANSI B16.10.

.2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.

.6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.

.7 Markings: to MSS SP-25.

.8 Identification:

.1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.

.2 Body markings: manufacturer, size, primary service rating, material symbol.

.9 CRN registration number required for all products.

2.2 GATE VALVES

.1 NPS 2 1/2 - 12, rising stem, OS Y, solid wedge disc, flanged ends.

.1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.

.2 Body/bonnet joint: flat or male-female face with corrugated metallic gasket.

.3 Bonnet studs: to ASTM A193/A193M Type B7.

.4 Bonnet nuts: to ASTM A194/A194M Type 2H.

.5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.

.6 Gland packing: containing corrosion inhibitor to prevent stem pitting.

.7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.

.8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.

.9 Disc: with disc stem ring to connect to stem, guided throughout its travel.

.1 NPS 2 1/2 - 6: solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.

.2 NPS 8 and larger: carbon steel faced with corrosion and heat resistant 13 chromium steel with minimum hardness of 350 HB.

.10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.

.11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.

.12 Operator: see elsewhere in this Section.

2.3 GLOBE VALVES

.1 NPS 2 1/2 - 12, rising stem, OS Y, flanged ends, Class 150

.1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.

.2 Body/bonnet joint: [flat] [male-female] face with corrugated metallic gasket.

.3 Bonnet studs: to ASTM A193/A193M Type B7.

.4 Bonnet nuts: to ASTM A194/A194M Type 2H.

.5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.

.6 Gland packing: containing corrosion inhibitor to prevent stem pitting.

.7 Yoke bushing: Ni-Resist, minimum melting point above 954 degrees C.

.8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.

.9 Disc: plug type with 15 degrees taper seat and bottom guide or ball type with 35 degrees taper seat.

.10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.

.11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.

.12 Operator: see elsewhere in this Section.

2.4 VALVE OPERATORS

.1 Handwheel: on all valves.

.2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.

2.5 CHECK VALVES

.1 NPS 2 1/2 and over, flanged ends, Class150swing check.

.1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.

.2 Cap studs: to ASTM A193/A193M Type B7.

.3 Cap nuts: to ASTM A194/A194M Type 2H.

.4 Body/cap joint: male-female face with corrugated metallic gasket.

.5 Disc: heat treated corrosion and heat resistant 13% chromium steel.

.6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.

.7 Hinge: ASTM A182/A182M.

.8 Hinge pin: ASTM A182/A182M.

.9 Hinge pin plugs: ASTM A182/A182M.

2.6 SILENT CHECK VALVES

.1 Construction:

.1 Body: cast steel.

.2 Pressure rating: Class 125].

.3 Connections: flanged ends.

.4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.

.5 Stainless steel spring, heavy duty.

.6 Seat: regrindable.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.3 COMMISSIONING

.1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

.3 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by cast steel valve installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASME B31.1-2007/B31.3-2008 - Power Piping and Process Piping (Set).

.2 ASME B31.2-1968 - Fuel Gas Piping.

.3 ASME B31.5-2010 - Refrigeration Piping and Heat Transfer Components.

.4 ASME B31.9-2011 - Building Services Piping.

.5 ASTM F708-92(2008) - Standard Practice for Design and Installation of Rigid Pipe Hangers.

.6 MSS SP-58-2009 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

.7 MSS SP-69-2002 - Pipe Hangers and Supports Selection and Application.

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

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

.10 UL 203-2005 - Pipe Hanger Equipment for Fire-Protection Service (9th Edition).

1.2 SUBMITTALS FOR REVIEW

.1 Section 01 33 00: Submission procedures.

.2 Product Data: Provide manufacturers catalogue data including load capacity.

.3 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.

1.3 SUBMITTALS FOR INFORMATION

.1 Section 01 33 00: Submission procedures.

.2 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

.3 Installation Data: Indicate special installation procedures and assembly of components.

1.4 REGULATORY REQUIREMENTS

.1 Conform to applicable code for support of hydronic and plumbing and piping.

.2 Supports for Sprinkler Piping: To NFPA 13.

.3 Supports for Standpipes: To NFPA 14.

Part 2 Products

2.1 PIPE HANGERS AND SUPPORTS

.1 Fire Protection Piping:

.1 Conform to NFPA 13.

.2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm: Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.2 Plumbing Piping - DWV:

.1 Conform to ASTM F708

.2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel, adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm: Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.3 Plumbing Piping - Water:

.1 Conform to ASME B31.9.

.2 Hangers for Pipe Sizes 13 to 38 mm Carbon steel, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.

.5 Hangers for Hot Pipe Sizes 150 mm and over: Adjustable steel yoke, cast iron roll, double hanger.

.6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.7 Multiple or Trapeze Hangers for Hot Pipe Sizes 150 mm and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

.8 Wall Support for Pipe Sizes to 75 mm: Cast iron hook.

.9 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.

.10 Wall Support for Hot Pipe Sizes 150 mm and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast-iron roll.

.11 Vertical Support: Steel riser clamp.

.12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.13 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.14 Floor Support for Hot Pipe Sizes 150 mm and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

.15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.4 Hydronic Piping:

.1 Conform to ASME B31.9.

.2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel, adjustable swivel, split ring.

.3 Hangers for Cold Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.

.4 Hangers for Hot Pipe Sizes 50 to 100 mm: Carbon steel, adjustable, clevis.

.5 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.6 Wall Support for Pipe Sizes to 76 mm: Cast iron hook.

.7 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.

.8 Vertical Support: Steel riser clamp.

.9 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.10 Floor Support for Hot Pipe Sizes to 100 mm: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.11 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

.5 Refrigerant Piping:

.1 Conform to ASME B31.5.

.2 Hangers for Pipe Sizes 13 to 38 mm: Carbon steel adjustable swivel, split ring.

.3 Hangers for Pipe Sizes 50 mm and Over: Carbon steel, adjustable, clevis.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

.5 Wall Support for Pipe Sizes to 75 mm: Cast iron hook.

.6 Wall Support for Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

.9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

.1 Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS

.1 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.4 FLASHING

.1 Metal Flashing: 0.50 mm galvanized steel.

.2 Metal Counterflashing: 0.80 mm galvanized steel.

.3 Lead Flashing:

.1 Waterproofing: 24.5 kg/sq m sheet lead.

.2 Soundproofing: 5 kg/sq m sheet lead.

.4 Flexible Flashing: 1.2 mm thick sheet butyl; compatible with roofing.

.5 Caps: Steel, 0.8 mm minimum; 1.5 mm at fire resistant elements.

2.5 EQUIPMENT CURBS

.1 Fabrication: Welded 1.2 mm galvanized steel shell and base, mitred 75 mm cant, variable step to match root insulation and factory installed wood nailer.

2.6 SLEEVES

.1 Sleeves for Pipes Through Non-fire-Rated Floors: 1.2 mm thick galvanized steel.

.2 Sleeves for Pipes Through Non-fire-Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 1.2 mm thick galvanized steel.

.3 Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed, refer to Section 07 84 00.

.4 Sleeves for Round Ductwork: Galvanized steel.

.5 Sleeves for Rectangular Ductwork: Galvanized steel or wood.

.6 Firestopping and Insulation: Glass fibre type, non-combustible; refer to Section 07 84 00.

.7 Sealant: Acrylic, refer to Section 07 92 00.

Part 3 Execution

3.1 INSTALLATION

.1 Install components to manufacturer's written instructions.

3.2 INSERTS

.1 Provide inserts for placement in concrete formwork.

.2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

.3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 100 mm.

.4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

.5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with above slab.

3.3 PIPE HANGERS AND SUPPORTS

.1 Support horizontal piping as scheduled.

.2 Install hangers to provide minimum 13 mm space between finished covering and adjacent work.

.3 Place hangers within 300 mm of each horizontal elbow.

.4 Use hangers with 38 mm minimum vertical adjustment.

.5 Support horizontal cast iron pipe adjacent to each hub, with 1.5 m maximum spacing between hangers.

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

.7 Support riser piping independently of connected horizontal piping.

.8 Provide copper plated hangers and supports for copper piping.

.9 Design hangers for pipe movement without disengagement of supported pipe.

.10 Prime coat exposed steel hangers and supports as specified in Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 EQUIPMENT BASES AND SUPPORTS

.1 Provide housekeeping pads of concrete, minimum 100 mm thick and extending 150 mm beyond supported equipment. Refer to Section 03 30 00.

.2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

.3 Construct supports of steel members. Brace and fasten with flanges bolted to structure.

.4 Provide rigid anchors for pipes after vibration isolation components are installed.

3.5 FLASHING

.1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm minimum above finished roof surface with lead worked 25 mm minimum into hub, 200 mm minimum clear on sides with 600 x 600 mm sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.

.3 Flash floor drains in floors with topping over finished areas with lead, 250 mm clear on sides with minimum 910x 910 mm sheet size. Fasten flashing to drain clamp device.

.4 Seal shower, floor, mop sink and drains watertight to adjacent materials.

.5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms and acoustic rated rooms, installed to manufacturer's written instructions for sound control.

.6 Provide curbs for mechanical roof installations 350 mm minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.

.7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

.1 Set sleeves in position in formwork. Provide reinforcing around sleeves.

.2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

.3 Extend sleeves through floors 25 mm above finished floor level. Caulk sleeves.

.4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping and insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

.5 Install chrome plated steel escutcheons at finished surfaces.

3.7 SCHEDULES

PIPE SIZE	MAX. HANGER SPACING	DIAMETER
12 - 32 mm	2 m	9 mm
38 - 50 mm	3 m	9 mm
62 - 75 mm	3 m	13 mm
100 - 150 mm	3 m	15 mm
200 - 300 mm	4.25 m	22 mm
PVC (All Sizes)	1.8 m	9 mm

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

.2 National Fire Protection Association (NFPA)

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

.3 National Building Code of Canada (NBC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit copy of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

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

.1 Provide separate shop drawings for each isolated system complete with performance and product data.

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

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

.2 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 QUALITY ASSURANCE

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

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

2.2 ELASTOMERIC PADS

.1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.

.2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30durometer natural rubber; maximum loading 415 kPa.

.3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.

.4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

.1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

.1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.

.2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.

.3 Cadmium plate for outdoor installations.

.4 Colour code springs.

2.5 SPRING MOUNT

.1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.

.2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.

.3 Type M3 - stable open spring: 6]mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.

.4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.

.5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

.6 Performance: as indicated.

2.6 HANGERS

.1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.

.2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.

.3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.

.4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.

.5 Type H4 - stable spring, elastomeric element with pre-compression washer and nut with deflection indicator.

.6 Performance: as indicated.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

.1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy-duty duck and neoprene isolation material.

2.8 HORIZONTAL THRUST RESTRAINT

.1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.

.2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.9 STRUCTURAL BASES

.1 Type B1 - Prefabricated steel base: integrally welded on sizes up to 2400 mm on smallest dimension, split for field welding on sizes over 2400 mm on smallest dimension and reinforced for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; pre-drilled holes to receive equipment anchor bolts; and complete with adjustable built-in motor slide rail where indicated.

.2 Type B2 - Steel rail base: structural steel, positioned for alignment of drive and driven equipment; without supplementary hold down devices; complete with isolation element attached to base brackets arranged to minimize height; and pre-drilled holes to receive equipment anchor bolts.

.3 Bases to clear housekeeping pads by 25 mm minimum.

2.10 INERTIA BASE

.1 Type B3 - Full depth perimeter structural or formed channels, frames: welded in place reinforcing rods running in both directions; spring mounted, carried by gusseted height-saving brackets welded to frame; and clear housekeeping pads by 50 mm minimum.

.2 Pump bases: "T" shaped, where applicable, to provide support for elbows.

.3 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.

2.11 ROOF CURB ISOLATION RAILS

.1 General: complete factory assembled without need for sub-base.

.2 Lower member: continuous rectangular steel tube

.3 Upper member: continuous rectangular steel tube to provide continuous support for equipment, complete with all-directional neoprene snubber bushings 6 mm thick to resist wind forces.

.4 Springs: steel, adjustable, removable, selected for 25 mm maximum static deflection plus 50% additional travel to solid, cadmium plated, sized and positioned to ensure uniform deflection.

.5 High frequency isolation: 6 mm minimum thick continuous gasket on top and bottom of complete assembly. Material: closed cell neoprene.

.6 Weatherproofing: continuous flexible counterflashing to curb and providing access to springs. Material: aluminum

.7 Hardware: cadmium plated or galvanized.

.8 Roof curbs to meet ARCA requirements.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.

.2 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.

.3 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:

.1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.

.2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.

.4 Where isolation is bolted to floor use vibration isolation rubber washers.

.5 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

.6 Install roof curbs to meet ARCA requirements.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.

.2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:

.1 After delivery and storage of Products.

.2 After preparatory work is complete but before installation commences.

.3 Twice during the installation, at 25% and 60% completion stages.

.4 Upon completion of installation.

.3 Submit manufacturer's reports to Consultant within 3 days of manufacturer representative's review.

.4 Make adjustments and corrections in accordance with written report.

.2 Inspection and Certification:

.1 Experienced and competent sound and vibration testing professional engineer to take vibration measurement for HVAC systems after start-up and TAB of systems to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.2 Take vibration measurements for equipment listed below.

.1 Chiller

.2 AHU

.3 Pumps

.3 Provide Consultant with notice 24 h in advance of commencement of tests.

.4 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).

.5 Submit complete report of test results including sound curves.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. General

1.1 SCOPE

.1 Prepare the facility for balancing.

1.2 RELATED REQUIREMENTS

.1	HVAC Equipment Testing and Start-Up	Section 23 05 08
.2	General Commissioning	Section 01 91 13

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

.1	Documentation for HVAC Systems	Section 23 05 05
.2	Testing, Adjusting and Balancing for HVAC Systems	Section 23 05 93
.3	Commissioning	Section 01 91 13

2. Products

Not Applicable

3. Execution

3.1 INSTALLATION

.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, clean systems as per Section 23 08 02, HVAC Water Treatment, drain and fill with clean treated heat exchange fluid.
- .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.
- .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.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

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

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Provide documentation confirming qualifications, successful experience.

.2 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.

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

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

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

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

.7 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started to

.2 confirm in writing to Consultant adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.3 Review specified standards and report to Consultant in writing proposed procedures which vary from standard.

.4 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required Consultant for verification of TAB reports.

1.9 START OF TAB

.1 Notify Consultant 5 days prior to start of TAB.

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

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

.4 Application of weatherstripping, sealing, and caulking.

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

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC Equipment: plus 5%, minus 5 %.

.2 HVAC Diffusers/Grilles: plus 10%, minus 10 %.

.3 Hydronic Equipment: plus or minus 5 %.

.4 Hydronic Terminals Units: plus or minus 10 %.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Consultant list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Consultant.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Consultant, prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.15 TAB REPORT

.1 Format in accordance with [referenced standard].

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 1 copy of TAB Report to Consultant for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Consultant.

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

.3 Number and location of verified results as directed by Consultant.

.4 Pay costs to repeat TAB as required to satisfaction of Consultant.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Consultant, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Consultant.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of this section and TAB standards of SMACNA and ASHRAE.

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

.3 Qualifications: personnel performing TAB current member in good standing of AABC and NEBB.

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

.5 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

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

1.20 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:

.1 Qualifications of TAB personnel: as for air systems specified this section.

.2 Quality assurance: as for air systems specified this section.

.2 Building pressure conditions:

.1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times

.3 Zone pressure differences:

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

.4 Measurement of spatial noise:

.1 TAB procedures:

.1 Measure and record noise in 6 selected rooms to document fan coil and air supply noise.

1.21 POST-OCCUPANCY TAB

.1 Participate in systems checks once during Warranty Period.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 NOT USED

.1 Not used.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA HVAC Air Duct Leakage Test Manual.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:

.1 Submit proposed report form and test report format to Consultant for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Consultant.

.2 Prepare report of results and submit to Consultant within 24 hours of completion of tests. Include:

.1 Schematic of entire system.

.2 Schematic of section under test showing test site.

.3 Required and achieved static pressures.

.4 Orifice differential pressure at test sites.

.5 Permissible and actual leakage flow rate (L/s) for test sites.

.6 Witnessed certification of results.

.3 Include test reports in final TAB report.

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

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturer's field reports specified.

1.3 QUALITY ASSURANCE

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting one week prior to beginning work of this Section.

.1 Verify project requirements.

.2 Review installation conditions.

.3 Co-ordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

Part 2 Products

2.1 TEST INSTRUMENTS

.1 Test apparatus to include:

.1 Fan capable of producing required static pressure.

.2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.

.3 Flow measuring instrument compatible with the orifice plate.

.4 Calibration curves for orifice plates used.

.5 Flexible duct for connecting to ductwork under test.

.6 Smoke bombs for visual inspections.

.2 Test apparatus: accurate to within +/- 3 % of flow rate and pressure.

.3 Submit details of test instruments to be used to Consultant at least three months before anticipated start date.

.4 Test instruments: calibrated and certificate of calibration deposited Consultant no more than [28] days before start of tests.

.5 Re-calibrated every six months thereafter.

2.2 EQUIPMENT LEAKAGE TOLERANCES

.1 Equipment and system components such as fan coil units, duct heating leakage: 2 %.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 TEST PROCEDURES

.1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.

.2 Section of duct to be tested to include:

.1 Fittings, branch ducts, tap-ins.

.3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.

.4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

.5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

.1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: not to exceed total allowable leakage.

.2 Leakage tests on following systems not to exceed specified leakage rates.

.1 Small duct systems up to 250 Pa: leakage 2%.

.2 VAV box and duct on downstream side of VAV box: leakage 2%.

.3 Large low-pressure duct systems up to 500 Pa: leakage 2%.

.4 MP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1%.

.3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

.1 Test ducts before installation of insulation or other forms of concealment.

.2 Test after seals have cured.

.3 Test when ambient temperature will not affect effectiveness of seals, and gaskets.

.4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services.

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately, to Consultant.

.2 Performance Verification:

.1 To be certified by same TAB agency approved by Consultant to undertake TAB on this project.

3.6 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - means "not concealed" as previously defined.

.3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:

.1 CRD: Code Round Ductwork,

.2 CRF: Code Rectangular Finish.

.2 Reference Standards:

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

.1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Green Seal Environmental Standards (GSES)

.1 Standard GS-36, Commercial Adhesives.

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.7 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.

.1 Description of equipment giving manufacturer's name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

.3 Samples:

.1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.

.2 Mount sample on 12 mm plywood board.

.3 Affix typewritten label beneath sample indicating service.

.4 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, and cleaning procedures.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: specialist in performing work of this section and have at least 3 years successful experience in this size and type of project and a member of TIAC.

1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

.3 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 To CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

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

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

.4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).

.1 Mineral fibre: to ASTM C553.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to ASTM C553.

2.3 JACKETS

.1 Canvas:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.1 Maximum VOC limit to SCAQMD Rule 1168

.3 Aluminum:

.1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.

.2 Thickness: 0.50 mm sheet.

.3 Finish: Smooth

.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

.1 Stainless steel:

.5 Type: 316.

.6 Thickness: 0.25mm sheet.

.7 Finish: Smooth

.8 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

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

.1 Maximum VOC limit to SCAQMD Rule 1168.

.2 Indoor Vapour Retarder Finish:

.1 Vinyl emulsion type acrylic, compatible with insulation.

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

.4 ULC Listed Canvas Jacket:

.1 220 gm/m^2 cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921

.5 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

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

.6 Tape: self-adhesive, aluminum, plain 75 mm wide minimum.

.7 Contact adhesive: quick-setting

.1 Maximum VOC limit to SCAQMD Rule 1168.

.8 Canvas adhesive: washable.

.1 Maximum VOC limit to SCAQMD Rule 1168.

.9 Tie wire: 1.5 mm stainless steel.

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

.11 Facing: 25 mm stainless steel hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face.

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

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE-INSTALLATION REQUIREMENTS

.1 Pressure test ductwork systems complete, witness and certify.

.2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

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

.3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Ensure hangers and supports are outside vapour retarder jacket.

.5 Hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum [2] rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Supply, return and exhaust ducts exposed in space being served	none		
Outside air ducts to mixing plenum	C-1	yes	25
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts	none		

.2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:

.1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.1 Finishes: conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

3.5 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ANSI/ASHRAE 90.1-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.2 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

.4 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.

.5 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.6 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52MA, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB 51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.

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

.1 Material Safety Data Sheets (MSDS).

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Thermal Insulation Association of Canada (TIAC)

.1 National Insulation Standards 2005.

.7 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide one copy WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 – Environmental Procedures.

.3 Samples:

.1 Provide for review: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.

.1 Mount sample on 12 mm plywood board.

.2 Affix typewritten label beneath sample indicating service.

.4 Manufacturer's Instructions:

.1 Include procedures to be used and installation standards to be achieved.

.5 Qualifications:

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

1.3 DELIVERY, STORAGE AND HANDLING

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

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

.3 Store at temperatures and conditions recommended by manufacturer.

.4 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 Fire and smoke ratings to CAN/ULC-S102:

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre: includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Maximum "k" factor: ASTM C547.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C547.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C547.

.5 TIAC Code C-1: rigid mineral fibre board, unfaced.

.1 Mineral fibre: ASTM C612.

.2 Maximum "k" factor: ASTM C612.

.6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.

.1 Mineral fibre: ASTM C612.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C612.

.7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: ASTM C553.

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor: ASTM C553.

.8 TIAC Code A.6: flexible unicellular tubular elastomer.

.1 Insulation: [with vapour retarder jacket].

.2 Jacket: to CGSB 51-GP-52MA.

.3 Maximum "k" factor.

.4 Certified by manufacturer free of potential stress corrosion cracking corrodents.

.9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: ASTM C533.

.2 Maximum "k" factor: ASTM C533.

.3 Design to permit periodic removal and re-installation.

2.3 CEMENT

.1 Thermal insulating and finish

.1 To: ASTM C449/C449M.

.2 Hydraulic setting Air drying on mineral wool, to ASTM C449.

2.4 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint as selected by Consultant

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.8 Covering adhesive: compatible with insulation.

.2 Canvas:

.1 220gm/m^2 cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.3 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: smooth

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, [0.5]mm thick at 300 mm spacing.

.4 Stainless steel:

.1 Type: 316.

.2 Thickness: 0.25 mm.

.3 Finish: smooth

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.5 INSULATION SECUREMENTS

.1 Tape: self-adhesive, aluminum, plain 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.

.6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation with expanded metal lath on other face].

.7 Fasteners: 4 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

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

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER MASTIC

.1 Vinyl emulsion type acrylic, compatible with insulation.

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

Part 3 Execution

3.1 APPLICATION

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

3.2 PRE- INSTALLATION REQUIREMENTS

.1 Pressure testing of equipment and adjacent piping systems complete, witnessed and certified.

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

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards

.1 Hot equipment: To TIAC code 1503-H.

.2 Cold equipment: to TIAC code 1503-C.

.2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.

.3 Provide vapour retarder as recommended by manufacturer.

.4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.

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

.6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Hangers and supports outside vapour retarder jacket.

.7 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: At expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

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

3.5 FIRE SUPPRESSION EQUIPMENT INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 Hot Equipment:

.1 TIAC code A-1with bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC code C-2 unfaced with bands and 13 mm cement precede by one layer of reinforcing mesh.

.3 Thicknesses: heat exchanges 50 mm.

.3 Cold equipment:

.1 TIAC A-3with bands and 13 mm cement reinforced with one layer of reinforcing mesh.

.2 TIAC C-2 faced with vapour retardant jacket and with bands and 13 mm cement preceded by one layer of reinforcing mesh.

.3 TIAC A-6with bands.

.4 Thicknesses: chillers (except factory insulated) 50 mm.

.4 Finishes:

.1 Equipment in mechanical rooms: TIAC code CEF/1 with aluminum jacket.

.2 Equipment elsewhere: TIAC code CEF/2 with 13 mm cement jacket.

3.6 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

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

.1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.

.2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.

.6 ASTM C547, Mineral Fiber Pipe Insulation.

.7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.

.2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations

.1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

.3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings

.4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.2 DEFINITIONS

.1 For purposes of this section:

.1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.

.2 "EXPOSED" - will mean "not concealed" as specified.

.2 TIAC ss:

.1 CRF: Code Rectangular Finish.

.2 CPF: Code Piping Finish.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit one copy of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.3 Shop Drawings:

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

.4 Samples:

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

.2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.

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

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

1.4 QUALITY ASSURANCE

.1 Qualifications:

.2 Installer: specialist in performing work of this Section and have at least 3 years successful experience in this size and type of project, member of TIAC.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

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

.2 Storage and Protection:

.1 Protect from weather, construction traffic.

.2 Protect against damage.

.3 Store at temperatures and conditions required by manufacturer.

.3 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Place excess or unused insulation and insulation accessory materials in designated containers.

.3 Dispose of unused adhesive material at official hazardous material collections site.

Part 2 Products

2.1 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.2 INSULATION

.1 Mineral fibre specified includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.

.3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702

.2 Maximum "k" factor: to CAN/ULC-S702.

.4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.

.1 Mineral fibre: to CAN/ULC-S702.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702

.5 TIAC Code C-2: mineral fibre blanket faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).

.1 Mineral fibre: to CAN/ULC-S702

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Maximum "k" factor: to CAN/ULC-S702

.6 TIAC Code A-6: flexible unicellular tubular elastomer.

.1 Insulation: with vapour retarder jacket.

.2 Jacket: to CGSB 51-GP-52Ma.

.3 Certified by manufacturer: free of potential stress corrosion cracking corrodents.

.7 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.

.1 Insulation: to ASTM C533.

.2 Design to permit periodic removal and re-installation.

2.3 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain 50 mm wide minimum.

.2 Contact adhesive: quick setting.

.3 Canvas adhesive: washable.

.4 Tie wire: 1.5 mm diameter stainless steel.

.5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

.1 Thermal insulating and finishing cement:

.1 Air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 JACKETS

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.

.2 Colours: to match adjacent finish paint as selected by Consultant.

.3 Minimum service temperatures: -20 degrees C.

.4 Maximum service temperature: 65 degrees C.

.5 Moisture vapour transmission: 0.02 perm.

.6 Fastenings:

.1 Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Tacks.

.3 Pressure sensitive vinyl tape of matching colour.

.7 Special requirements:

.1 Outdoor: UV rated material at least 0.5 mm thick.

.2 Canvas:

.1 220gm/m² cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

.3 Aluminum:

.1 To ASTM B209.

.2 Thickness: 0.50 mm sheet.

.3 Finish: smooth

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

.4 Stainless steel:

.1 Type: 316.

.2 Thickness: 0.25 mm.

.3 Finish: smooth.

.4 Joining: longitudinal and circumferential slip joints with 50 mm laps.

.5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5mm thick at 300 mm spacing.

2.9 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 00 - Joint Sealants.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 PRE-INSTALLATION REQUIREMENT

.1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

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

3.3 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturers instructions and this specification.

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

.4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.

.1 Install hangers, supports outside vapour retarder jacket.

.5 Supports, Hangers:

.1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Application: at expansion joints, valves, primary flow measuring elements, flanges and unions at equipment.

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

.3 Insulation:

.1 Insulation, fastenings and finishes: same as system.

.2 Jacket: aluminum or PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.

.2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

.1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.

.2 TIAC Code: A-1.

.1 Securements: Tape

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code 1501-H.

.3 TIAC Code: A-3.

.1 Securements: Tape.

.2 Seals: VR lap seal adhesive, VR lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.4 TIAC Code: A-6.

.1 Insulation securements:

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code.

.5 TIAC Code: C-2 with vapour retarder jacket.

.1 Insulation securements:

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-C.

.6 TIAC Code: A-2.

.1 Insulation securements:

.2 Seals: lap seal adhesive, lagging adhesive.

.3 Installation: TIAC Code: 1501-H.

.7 Thickness of insulation as listed in following table.

.1 Run-outs to individual units and equipment not exceeding 4000 mm long.

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

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)	to 1	1 1/4 to 2	2 1/2 to 4
Run out	up to 175	[A-1]		25	25	38
Hot Water Heating	60 - 94	[A-1]		38	50	50
Hot Water Heating	up to 59	[A-1]		25	38	38
Glycol Heating	60 - 94	[A-1]		38	50	50
Glycol Heating	up to 59	[A-1]		25	38	38
Domestic HWS		[A-1]		25	25	38
Chilled Water	4 - 16	[A-3]		25	25	25
Chilled Water or Glycol	below 4	[A-3]		25	38	38
Chilled Water Pump Casing		[A-3]		25	25	25
Domestic CWS		[A-3]		25	25	25
Domestic CWS with vapour retarder		[C-2]		25	25	25
Refrigerant hot gas, liquid, suction		[A-6]		25	25	25
RWL and RWP		[C-2]		25	25	25
Cooling Coil cond. drain		[C-2]		25	25	25

.8 Finishes:

.1 Exposed indoors: PVC jacket.

.2 Exposed in mechanical rooms: canvas jacket.

.3 Concealed, indoors: canvas on valves, fittings. No further finish.

.4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.

.5 Outdoors: water-proof aluminum jacket.

.6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.

.7 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

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

1.3 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

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

.2 When systems are operational, perform following tests:

.1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

.2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.

.1 Pump operation.

.2 Boiler and/or chiller operation.

.3 Pressure bypass open/closed.

.4 Control pressure failure.

.5 Maximum heating demand.

.6 Maximum cooling demand.

.7 Boiler and/or chiller failure.

.8 Cooling tower (and/or industrial fluid cooler) fan failure.

.9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.4 HYDRONIC SYSTEM CAPACITY TEST

.1 Perform hydronic system capacity tests after:

.1 TAB has been completed

.2 Verification of operating, limit, safety controls.

.3 Verification of primary and secondary pump flow rates.

.4 Verification of accuracy of temperature and pressure sensors and gauges.

.2 Calculate system capacity at test conditions.

.3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.

.4 When capacity test is completed, return controls and equipment status to normal operating conditions.

.5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.

.6 Heating system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or

.2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.

.2 Test procedures:

.1 Open fully heat exchanger, heating coil and radiation control valves.

.2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.

.3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

.7 Chilled water system capacity test:

.1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:

.1 Adding heat from building heating system or;

.2 Raising space temperature by turning off cooling and air systems for sufficient period of time before starting testing and pre-heating building to summer design space temperature (occupied) or above. Set OAD and RAD for minimum outside air if OAT is near outside design temperature or to maximum recirculation if RAT is greater that OAT. RAT to be at least 23 degrees C minimum.

.2 Test procedures:

.1 Open fully cooling coil control valves.

.2 Set thermostats on associated AHU's for maximum cooling.

.3 Set AHU's for design maximum air flow rates.

.4 Set load or demand limiters on chillers to 100%.

.5 After system has stabilized, record chilled water, and condenser water flow rates and supply and return temperatures simultaneously.

1.5 GLYCOL SYSTEMS

.1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.6 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:

.1 Verify performance of equipment and systems as specified elsewhere in Division 23.

.2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.

.3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

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

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

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

.3 Demonstrate that fire hose will reach to most remote location regardless of partitions, and obstructions.

.4 Verify operation of interlocks between HVAC systems and fire alarm systems.

1.8 SANITARY AND STORM DRAINAGE SYSTEMS

.1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and freedom from obstructions.

.2 Ensure that traps are fully and permanently primed.

.3 Ensure that fixtures are properly anchored, connected to system.

.4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

.5 Cleanouts: refer to Section 22 42 00 – Commercial Plumbing Fixtures.

.6 Roof drains:

.1 Refer to Section 22 42 00 – Commercial Plumbing Fixtures.

.2 Remove caps as required.

1.9 REPORTS

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements]: Reports, supplemented as specified herein.

1.10 TRAINING

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified herein.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

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

.1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

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

1.3 QUALITY ASSURANCE

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 CLEANING SOLUTIONS

.1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.

.2 Sodium carbonate: 0.40 kg per 100 L water in system.

.3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 CLEANING HYDRONIC AND STEAM SYSTEMS

.1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.

.2 Cleaning Agency:

.1 Retain qualified water treatment specialist to perform system cleaning.

.3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete.

.4 Cleaning procedures:

.1 Provide detailed report outlining proposed cleaning procedures at least [4] weeks prior to proposed starting date. Report to include:

.1 Cleaning procedures, flow rates, elapsed time.

.2 Chemicals and concentrations used.

.3 Inhibitors and concentrations.

.4 Specific requirements for completion of work.

.5 Special precautions for protecting piping system materials and components.

.6 Complete analysis of water used to ensure water will not damage systems or equipment.

.5 Conditions at time of cleaning of systems:

.1 Systems: free from construction debris, dirt and other foreign material.

.2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.

.3 Strainers: clean prior to initial fill.

.4 Install temporary filters on pumps not equipped with permanent filters.

.5 Install pressure gauges on strainers to detect plugging.

.6 Report on Completion of Cleaning:

.1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.

.7 Hydronic Systems:

.1 Fill system with water, ensure air is vented from system.

.2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

.3 Use water metre to record volume of water in system to +/- 0.5%.

.4 Add chemicals under direct supervision of chemical treatment supplier.

.5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.

.6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.

.7 Add chemical solution to system.

.8 Establish circulation, raise temperature slowly to maximum design, 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

.8 Glycol Systems:

.1 In addition to procedures specified above perform specified procedures.

.2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF HYDRONIC SYSTEMS

.1 After cleaning is completed and system is filled:

.1 Establish circulation and expansion tank level, set pressure controls.

.2 Ensure air is removed.

.3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.

.4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.

.5 Clean out strainers repeatedly until system is clean.

.6 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.

.7 Repeat with water at design temperature.

.8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.

.9 Bring system up to design temperature and pressure over a 48-hour period.

.10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

.11 Adjust pipe supports, hangers, springs as necessary.

.12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.

.13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.

.14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.

.15 Check operation of drain valves.

.16 Adjust valve stem packings as systems settle down.

.17 Fully open balancing valves (except those that are factory-set).

.18 Check operation of over-temperature protection devices on circulating pumps.

.19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23, EMCS General Requirements and other related EMCS Sections.

1.2 RELATED REQUIREMENTS

.1 EMCS Field Sensing Devices and Actuators: Section 23 09 29.

.2 EMCS Control Sequences: Section 23 09 93.

1.3 START-UP SHEETS

.1 Provide "Physical Point Confirmation" sheets as follows:

1. Basic form of sheets shall follow ordering and layout of point sheets in section 230930. Provide sample for review prior to commencement of Start-up checks.
2. Include the following information/fields:
   - .1 System description and mnemonic
   - .2 Point description and mnemonic
   - .3 RCU number or identifier
   - .4 Point Type and Specified accuracy
   - .5 Tagged (tick box indicating presence of properly affixed identification tag/s)
   - .6 Verified (tick box indicating successful end-to-end wiring check)
   - .7 EMCS displayed value
   - .8 Field measured value
   - .9 Calibration offset value
   - .10 Identifier/name of graphic containing EMCS displayed value
   - .11 Contractor's initials
   - .12 Verifier's initials (Minister's Representative)
   - .13 Remarks

.2 Provide "Analogue Output Device Range" sheets as follows:

1. These sheets are to be used in addition to the Physical Point Confirmation sheets and shall include all EMCS analogue output devices. Order of devices shall follow ordering of analogue outputs as found on the Physical Point Confirmation sheets. Provide sample for review prior to commencement of Start-up checks.
2. Include the following information/fields:
   - .1 System description and mnemonic
   - .2 Point description and mnemonic
   - .3 RCU number or identifier
   - .4 Specified range

.5 FCE state at EMCS output value of 0% of range
.6 FCE state at EMCS output value of 20% of range
.7 FCE state at EMCS output value of 80% of range
.8 FCE state at EMCS output value of 100% of range
.9 FCE state at EMCS output value of 80% of range
.10 FCE state at EMCS output value of 20% of range
.11 FCE state at EMCS output value of 0% of range
.12 Actual range of device
.13 Verified FCE end-of-travel @ 0% (tick box indicating successful check)
.14 Verified FCE end-of-travel @ 100% (tick box indicating successful check)
.15 Failsafe position (NO/NC, OFF/ON, etc.)
.16 Verified (tick box indicating successful failsafe check)
.17 Contractor's initials
.18 Verifier's initials (Minister's Representative)
.19 Remarks

NOTE 1: FCE state refers to the position or value of the Final Control Element affected by the analogue output. Examples: damper or valve position, fan speed, setpoint reset value, etc.

NOTE 2: FCE end-of-travel refers to the end condition achieved by the FCE. Examples: dampers/valves achieve full open or tight shut off, fan achieves specified min/max speed, setpoint achieves specified max/min reset value, etc

.3 Provide "Flow Measuring Station Calibration" sheets as follows:

3. These sheets are to be used in addition to the Physical Point Confirmation sheets and shall include all EMCS analogue input devices used for flow rate measurement. Provide a sheet for each station. Sort sheets to follow ordering of these inputs as found on the Physical Point Confirmation sheets. For each flow station type, provide sample for review prior to commencement of Start-up checks.
4. Include the following information/fields:
   .1 System description and mnemonic
   .2 Point description and mnemonic
   .3 RCU number or identifier
   .4 Type, make, model and serial number of each measuring instrument used
   .5 Flow station type, make, model, size and serial number if available
   .6 Transducer:
   .7 type, make and model
   .8 operating range
   .9 serial number if available
   .10 zeroed (tick box indicating device was checked for proper zero reading)
   .11 Start and stop times of measurement sequence
   .12 Media (air, water, glycol) temperature

5. For Air-Flow Stations: Provide fields to record traverses according to recommendations of the 2005 A.S.H.R.A.E. Fundamentals Handbook (SI version), chapter 14 "Measurement and Instruments", page 14.17 “Measuring Flow in Ducts”. Use the Log-Tchebycheff Rule dimensions, for both rectangular and round ducts as given in Figure 7 on page 14.18. Include field to record atmospheric barometric pressure at time of testing.
6. For Fluid-Flow Stations: Provide fields to record data according to the station manufacturer’s recommended calibration procedures. Include fields to record fluid type, density and application.
7. Provide space for performing required calculations. Include all flow calculation formula used as well as fields for correction factors applied.
8. Include fields to record EMCS trend data and the calculations used in determining the average of the displayed flow rates over the duration of the tests.
9. Provide a summary area for the calculation of a flow station calibration equation that will be entered into the EMCS database or via programming.

.4 All values and calculations shall be in MKS (metric) units.

1.4 DOCUMENTATION

.1 Submit complete system documentation before start of testing, including:

1. programmer's instruction manuals.
2. CCU operating system software manuals and original diskettes.
3. application software program manuals and original diskettes.
4. operating manuals for terminals and end devices.
5. interlock and control schematics for each system controlled, identifying each EMCS physical point by mnemonic.
6. table of operating set points and alarm limits for each system.
7. device calibration methods and procedures.
8. list of all real and virtual mnemonics, with full English description of each mnemonic.
9. well documented User Control Language software with comment lines to explain control strategies. Alternatively, written description of control strategy for each software module.
10. backup disks for User Control Language Software.

2. Products

Not Used

3. Execution

3.1 HARDWARE

.1 Verify that each hardware component has been properly installed as recommended by manufacturer and is functioning correctly.

.2 Verify that all circuits are complete and all terminal wiring connections are tight.

.3 Electronic hardware:

1. Start-up electronic hardware as recommended by manufacturer.
2. Replace defective components.
3. Prove proper operation, use software diagnostic.

.4 Interfaces:

1. Test to ensure interfaces with Division 26 and other control packages are complete.
2. Verify that interface cabinets comply with applicable codes and specified requirements.

.5 Check operation of system under failure modes:

1. Power failure.
2. RCU failure.
3. Network failure.
4. Sensor failure.

3.2 POINT CHECK OUT

.1 Verify point mnemonic, hardware address, correct physical location and proper Functioning of each hardware point on system. Record verification of each point on “Physical Point Confirmation” sheets.

.2 Calibrate all analogue input/output devices, actuators, transducers and sensors as recommended by manufacturer.

.3 Achieve end-to-end (between field device and actual value displayed on screen) calibration accuracy over full expected operating range as specified for each analogue point type in Section 23 09 30:

1. Calibration may be performed on the hardware device if this feature is available, or may be entered into database/software provided correction is not greater than five (5) times specified accuracy for device. Device must be replaced and calibrated again if correction is outside this band. Combination coarse hardware and fine database/software calibration is allowed.
2. Simple offset calibration is acceptable where the operating range is less than 25% of the device span. Slope calibration is required for devices operating over larger spans. A two-point slope calibration, where the samples are about 20% from each end of the operating range is acceptable if the resulting offset at the middle of the operating range falls within the specified accuracy.
3. All database/software calibrations must be entered even if these fall within the specified accuracy.
4. Document each calibration correction on "Physical Point Confirmation" Sheets.

.4 Check range and repeatability of each analogue output point. Ensure tight shut-off of dampers and valves.

.5 Variable Air Volume systems with Air Flow Measuring stations:

1. Statically adjust each pressure transducer to zero with both ports at ambient pressure. Check each transducer's span for linearity and range using an inclined manometer or a Shortridge Air Data Multi-meter in parallel with the transducer.
2. Dynamically calibrate each Air Flow Measuring station using the procedure defined on "Flow Measuring Station Calibration" sheets. Document the results on "Flow Measuring Station Calibration" sheets. For air systems flowing less than 5000 l/s, it is acceptable to use two calibration points at 60% and 85% vane/speed position. For small air systems flowing less than 2000 l/s, it is acceptable to use a single calibration point at 75% vane/speed position.
3. If, at any flow setting, the EMCS displayed flow rate differs by more than 5% from the measured flow rate, add an air flow measuring station calibration correction equation to the controls software or point database. The equation must go through the origin. Any zero offset usually corresponds to an improper zeroing of the velocity pressure transducer. A linear equation that provides a simple slope correction to achieve final accuracy to better than 5% is preferred.

3.3 APPLICATION SOFTWARE

.1 Ensure all hardware is installed and started and fully operational before software start-up.

.2 Enter each physical point into database and include following:

1. Set up run time capture for each digital output.
2. Enter engineering units for each analogue point.
3. Set up an alarm point for each digital input/output pair, with delay before alarm is enunciated.
4. Set up an alarm point for each analogue input with high and low limits. Provide a reset differential.
5. Enter physical point calibration corrections.
6. Enter analogue input conversion equations for fluid velocity measuring devices.

.3 Enter start/stop schedules for all systems not required to run continuously.

.4 Trend Logs:

1. Enter trend logs for each physical input and output points in EMCS database. Trends will be set for 5 minutes intervals. IO that are stable in nature may be triggered on a change of state equal to 1% of full range. Instances of stable IO include space temperature and AHU supply air temperatures.
2. Provide trend log of ten second interval, readings for each P.I.D. loop controlling and controlled variable. Variables that are stable in nature may be triggered on a change of state. Instances of stable variables include temperature setpoints.
3. Trend logs stored in the remote controller units shall retain a minimum of four readings per hour for 24 hours. These trends will be uploaded on a daily bases to a storage devise sized to store two years of trend data.
4. Trend logs shall be continuous and shall overwrite information once it has been stored.
5. Grouping of trend log points on print outs shall be agreed with the Minister.

.5 Verify proper operation of dynamic graphics:

1. Proper identification of system and points on screen.
2. Data refresh period.
3. Dynamic valve/damper actuators displayed on screen.
4. Colour change on status change.
5. Reaction to alarms.
6. Trend graph reporting.

3.4 DEMONSTRATION OF APPLICATION SOFTWARE

.1 Demonstrate following to the building operator:

1. Man/machine interface to EMCS system, including operator access, all monitoring functions and command of points.
2. Saving and reloading of database. Provide a checklist describing the procedures to be followed.
3. The use of disk backup utilities by creating bootable CDs containing a complete image backup of the hard disk. Save must be performed at the highest rewrite speed available on CD-RW drive. Provide a checklist describing the procedures to be followed.
4. User Control Language program entry and editing.
5. Operation of specific application software such as:
   - .1 demand limiting.
   - .2 peak shaving.
   - .3 night setback.
   - .4 optimum start of heating/cooling systems.
   - .5 building dynamic control.
   - .6 alarm conditions and printouts.
   - .7 automatic report generation.

3.5 3.8 USER CONTROL SOFTWARE IMPLEMENTATION

.1 Demonstrate User Control Language software operation, start up and shut down sequences, software interlocks, fail safe, emergency shut down and alarm condition control strategies in accordance with the requirements of Section 23 09 93.

END OF SECTION

1. General

1.1 INTENT

.1 This Section specifies general requirements common to all energy management and control system (EMCS) work. Read this Section in conjunction with all Sections that specify EMCS work.

1.2 QUALITY ASSURANCE

.1 Provide a complete EMCS for the mechanical systems supplied and installed by firms specializing in this type of work.

.2 At completion of installation provide minimum of 3 half day instruction periods for operating personnel.

.3 Provide for complete service of controls systems, including callbacks, for one year running concurrent with guarantee.

1.3 RELATED REQUIREMENTS

.1 Available Information Documents: Section 00 31 00.

.2 Common Work Results For Electrical: Section 26 05 00.

.3 Conduit: Section 26 05 34.

1.4 ABBREVIATIONS

.1 BACnet: ASHRAE Standard Building Automation & Control Network Protocol

.2 BIBB: BACnet Interoperability Building Block

.3 Blu_Ray: High density digital video/data disk

.4 CCS: Central Control Station

.5 DDC: Distributed Digital Control

.6 DVD: Digital Video Disk (-R, +R, -RW etc)

.7 EEPROM: Electrically Erasable Programmable ROM

.8 EMCS: Energy Management Control Systems

.9 EPROM: Ultraviolet Erasable Programmable ROM

.10 LonWorks: ANSI/EIA 709.1 Control Networking Standard

.11 LonMark: LonWorks devices certified by the LonMark Interoperability Association

.12 Objects: Data constructs containing information including, but not limited to, physical or virtual points and attributes.

.13 Examples: analogue or digital inputs, outputs and calculated values, occupancy schedules, control loops, alarms, commands, programs, etc.

.14 PCS: Portable Control Station

.15 PID: Proportional Integral Derivative

.16 RAM: Random Access Memory

.17 RCU: Remote Control Unit

.18 ROM: Read Only Memory

.19 TCU: Terminal Control Unit

.20 UCL: User Control Language

1.5 CONSTRUCTION SCHEDULE

.1 Comply with requirements of Division 01.

.2 Include EMCS installation schedule as part of the construction progress schedule. Include start and finish dates for:

1. equipment ordering and delivery.
2. hardware installation.
3. start-up and point calibration
4. software loading and testing
5. system testing and trial use by owner.

.3 Coordinate EMCS schedule with construction schedule.

1.6 CONSTRUCTION PROGRESS MEETINGS

.1 Comply with requirements of Division 01.

1.7 SHOP DRAWINGS AND INFORMATION

.1 Comply with requirements of Division 01 and as follows:

1. Within [30] days of contract award, provide:
   - .1 CAD drawings of the proposed system architecture. Include all CCSs, RCUs and TCUs as well as LAN devices.
   - .2 point layouts of all RCUs as well as wiring diagrams for attached devices. Include Logical Point Mnemonics.
   - .3 technical data sheets for all equipment and devices.
2. Within [60] days of contract award, provide:

.1 control software descriptions, by module, explaining EMCS control sequences and logic. Include Logical Point Mnemonics for all virtual points as well as print out or code for each module.

.2 dynamic graphic displays, for key plan, each mechanical system and floor plan.

1.8 PROJECT RECORD DOCUMENTS

.1 Comply with requirements of Division 01.

1.9 EMCS MANUALS, CATALOGUES AND BACKUPS

.1 Operators' Manuals: Provide operators' instruction manuals. Manuals shall guide operators through all menu options, with an explanation of each option. Manuals shall describe the use of operator's interface including all function keys, "hot" keys, reporting features, start/stop scheduling, etc.

.2 Programmers' Manuals: Provide programming instruction manuals for the User Control Language. Manuals shall list all procedures, functions, operators and reserved words together with a description and examples of their use in programming.

.3 Application Program Manuals: Provide instruction manuals for any brand-name or proprietary software used for terminal emulation, communication, graphics generation, etc.

.4 Computers, Peripheral and Device Manuals: Provide instruction and maintenance manuals for all CCSs, PCSs, printers and modems as well as any other peripheral or electronic device supplied under this contract.

.5 Proof of ownership: Provide proof-of-ownership in the form of licensed disks, software manuals, registration cards, or, in the case of proprietary software, formal letter of transmittal, for all software that is required to fulfill contract requirements.

.6 EMCS Catalogue: Provide a current catalogue and price list that includes the components provided under this contract as well as related system components and accessories.

.7 Backups: Download all RCU and TCU databases and programs onto the primary CCS hard disk prior to performing a comprehensive backup. Provide three (3) complete system backup packages. Each package shall contain everything necessary to restore the EMCS to full operation should a catastrophic failure occur and as follows:

1. Include an image backup of the complete CCS hard disk, onto removable media, using the system backup software specified in Section 23 09 25 "EMCS Central Portable Control Stations".
2. Include a copy of the software required to restore the hard drive from the image backup.
3. Include text files of the CCS's CMOS settings as well as any important configuration files such as config.sys and autoexec.bat.
4. Include a hardcopy sheet describing the exact steps required to restore the hard drive.
5. Include a hardcopy sheet describing the exact steps required to restore an RCU or TCU.

6. One backup package shall be left at the primary CCS location. Another is to be included in the Operation & Maintenance Manual that will remain on site. The final package shall be turned over to the Owner.

1.10 OPERATION & MAINTENANCE MANUALS AND O&M DISK

.1 Provide three complete copies of an EMCS Operation and Maintenance Manual.

1. Organize manual as follows:
   - .1 Operations Division: EMCS Hardware (Configuration/Installation)
   - .2 Operations Division: EMCS Software (Database/Programming)
   - .3 Operations Division: Pneumatic/Electric (Non-EMCS Subsystems)
   - .4 Maintenance Division
   - .5 Contract Documentation Division
   - .6 O&M Disk (full manual and system backup in electronic format)
2. Split manual into two or more binders if content exceeds 75mm in thickness.
3. At the beginning of each binder, provide a table of contents listing divider tabs in all binders making up the full manual.
4. D-ring binders with two plastic sheet lifters and clear outside overlay pockets are acceptable if total contents are less than 35mm in thickness. Otherwise provide binders that are silk screened, commercial quality, fabric coated, three post, with hard covers attached to spine with metal piano hinges.
5. Each binder cover and spine shall display the following information:
   - .1 City/Town
   - .2 Building Name
   - .3 Project Title
   - .4 Binder Name, examples:
     - .1 EMCS Operations and Maintenance Manual
     - .2 EMCS Operations and Maintenance Manual
     - .3 (Operations Division: Hardware and Software)
     - .4 EMCS Operations and Maintenance Manual (Maintenance and Contract Divisions)
     - .5 Date (month and year only)

.2 Operations Division - EMCS Hardware (Configuration/Installation):

1. Organize the information into sections, with index and divider tabs, as follows:
   - .1 EMCS Configuration (include explanations of architecture)
   - .2 TCU Cross References
   - .3 System Schematics
   - .4 RCUs/TCUs
2. EMCS Configuration: Provide a basic configuration diagram showing each CCS, peripheral devices and RCU with information as to their locations. Provide lists or diagrams showing which TCUs are connected to what RCU. Provide an explanation of system architecture. Describe each hardware component and the networks that manage system communications.

3. TCU Cross References: Provide two cross referenced TCU listings. One listing to be sorted by TCU identifier, the other to be sorted by room number. Each listing to have the following columns:
   .1 TCU identifier
   .2 RCU sub-network if this data is not in TCU identifier
   .3 TCU type and model number
   .4 Terminal equipment identifier (box number etc.)
   .5 Room number
4. System Schematics: Provide schematics of each mechanical system indicating point locations, mnemonics and hardware address. Include any wiring details and equipment schematics showing where and how equipment is interfaced to EMCS. Drawings must be clear and of adequate size for easy reading. If necessary, fold larger sheets into binder.
5. RCUs/TCUs: Provide a divider tab for each RCU. Under each RCU provide the following information separated with coloured sheets:
   .1 RCU panel directory showing point mnemonics, termination addresses and wiring numbers.
   .2 Panel directory of each associated equipment cabinet.
   .3 Panel directories of each associated TCU showing point mnemonics, termination addresses and wiring numbers.

.3 Operations Division - EMCS Software (Database/Programming):

1. Organize the information into sections, with index and divider tabs, as follows:
   .1 Point Lists
   .2 Graphics
   .3 Descriptions and Procedures
   .4 TCU General
   .5 RCUs/TCUs
   .6 CCS Setup
2. Point Lists: Provide two complete lists containing all the physical and virtual points in the facility as well as a suitable description as to each points function. The first listing to be sorted by logical point mnemonic, the second to be sorted by hardware address. Each listing to have the following columns:
   .1 Logical point mnemonic
   .2 Description
   .3 Hardware or virtual point address
3. Graphics: Provide a hardcopy of all dynamic graphic display screens if a graphical user interface has been provided. Good quality screen dumps may be used for this purpose.
4. Descriptions and Procedures: Provide a brief description of overall control philosophy. Describe all hardware interlocks with other equipment that may affect or override action of software control modules. Provide procedures for operating staff to interface with software control modules, to override system or component operation, to adjust system or building control setpoints, etc. Name virtual points provided in software for this purpose and recommend adjustment increments and limits where applicable

5. TCU General: Provide a divider tab for each type of TCU and include the following information separated with coloured sheets:
   - .1 A short general description of the TCU and intended application followed by a listing and description of every available parameter, input and output.
   - .2 A detailed description of each configurable module, object, function, procedure and related sequence of operation.
   - .3 For LonWorks based TCUs, provide functional profile diagrams and descriptions of all Mandatory and Optional Network Variables.
6. RCUs/TCUs: Provide a divider tab for each RCU. Under each RCU provide the following information separated with coloured sheets:
   - .1 List of physical and virtual point mnemonics, with a description of the meaning of each mnemonic.
   - .2 For each User Control Language Program module in the RCU provide:
     - .1 a description of purpose and logic of module.
     - .2 a hardcopy listing of the program module.
   - .3 Complete hardcopy listing of the RCU database. Include each hardware point, virtual point, schedule, report, trend, controller etc.
   - .4 Provide a divider sub-tab for each associated TCU and include the following information separated with coloured sheets:
     - .1 References to any common configurable modules described under the TCU General section and a listing of the configuration data for the respective TCU.
     - .2 List of any physical and virtual point mnemonics, with a description of the meaning of each mnemonic.
     - .3 For any User Control Language Program in the TCU provide:
       - .1 a description of purpose and logic of module.
       - .2 a hardcopy listing of the program module.
     - .4 Complete hardcopy listing of the database. Include each hardware point, virtual point, schedule, report, trend, controller etc.
7. CCS setup: Provide hardcopy listings of all configuration information including CMOS setup, directory listing showing all installed files and locations as well as user interface program configuration data.
8. All listings to be laser printed.

.4 Operations Division: Pneumatic/Electric (Non-EMCS Subsystems)

1. Provide system configuration, schematic diagram, detailed operating sequence and component listing for each non-EMCS controls subsystem.

.5 Maintenance Division:

1. Summarize data for this section from supplier and sub trade maintenance submissions, supplemented by appropriate additional material. Organize the information into sections, with index and divider tabs, as follows:
   - .1 Maintenance
   - .2 Spare Parts
   - .3 Suppliers and Contractors

2. Maintenance: Provide a description of maintenance procedures for all equipment and systems. Include a schedule for recommended planned and preventative maintenance work and intervals.
3. Spare Parts: Provide a list of recommended spare parts.
4. Suppliers and Contractors: For each piece of equipment, provide a list of resources to call upon for maintenance and servicing of equipment. Include the supplier's name, address and phone number as well as the service contact.

.6 Contract Documentation Division:

1. Organize the information into sections, with index and divider tabs, as follows:
   - .1 Drawings List
   - .2 Shop Drawings and Product Data
   - .3 Certifications and Reports
   - .4 Warranties and Bonds
2. Drawings List: Provide a list of all drawings used in performance of the contract.
3. Shop Drawings and Product Data: Provide final reviewed copies of all shop drawings and product data. Provide copies of all manufacturers' data sheets, installation and maintenance brochures pertaining to each installed device, piece of equipment or system. Organize by system with a separate divider tab for the common devices and components.
4. Certifications and Reports: Provide copies of Contractor certifications for performance of products and systems. Collect and include field reports:
   - .1 EMCS physical point confirmation and calibration reports as specified in Section 23 08 95.
   - .2 Start-up and testing reports as specified in Sections 23 08 95
   - .3 EMCS software verification reports as specified in Section 23 09 93.
   - .4 EMCS Quality Assurance Logbook as specified in Section 23 09 23.1.12.3.
   - .5 Any other test report verifying performance of EMCS products and systems.
5. Warranties and Bonds: Provide one copy each of the EMCS Contractor's warranty, EMCS Manufacturers' warranties, and any EMCS service contracts provided by the Contractor. Provide a copy of the bond only in contracts where the EMCS contractor is the general.

.7 O&M Disk (full manual and system backup in electronic form):

1. In addition to the hardcopy manuals, provide the Operation and Maintenance Manuals in electronic form as follows:
   - .1 O&M data shall be organized exactly as specified for the hardcopy manuals.
   - .2 Data shall be compiled into Adobe portable document format and assembled into as few files as practical. (NOTE: It would be preferable if there were no more than one file per division.)
   - .3 Include table of contents links that allow direct access to data as per the divider tabs required in the hardcopy manual.

2. Provide the O&M Disk, in the form of a thumb drive for each hardcopy manual and backup package. Backup disks shall be archival quality, adequately labeled, protected in paper sleeves and inserted into archival quality plastic binder pages.
3. Provide an electronic copy of the O&M Disk onto each CCS and PCS hard drive under the C:\O&M_Manual directory.
4. Install a shareware copy of the latest version of Adobe Acrobat Reader on each CCS and PCS and create desktop shortcuts to the .pdf files to ease access.

1.11 QUALITY ASSURANCE

.1 Provide and install a fully proven system as described, including field tested hardware, operating system and applications software.

.2 Demonstrate capability to service system from service departments or organizations located within Alberta. Provide names, call out phone numbers and resumes for applicable service personnel.

.3 Provide a Quality Assurance Logbook at location of primary CCS. Logbook shall have holes appropriate for inclusion in O&M Manual binder. On completion of high speed trunk wiring and RCU installation, begin recording each RCU, TEC or unexplained failure (glitch). Provide the date, device identifier, type of failure, cause and how problem was resolved. Include all hardware failures as well as software/firmware problems such as panel lock-ups and loss of programming.

1.12 CONTRACT ACCEPTANCE PROCEDURES

.1 Comply with requirements of Division 01.

.2 Prior to Interim Acceptance of the Work provide all EMCS Manuals and Backups as well as the Operations and Maintenance Manuals.

.3 Prior to Interim Acceptance of the Work, complete all requirements of Section 23 08 95 “EMCS Start-up and Testing”. Submit a copy of the completed point checkout sheets. Provide reports or electronic copy on diskette of all trend logs and other data generated to prove correct function of each control module and tuned PID loop.

.4 Prior to Interim Acceptance of the Work, the installed system must be of acceptable quality by having:
1. no RCU failures over the previous 60 days of continuous operation.
2. not more than one TEC failure for every 300 installed TECs in the previous 40 days of continuous operation.
3. no significant unexplained failures (glitches) over the previous 20 days of continuous operation.

1.13 WARRANTY

.1 Correct all defects in workmanship, material or software during the duration of the warrantee period.

.2 Correct all system failures occurring during warranty period. After each occurrence:
1. Reload software lost as a result of system failure.

2. Record changes made to software in site log.
3. Download any changed databases and programs onto the CCS hard disk.
4. Backup RCU and TCU databases onto removable disk.

2. Products

2.1 ELECTRONIC DEVICES

.1 All RCUs and TCUs, whether fully user programmable or just configurable, as well all engineering and user interface software provided under this contract, shall be current product from the same manufacturer.

.2 . All user programmable devices such as RCUs and TCUs shall utilize a single identical User Control Language throughout the system. Systems that do not meet this requirement are NOT acceptable.

.3 BACnet devices shall be BACnet Testing Laboratory (BTL) Certified.

2.2 TAGS, LABELS, NAMEPLATES AND DIRECTORIES

.1 Comply with the identification requirements of Section 23 09 28 “Field Work”.

3. Execution

3.1 IDENTIFICATION

.1 Comply with the identification requirements of Section 23 09 28 “Field Work”.

3.2 START UP AND TESTING

.1 Start and test the EMCS system as specified in Section 23 08 95 EMCS Start-up and Testing

3.3 TRAINING OF OPERATORS

.1 Provide training for three operators according to the following schedule:

1. 1/2 day, ten days before Interim Acceptance of the Work, covering all aspects of system use as follows:
   - .1 Operation of hardware components.
   - .2 Tour of EMCS components.
   - .3 System software configuration.
   - .4 Man-machine interface.
2. 1 day of advanced training within one month after Interim Acceptance of the Work, covering all aspects of system use and maintenance as follows:
   - .5 Basic review of earlier training.
   - .6 Advanced man-machine interface.
   - .7 Programming basics.
   - .8 Calibration of sensors.
   - .9 Trouble shooting of system and components.
   - .10 Preventive maintenance.

3. ½ day seminar six to twelve months after Interim Acceptance of the Work for clarification of system operating techniques. Operators shall determine agenda.
4. Provide a sign off sheet, for inclusion in the system documentation manuals, which will be signed by the Contractor and the engineer representative at the completion of each phase of operator training.

3.4 FINAL UPDATES, BACKUPS AND O&M DISKS

.1 Just prior to Total Completion of the Work, provide the latest versions of all software and firmware in all CCSs, PCSs, RCUs, and TCUs.

.2 Just prior to Total Completion of the Work, provide updated backup packages.

.3 Just prior to Total Completion of the Work, provide updated O&M Disks. Copy these updates to all CCS and PCS hard drives.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23 - EMCS General Requirements and other related EMCS Sections.

2. Products

2.1 NETWORK COMMUNICATIONS

.1 Architecture:

.1 The EMCS shall support a two tiered network:

.1 The high speed primary network shall be Ethernet and shall operate at a speed of 10 Mbps or higher.

.2 The high speed primary network shall support multiple Remote Control Units (RCUs) and utilize a peer-to-peer protocol in a multi-drop architecture. Master-slave protocols are NOT acceptable. Any Central Control Stations (CCSs) or file servers, tied directly to this network, shall not significantly affect inter-RCU communications.

.3 Each RCU shall have a 9600 baud minimum speed sub-network to communicate with Terminal Control Units (TCUs) or protocol compliant equipment and smart devices.

.2 Information passing:

.1 Support direct peer-to-peer data sharing between all RCUs on the primary network so that physical or virtual point values resident in one RCU are available to all other RCUs. All CCSs/PCSs shall have data access to all RCUs on the primary network.

.2 Support data sharing between the RCU and its sub-networked TCUs/equipment/devices so that all physical or virtual point values, resident in the host RCU, are available to all TCUs/equipment/devices. As well, all physical or virtual point values, resident in the TCUs/equipment/devices, shall be available to the RCU hosting the sub-network and thus also available to all CCSs/PCSs.

.3 Values, statuses and attributes of physical and virtual points from one RCU, TCU or protocol compliant equipment or smart device shall be available for use in any other RCU, TCU, CCS, PCS or protocol compliant equipment or smart device without change of logical point mnemonic. The use of such information within a RCU, TCU function or program, shall require only that the correct logical point mnemonic be used within the program. As well, the use of such information in CCS/PCS graphics, reports, trending, alarming or configuration/ programming of any other CCS/PCS function shall require only that the correct logical point mnemonic be used within the function's setup.

.4 Setup of data sharing for the functionality described in the above clauses shall be automatic, requiring no programmer or operator action. Any broadcast points, send-receive blocks, data binding, or other form of table that is required to initialize and accomplish this function shall be invisible to the programmer and

be created automatically without user intervention. Systems that require any form of manual mapping of data transfer at any level are NOT acceptable.

.5 The system shall automatically discover what objects are available form any RCU, TCU or protocol compliant equipment or smart device connected to the high or low speed networks. This "auto discovery" shall occur, without manual intervention, whenever a new device restarts or is connected to a network.

.3 Logical point mnemonic:

.1 Each physical or virtual point, controller point or schedule, shall have a unique, user-definable, system-wide, logical point mnemonic. A length of at least 12 characters is required. Any combination of alphabetic or numeric characters shall be allowed plus a delimiter (at least one of the following: - _ , . /). The format of these point mnemonics shall conform to the Alberta Infrastructure EMCS Guideline for Logical Point Mnemonics.

.2 Once a logical point mnemonic has been defined, the point's hardware address shall not be required for control sequence programming or any man-machine interface function.

.4 Network failure modes:

1. On communication failure, retain the last legitimate value of global points. Continue to control the systems based on these values.
1. Failure of any panel on the primary network or on any sub-network shall not affect the ability of all other panels to communicate over the network.
2. A panel shall detect the failure of any other panel. This information shall be useable in custom control programming.
3. A panel shall detect the failure of any point it receives from the network. This information shall be useable in custom control programming.

.5 Network Protocols:

1. The RCU hosted sub-network protocol shall be BACnet compliant. Proprietary sub-network protocols are NOT allowed.
2. The BACnet protocol shall be used for all communications among RCUs, CCSs and PCSs. Future BACnet RCUs shall be able to be connected to the system's high speed network, at any RCU location, without the need to provide additional protocol interface devices or related software/firmware.

3. Execution

3.1 CONTROL LOOP CONFIGURATION

.1 Control loops shall be configured so the control loop, setpoint variable and all associated hardware points are in the same RCU.

.2 Control loops shall not be closed across inter-panel communications links.

1. A single BACnet sub-network from a single RCU, to individual field devices such as smart sensors and actuators and/or to individual field equipment such as a variable speed drives, boilers or chillers, is not considered to be an inter-panel link.

2. Such BACnet networks shall have a total length of less than 100 meters and be connected to no more than 16 devices.
3. Interposing gateways, protocol converters or network extenders are not allowed on such networks.

3.2 SYSTEM CONFIGURATION

.1 Provide a system configuration which complies with the general configuration shown on the diagram appended to this Section.

.2 Provide one CCS as follows:
1. CCS, keyboard, monitor and mouse.
2. Hard copy report printer.
3. Computer Desk

.3 Provide one RCU minimum:
1. for the boiler system

.4 Provide one RCU for each air handling unit. For packaged roof-top units locate RCU in unit service corridor.

.5 Provide one TCU for each heating zone.

.6 The TCUs of all heating zones served by a particular air system, shall be on the sub-network from the RCU controlling that air system.

3.3 INTEROPERABILITY

.1 Co-ordinate RCU sub-network communication protocols and functional requirements to allow specified device interoperability.

.2 Select/configure/create system parameters/variables/BIBBs/etc. as necessary to allow the following data to be: a) displayed on CCS/PCS graphic screens, b) manually accessed from the CCS/PCS via operator command, c) automatically accessed by the RCU under control of operating sequences created with the User Control Language:
1. TCUs: As required under section 23 09 27 “EMCS Terminal Control Units”.

END OF SECTION

1. GENERAL

1.1 Intent

.1 Read this Section in conjunction with Section 23 09 23 - EMCS General Requirements and other related EMCS Sections.

.2 The Central Control Station (CCS) hardware consists of the IBM-PC compatible computer, alarm printer, report printer and power side protection.

.3 The external system serial interface device (modem or serial device server) is included to allow a Portable Control Station (PCS) to have off-site access to the EMCS. It is intended that this device be connected directly to an RCU so that operation of the CCS is not necessary to gain access to the system.

2. PRODUCTS

2.1 CCS Computer - Hardware Features

.1 PC compatible computer, fitted in tower case, utilizing current industry standard ATX form-factor motherboard with the following features minimum:

- .1 Intel Quad Core 3.6 GHz. I7 microprocessor LGA2011 socket
- .2 Three x16 - PCIe slots.
- .3 8 Gbytes of RAM
- .4 Three USB 3.0 ports, (one to be front panel mounted).
- .5 One front panel mounted multi-card slot for (SD, miniSD, etc)
- .6 One external eSATA III 6Gb/s interface port
- .7 Two Ethernet ports (100 Mbps minimum)
- .8 Ability to boot from hard drive and Blu-Ray drive.

.2 Trend Storage:

- .1 Size CCS mass storage devices to allow the following data
  - .1 100% of all connected physical points values to be recorded every 5 minutes for a duration of 6 months.
  - .2 All set-points values to be recorded every 5 minutes for a duration of 6 months.
  - .3 All controller output values to be recorded every 5 minutes for a duration of 6 months.

.3 Blu-Ray HD DVD drive capable of 12X BD-R read/write, 6X BD-RE rewrite, 16X DVD+/-R read/write, 40X CD-R read/write. Provide 5 BD-RE disks and 10 DVD+RW disks.

.4 Mass storage backup in the form of one external hard drive with the following features:

- .1 USB 3.0 interface
  - .1 minimum 100g shock rating
  - .2 1 Tbyte minimum capacity
  - .3 padded carrying case

.5 Colour monitor and graphics card:

.1 LCD TFT Monitor, minimum screen size 609 mm (diagonal measurement).

.1 Minimum 1920x1080 pixel resolution.

.2 600:1 minimum contrast ratio, 160 degree minimum viewing angle

.3 250 cd/m2 minimum brightness , 8ms or better response time

.4 Screen brightness, contrast and image sizing controls.

.5 Video card to have compatible PCIe bus and capable of driving supplied monitor to its maximum resolution including 1680x1050, 1280x1024, and 1024x768 all in 32 bit colour as well as IBM SVGA and VGA in 16 bit colour.

.6 Screen image must be free of flicker, clear and sharp over entire screen area at all display resolutions.

.6 101 key keyboard with built in numeric keypad and 12 function keys.

.7 Optical wheel mouse with mouse pad. Wheel button to be programmed to act as double left click. Wheel to be programmed for scroll function.

.8 Safe shutdown of the CCS and mass storage components when power failure to the computer is detected. Provide for automatic restart of control system interface software once power has returned and has been stable for at least 1 minute.

2.2 CCS REPORT PRINTER

.1 Paper sheet fed printer, HP III laser jet compatible, with:

.1 2.0 Mbytes memory minimum.

.2 six page/minute minimum speed.

.3 250 sheet minimum capacity feeder tray.

2.3 CCS POWER SIDE PROTECTION

.1 For each CCS provide an uninterruptable power source (UPS) with:

.1 true continuous duty Delta-Conversion on-line design, 1500VA minimum. Inverter section rated for full load +10% short term overload. Standby models not acceptable.

.2 input harmonic current content less than 15%.

.3 pure sine wave output synchronized to utility line. Output harmonic current content less than 15%. Square, triangular or stepped output waveforms not acceptable.

.4 continuously regulated output 115 Vac +/- 5%, 60Hz +/- 0.1% for input voltages between 90 and 132 volts.

.5 isolated neutral and both normal and common mode transient protection with response time of less than 5 nanoseconds.

.6 dynamic clamping when tested against ANSI/IEEE C62.41-1991, and as follows:

.1 A Ringwave clamping 250V, peak 350V.

.2 B Ringwave clamping 250V, peak 350V.

.3 B Impulse clamping 400V, peak 450V.

.7 series or isolating design with silicon suppressors (transorbs, avalanche diodes). Devices that rely solely on MOVs not acceptable.

.8 over current and over temperature protection with failure indication.

.9 sealed maintenance free batteries with sufficient capacity to provide 20 minutes of on-battery power to the CCS, alarm printer and serial interface device.

.10 a recharge period, after 90% discharge, not exceeding 6 hours.

2.4 CCS Desk

.1 Provide a computer desk with the following features:

.1 Raised platform for monitor and alarm printer. Platform to be of sufficient height to allow keyboard, mouse and pad to slide underneath.

.1 Book shelf capable of storing all provided computer and O&M manuals.

.2 Two drawers with roller or ball bearing slides.

.3 Adequate space for computer, all peripherals and UPS or line conditioner as applicable. If location is enclosed or has a door or panel that can be closed, then ensure adequate ventilation is provided. Ambient temperature around computer and UPS shall not exceed 40 degC with all equipment powered and in active operation.

.2 No electronic peripheral or device shall be located on the floor.

.3 With all peripherals and devices in place, there shall be a clear work surface on the portion of the desk directly in front of the monitor. The size of this space shall be no smaller than 50cm by 80cm.

2.5 System Serial Interface Device And Remote Communications

.1 Serial device server for encapsulating serial data and transporting it over Ethernet for remote communications using a common web browser. Device shall connect to system RS-232C port and include all required software to configure unit as well as create a virtual serial link over the corporate intranet. Standard of quality: Lantronix UDS-10-IAP.

2.6 Operating System And Backup Utilities Software

.1 For each CCS and PCS, provide the latest full version of an industry standard operating system such as Windows XP/NT, complete with all available commands and functions.

.2 For each CCS and PCS, provide a complete set of disaster recovery CD-R drive utilities such as Symantec/PowerQuest Drive Image, capable of:

.1 creating a complete image backup of the CCS or PCS hard drive onto multiple spanned CD-Rs or an external backup hard drive.

.2 restoring hard drive contents by simply inserting a backup CD and turning on CCS or alternatively inserting a recovery disk followed by image backup CDs.

.3 partitioning and formatting a newly installed hard drive.

.4 automatic unattended backup of selected EMCS data directories into a separate backup directory.

.3 Provide complete installation CD/DVDs for each copy of system and utility software. Include all hardcopy manuals. If programs were delivered via download, then copy all

such programs, required license files and serial numbers as well as installation notes, onto CD/DVD. Print installation notes and include with CD/DVDs in suitable marked binder.

2.7 Graphical Operator Interface Application Software

.1 For each CCS and PCS provide an operator interface which allows:

.1 complete manual and automatic unattended saving, to the CCS's/PCS's hard drive, of ALL volatile and configurable information in every RCU and TCU. Battery backed RAM and EEPROM is considered volatile for these purposes.

.2 complete loading of all information specified above.

.3 editing of all programmable or configurable information including but not limited to database, passwords, User Control Language programs, control loop parameters, report setups, equipment start/stop schedules, etc.

.4 loading of User Control Language programs created and edited off line on an IBM PC or compatible computer with a 3-1/2" 1.44 Mega-byte floppy disk drive.

.2 The PCS operator interface shall:

.1 be able to interface to the EMCS locally through a hardwire connection at any RCU location or from off-site via the system serial interface device.

.2 provide the same compliment of functions and be identical in look and feel to the CCS interface no matter the type of connection or method of access.

.3 be a complete software package unto itself. Screen/keyboard mimicking software such as "PC Anywhere" is not allowed.

.3 Basic features:

.1 Windows style point and click operation with mouse, pull down menus or pop-up windows.

.2 Integrated "Help" application with information on basic operating procedures etc.

.3 Real time display of clock and operator identification.

.4 Automatic logging of operator sign-on/off including time and operator ID.

.5 Automatic display and logging of alarm occurrence including point mnemonic, message, time and date.

.6 Minimum 256 colour capability.

.4 Real time dynamic graphing display of trend data:

.1 Minimum of 4 points per graph with data from each point in a different colour.

.2 Allow analogue and digital data from physical and virtual points on same graph.

.3 Ability to select/deselect point data that is displayed.

.4 Two vertical scales with automatic grouping of points with same units.

.5 Automatic scaling on both axes to fit range of data displayed with ability to manually expand, under direct mouse control, any portion of the time scale to magnify data of interest.

.6 Graphing shall be in real time so as to include new data as it is trended.

.7 NOTE: Trend definition and setup are defined as RCU functions.

.5 Allow user to **view** dynamic point data superimposed upon a schematic diagram, photograph or blank background as required by the type of information displayed. These dynamic graphic displays (graphics) shall have the following features:

.1 Allowed number of graphics shall be no less than:

.2 6 + (number of TCUs) + (total number of RCU physical points / 15)

.3 Graphics shall be linked so as to allow for logical navigation through the displayed information.

.4 Each graphic shall be capable of displaying point mnemonic, value, units, alarm condition and operational status (auto/manual/failed) from at least 32 physical or virtual points. Data shall be logically positioned on the graphic screen.

.5 Displayed points shall be able to be commanded to any allowed state or value directly through the graphic. A point and click shall reveal the states/value window for the selected point. A state selection or value entry followed by a confirming click should end the operation and place the point into the desired state.

.6 Automatic update period for entire graphic shall be no longer than 10 seconds.

.6 Allow user to view documentation files for a displayed mechanical system by simply clicking upon a documentation link on the menu bar.

.7 Allow user to create and edit simple, text based, dynamic point data display pages as follows:

.1 The number of available display pages shall be no less than:

.2 10 + (number of TCUs) + (total number of RCU physical points / 10)

.3 Each display page shall be capable of showing data from at least 20 physical or virtual points.

.4 Each point location shall display point mnemonic, value, units, alarm condition and operational status (auto/manual/failed).

.5 Automatic update period for the entire page shall be no longer than 10 seconds.

.6 Pages shall be able to be able to be linked in whatever order is necessary to allow for logical navigation through the information.

.8 Provide complete installation disks or CDs for each copy of operator interface software.

2.8 Graphic Screen Creation/Edit Application Software

.1 For one CCS provide a dynamic colour graphics package which allows user to create, modify and delete dynamic graphics screens used within the Graphical Operator Interface.

.2 Basic features:

.1 Windows style point and click operation with mouse, pull down menus or pop-up windows.

.2 Allow creation of graphic links among screens and to trend graphs.

.3 Mechanism for copying, editing and saving graphics with similar layouts to create a custom library of generic schematics.

.4 Often used functions shall have a keyboard counterpart to improve the efficiency of the editing process.

.5 Minimum 256 colour capability.

.3 Creation and modification of graphics backgrounds shall allow:

.1 owner creation of symbols which can be stored in a custom symbol library.

.2 control of symbol scale, infill colour and location on screen.

.3 control of line and geometric shapes drawing.

.4 control of alpha numeric text and information windows.

.5 editing of text with search and replace feature.

.6 photographs to be used as graphics backgrounds or portions of backgrounds.

.4 Addition and modification of superimposed dynamic data shall allow:

.1 any combination of analog/digital information, graphic symbols or text, to be displayed at any location on the screen, minimum of 32 physical/virtual points per graphic.

.2 any combination of logical point mnemonic, descriptor, value, units and whether the point is in auto or manual operation, to be assigned for display at any point location.

.3 different symbol infill colours to be displayed based upon the state of a linked dynamic digital input or alarm point.

.5 Provide features to link Adobe Portable Document Format (.pdf) or text (.txt) based documentation files to graphic screens. Provide required editors to create and modify documentation file contents.

.6 Provide complete installation disks or CDs for each copy of graphics screen creation/edit software.

3. Execution

3.1 Installation

.1 Install all CCS hardware, software and peripheral devices at location specified. Neatly arrange all interconnect cabling. Loop and wire tie as necessary. Affix power bar and cabling to rear of desk as appropriate to ensure wiring remains off floor.

.2 CCS shall be connected to emergency power if such is available in the facility.

.3 All CCS hardware shall be powered from the same electrical outlet on the same circuit. The power side protection device UPS shall serve all of the CCS hardware.

.4 Under no circumstances shall the CCS share the same circuit as motorized equipment. Provide a separate circuit if necessary.

.5 Install an optically coupled data communications isolation and surge suppression device if the CCS is connected to an RCU with a non-isolated connection (i.e. RS-232 etc.) and any one of the following conditions exist:

.1 The CCS and RCU are not on the same electrical circuit.

.2 The CCS to RCU communications cable is more than 30 meters long.

.6 Install system serial interface device (modem or serial device server) at any convenient RCU. Securely attach device inside RCU or adjoining equipment cabinet, neatly arrange and wire-tie all cables. Install all required communications software and setup system alarming/messaging structure. Device shall be powered from the same electrical circuit as the device to which it is connected. If specified above, install data line isolation device at modem end of the RS-232 connection.

.7 Configure automatic backup and notification features of user interface and disk utilities as follows:

.1 Every two weeks, backup onto hard drive, ALL volatile and configurable information in every RCU and TCU.

.2 Every month, backup into separate hard drive backup directory, labeled by month (i.e. C:\Backup_Jan, C:\Backup_Feb, etc), the latest bi-weekly system backup.

.3 Every 3 months, send a notification message to the CCS screen as well as to the printer, requesting the operator to create a complete disk image backup onto DVD-R or removable hard drive.

3.2 System Graphics

.1 Every installed physical point, schedule, setpoint, user adjust point and alarm must appear at least once on an appropriate screen graphic. Locate points as close as possible to their graphical representations. Schedules and system user adjusts shall be located under the respective system title, left justified. Setpoints must be located under the sensed value but displayed in a different, less prominent colour.

.2 Selection of data shall be appropriate with regard to the underlying system schematic diagram and allow for complete operation and trouble shooting as determined by the sequence of operation. Virtual point data that is important to determining the proper operation of the system shall be included. These may be schedules, user adjusts, space condition information, control loop output values, etc.

.3 Air systems and major equipment shall be rendered as simple 2-dimensional or very flat 3-dimensional outlines with solid colour fill. The outline colour shall be similar to, but provide some contrast against the fill colour. Ductwork outlines, fans and pumps shall have a shape or arrow indicating direction of flow. In general colours shall be as follows:

.1 Acid: Purple

.2 Air systems: Grey

.3 Boilers, coils and related piping: Yellow

.4 Boiler feed water and condensate: Green

.5 Chillers, coils, cooling towers and related piping: Green

.6 Domestic cold water: Light Blue

.7 Domestic hot water: Green

.8 Freon equipment and piping: Grey

.9 Fire equipment and related piping: Red

.10 Glycol heat exchangers, coils and related piping: Vista Green

.11 Oil: Brown

.12 Steam heat exchangers, coils and related piping: Yellow

.4 Equipment outlines shall be sized to allow sufficient room for all required dynamic display information to be placed on the screen without creating a cluttered appearance. The graphic designer shall strive to create graphics that provide ease of operation, simplicity and a clean appearance. Text must be large enough for easy viewing and colours should be selected to match visual impact with the importance of the information being displayed. However, the use of too much or clashing colours, or colour combinations that cause eye strain because of incompatible perceptual depths, must be avoided.

.5 Units of ON/OFF shall be reserved for a device's actual input point operating status. The commanded condition of a device or virtual point flag shall be defined as Start/Stop, Enable/Disable, Yes/No, Go/NoGo, etc.

.6 Analogue input or output values with units of "%" shall be shown as % of product. This is to be the case regardless of the safe failed position of the final control element. Example: cooling coil valve at 100% means full flow through coil, heating coil valve at 100% means full flow through coil even though signal to valve may actually be zero.

.7 A depicted device, or portion of that device shall show green when the device command state and status are ON, grey if they are both OFF and flashing red when in an alarm condition. An alarm shall not be displayed unless command value and status do not match and then only after the allotted alarm timeout has expired.

.8 Every point on every graphic shall indicate, with colour change or appended letter, whether or not it is under manual override control.

.9 Floor plans are to be colour coded to the air handling unit serving that portion of the floor. Selecting (left clicking) the area shall bring up the air handler's graphic. Co-ordinate colour scheme with Minster.

.10 For facilities with large floor plates, provide a small key plan in the lower right hand portion of each screen to show the depicted floor plan as a shaded portion relative to the building outline. Include floor number if appropriate. Provide links in the key plan to allow navigating to other areas of the same floor, or to jump to the same portion on another floor.

.11 Graphic titles shall be located at the top center of each screen in a simple bold font of sufficient size to be obvious as a title. Colour shall be white or other neutral colour that provides sufficient contrast against background without detracting from the mechanical system portrayed.

.12 The date of the last revision shall be located in the very top right hand corner of the graphic. Format as yyyy/mm/dd using a small but legible font in a shade that has just enough contrast to be seen without making it obvious to a casual glance.

.13 Create a menu bar containing links at the bottom of each graphic screen with the exception of the Startup screen. The bar shall be placed in exactly the same location on every graphic and have link buttons of exactly the same size to allow logical browsing through the mechanical systems without moving the mouse. The bar shall provide the following links to standardize movement:

.1 MAIN: locate in first (furthest left position) on all but the Main screen. Selection of MAIN will cause Main screen to be displayed. On the Main screen, put "BYE" in this location. Selection of BYE will sign-off operator and display startup screen.

.2 PREVIOUS: locate in second position on all but the startup screen. Selection of this link button will bring up "last viewed" graphic.

.3 Custom Buttons: locate in center area of bar. Name and arrange to scroll through screens in logical order.

.4 MLOG: locate in second last position on every screen. Selection of MLOG will display and operator editable text file that can be used by the operators to enter useful maintenance information or to document equipment problems.

.5 DOC: locate in last position on all but the Main screen. Selection of DOC will display the documentation relating to the portrayed mechanical system. On Main

screen, put "HELP" in this location. Selection of HELP will bring up the EMCS's help application

.14 As a minimum, create and link dynamic graphic display screens as follows:

.1 One or more graphic screens for each mechanical system under EMCS monitoring or control as well as for miscellaneous systems such as domestic hot/cold water, emergency generator, parking garages, lighting, parking lots, etc.

.2 Link the relevant portions of the electronic Operating and Maintenance Manual, located in the C:\O&M_Manual directory, to the "DOC" button on the menu bar of each graphic screen. As an acceptable alternative, create text based mechanical system documentation files for each mechanical system and link these to the relevant "DOC" buttons.

.3 One graphic screen for each Terminal Control Unit (TCU).

.4 Building floor plans showing location of TCUs and displaying each room temperature. Besides normal menu bar, provide suitably located links to each TCU graphic.

.5 TCU summary screens showing the space temperatures, setpoints, damper positions and flow rates (VAV) for a group of TCUs. Group TCUs as per the air system serving a particular area. Provide links to respective air systems and to individual TCU graphics.

.6 Alarm summary screens.

.7 Schedule summary screen.

.8 Main screen with overall building plan showing approximate locations of mechanical rooms. Title "MAIN SCREEN". Besides normal menu bar, provide suitably located links to floor plans, alarm summary and schedule screens as well as all mechanical systems depicted on the overall plan. Main screen must display outdoor air conditions.

.9 A startup screen that is displayed when no operator is signed onto the system. It shall consist of a photograph of the front of the building with the title being the building name. Outdoor air conditions may be displayed but nothing more. A selection (left mouse click) anywhere on the screen shall bring up the system's sign-on window. On proper sign-on, main screen shall be displayed.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23 EMCS General Requirements and other related EMCS Sections.

2. Products

2.1 REMOTE CONTROL UNITS GENERAL

.1 Each RCU shall:

include a real time operating system that:

.2 executes control, timing and sequencing of all programs.

.3 performs multi-tasking to run programs and concurrently communicate with other RCUs and the CCS over the high speed network, with TCUs connected its sub-network or with the serial ports.

.4 provides automatic means of sharing physical and virtual point information with rest of system.

.5 automatically restarts RCU when power is restored.

.6 as diagnostic software to test RCU integrity, and data transmissions.

1. provide fully stand-alone operation by acquiring information from input points and locally processing this information to control output devices according to the User Control Language.
2. record, evaluate and report changes of state/value that occur to physical or virtual points within the RCU.
3. keep a record of security passwords, and supervise any local operator access to the EMCS.
4. include all necessary hardware, software and firmware as required to interface to primary network as defined in Section 23 09 24 and the sub-network as defined in Section 23 09 27.
5. allow the processing and execution of operator commands as well as the downloading of the complete RCU programming and database, from a Central Control Station (CCS), locally connected laptop computer (PCS) or from a remote PCS through serial interface device (modem).

.7 Any slave panel, sub module, or any form of point expansion panel that is connected to an RCU, and located within 1 meter of the RCU, shall be considered an integral part of the RCU.

.8 The data base and control strategies for any point connected to a slave panel, sub module or point expansion panel shall be resident in the RCU.

.9 Only BACnet devices are allowed.

2.2 REMOTE CONTROL UNITS FEATURES

.1 Minimum 32 bit full floating point mathematics.

.2 Minimum 8 inputs and 8 outputs. Maximum of 128 input/output points.

.3 Minimum of one sub-network port.

.4 Minimum of two serial ports for communication with any two system peripherals, such as a printer or portable operator terminal and a modem or serial device server.

.5 Watchdog timer. Failure of RCU shall automatically switch outputs to a pre-selected fail-safe condition and initiate a cold restart.

.6 Real Time Clock accurate to one minute per month and capable of maintaining accurate time through a 72 hour power failure. Clock to be synchronized to a master timekeeping RCU or the CCS real time at least every 24 hours.

.7 Network monitoring routines. Failure of primary network or sub-network shall be detected. RCU shall continue to control environment using last reliable setpoint or operating mode. A read-only indicator of this failure shall be available for use within the custom controls programming.

.8 Hardware monitoring routines. Failure of any RCU physical point shall be detected. RCU shall continue to control environment using last reliable information. A point attribute or other read-only indicator of this failure shall be available for use within the custom controls programming.

.9 Permanently marked removable terminal block for the wiring of all sensors, control devices, network and RCU power.

.10 Free standing or wall mounted robust metal or plastic cabinets with hinged and key-locked front door with common keying for all RCU and equipment cabinets.

2.3 MEMORY

.1 User Control Language program and data base memory shall be EEPROM or 72 hour battery or capacitor backed RAM.

.2 Data/stack memory space shall be 72 hour battery or capacitor backed RAM.

.3 System firmware shall be in non-volatile EEPROM memory.

.4 Provide sufficient memory:

1. to allow creation and execution of specified User Control Language programs. As a minimum, for each connected physical point, provide sufficient capacity to create programs containing the following:

.5 10 logical operators (eg. AND, OR, NOT)

.6 10 mathematical operators (+, -, /, *, ^)

.7 Five commands or functions (eg. START, STOP, MIN, MAX, SQRT)

1. to create one PID controller for every available analogue output.
2. to simultaneously maintain 256 trend samples for each physical point connected to the RCU.
3. to contain the data base for all physical points and for two virtual points for each physical point connected to RCU as well as at least one annual schedule and 2 daily schedules.

2.4 SIGNAL PROCESSING

.1 Analog Input Processing:

1. Each analog input shall be converted to digital format at a minimum frequency of 1 conversion per second.
2. Relative errors between analog inputs shall not exceed 0.25% of span.
3. Each input shall be individually calibrated for zero and span in software.
4. On board circuitry shall protect each input from short circuit and have a 500 volt minimum isolation.
5. The following ranges are required:
   .1 4 - 20 mA DC
   .2 0 - 10 VDC
6. A special range for direct input resistance temperature sensors is allowed.

.2 Analog Output Processing:

1. Each analog output shall be converted to analog format at a minimum frequency of one conversion per second.
2. Digital to analog conversions shall have 32 bit resolution minimum. The output signal shall be linear.
3. Each output shall be individually calibrated for zero and span in software.
4. On board circuitry shall protect each output from short circuit and have 500 volt minimum isolation
5. The following ranges are required:
   .1 4 - 20 mA DC
   .2 0 - 10 VDC

.3 Digital Input Processing:

1. Inputs shall accept dry contacts.
2. Provide one pulse counter input per RCU which will accept pulse rates up to 1000 Hz.
3. Provide minimum 500 volt isolation for each point through use of optical isolators or equivalent on termination board.

.4 Digital Output Processing:

1. Provide outputs capable of switching a 120 VAC external power supply, or triac SCRs rated at 0.5 Amp 24 VAC minimum.
2. Provide full protection to hardware and software from switching transients.

2.5 POWER SUPPLY

.1 For each RCU, provide:

1. a line voltage isolation transformer.
2. a power supply with fused over current protection and power on indication.
3. transient surge suppression as part of the power supply or as a separate device.

.2 Transient surge suppression requirements:

1. Provide protection from both Normal and Common Mode transients. Response time to Common mode transients shall be less than 5 nanoseconds
2. Let-through voltages (L-N) when tested against ANSI/IEEE C62.41-1991 and C62.45, 1992 shall be as follows:

.3 Category A3 and B3 Ringwave (6000V, 200A) let-through less than 15V.

.4 Category B3/C1 Combination (Impulse) Ringwave (6000V, 300A) let-through less than 200V.

1. Separate devices shall use hybrid circuits. Circuits that rely solely on MOV's or avalanche diodes will not be accepted.
2. Separate devices shall have a minimum nominal capacity rating of 3 Amps at 120 VAC or three times the maximum current draw of the RCU and all connected components, whichever is greater. The device shall be either UL listed or CSA approved.
3. Provide documentation or test results that show that transient suppression meets the specified requirements.

2.6 DATA BASE

.1 Provide data base creation and modification at a CCS, a PCS connected to any RCU serial port or from a remote location via the system's serial interface device. The user shall have data base manipulation capability, while on line, to add, modify and delete points, alarms, schedules, trend logs, custom point groups, start/stop sequences, engineering units, spring ranges and point maps.

.2 Each physical and virtual point shall be tagged with a unique name according to the most recently available "Alberta Infrastructure EMCS Guideline for Logical Point Mnemonics". Specialty points or functions such as alarms, totalizers, point groups, etc., shall be assigned a unique name closely resembling the point mnemonic of the associated points.

.3 Provide:

1. virtual points which can store 32 bit floating point numbers and which can be manipulated in the same manner as analog or digital physical points.
2. custom units, minimum 6 characters in length, assignable to any point or state of point operation (examples: L/s, KWhrs, High, Slow, Off, mA, Jouls)
3. conversion tables or other mapping functions for analog input and output points that define how the input or output hardware values relate to the engineering units used. Accommodate non-linear relationships using a mathematical formula or a conversion table with a minimum of 10 individually definable segments.
4. mapping functions for digital input, output and virtual points for assigning any pair of engineering units to the active/inactive or energized/de-energized states of the points (examples: Start/Stop, On/Off, Open/Closed, Alarm/Normal, Yes/No, Enable/Disable, Lead/Lag).
5. totalization functions for digital input, output and virtual points capable of counting the accumulate hours or minutes of run time or contact status for at least 9999 minutes.

2.7 BASIC OPERATOR INTERFACE

.1 Provide a basic, RCU hosted, system/operator interface with:

1. interrogation via a text based command line, a succession of menus, or a graphical user interface.
2. basic creation and editing of physical and virtual point database.
3. software grouping of points for monitoring and system control functions.

4. dynamic data display of a selected grouping of points with all required functions to create or edit display data groups.
5. operator override capabilities that allow manually command/override of any physical or virtual point to a desired state or value, so that User Control Language programs cease to control that point.
6. at least three access security levels for a minimum of eight operators with hard copy reporting of all authorized and unauthorized sign-on or sign-off events.

.2 Provide software packages and interface cables for each PCS to access the EMCS through the RCU via the basic operator interface. A minimum of one package shall be provided.

2.8 ALARMS

.1 Provide RCU operating system alarms for the following malfunctions:

1. Communications failure with any connected TCU or adjacent RCU.
2. Watch-dog-timer activation.
3. Input or output point failure.
4. Control program execution error (divide by zero, etc.)
5. Power interruption restore or other cold start

.2 Provide change of state alarms for digital physical or virtual points with user selection of which digital contact state is the alarm.

.3 Provide high and low limit alarms for analogue physical or virtual points with user defined high and low alarm limits as well as relative alarm limits (differential) referenced to a virtual set-point such that the alarm limits automatically adjust with change in set point value.

.4 Alarms shall be able to be directed to the CCS and/or a peripheral device at any user-defined RCU serial port.

.5 Provide ability to automatically disable an alarm or group of alarms based upon the status of any selected digital physical or virtual point.

.6 Each non-system alarms shall have user adjustable time delay settable within a range of 5 seconds to 30 minutes.

.7 Alarms shall be able to be categorized as critical or non-critical. Critical alarms shall require operator acknowledgement.

.8 Each non-system alarm shall include a user defined alarm message, 30 characters minimum length.

.9 All alarms shall be logged with:

1. current time, date and initials of on-duty operator.
2. point mnemonic and description.
3. current value or status, including engineering units.
4. nature of alarm - high or low, on or off, open or closed, etc.
5. critical or non-critical alarm designation.
6. alarm message

2.9 TREND LOGGING

.1 The RCU shall be able to trend log all physical or virtual point, controller output, or schedule result defined in the RCU or any TCU connected on its sub-network . Required features:

1. User defined start and stop times or continuous sampling.
2. User adjustable sampling frequency from 5 seconds to 24 hours.
3. Number of samples per trend selectable from 1 to 128.
4. User selectable sample initiation by time interval or change of state.

.2 RCU shall be able to automatically dump trend data to the CCS hard drive at user specified intervals or to clear allocated RAM when full. Stored data shall be in ASCII format.

.3 Trend reports shall display and print a minimum of four logged points across the page. RCUs with graphic interface shall be able to display trend data graphically.

2.10 SCHEDULING

.1 Provide a minimum of two annual/holiday schedules as well as 20 start/stop schedules for designated points or groups of points.

.2 Start/stop schedules shall allow defining a minimum of 4 starts and 4 stops per day to a resolution of 15 minutes. Each schedule shall include weekend, holiday and annual schedule skip features.

.3 Provide:

1. time delays between successive commands (for groups of points).
2. operator override of the schedule for each point.
3. report of all time schedules and their associated commanded points.

2.11 REPORTING

.1 Reports and logs shall be able to be directed to the CCS and/or a peripheral device at any user-defined RCU serial port.

.2 Reports and logs shall:

1. be capable of manual or automatic (time and date or event) initiation.
2. include a header with a report title as well as the current time and date.
3. include sufficient English language description to allow the contents to be understood by anyone with modest controls familiarity.

.3 For the RCU and any TCU connected on its sub-network, provide:

1. summary reports with current list of:
   - .1 operator overridden points.
   - .2 points in alarm condition.
   - .3 points in trend logs.
   - .4 totalized points.
2. reports listing current point value or status for any building, system, or user-defined group of points.

3. database, alarm, trend and schedule reports that produce on-screen and hardcopy listings selectable by individual point, point type or database category. Listings to include current data and all information required to re-create the selected database elements.

.4 Provide operator access reports listing the operator's name, password, on-duty initials and system access level or access matrix.

.5 Provide security log reports listing at least the last 500 system transactions including operator initials, command performed and time and date. Include all sign-on, sign-off and invalid system access attempts.

.6 Provide system diagnostics reports that list current and past system hardware and software errors.

2.12 USER CONTROL LANGUAGE (UCL)

.1 The User Control Language (UCL) shall allow the user to develop and program custom operational sequences, unique control algorithms, interactive point relationships, custom calculations using any combination of mathematical, relational and logical operators. UCL custom control sequences shall be able to:

1. calculate flow rates, energy consumption, electrical demand and heating/cooling loads.
2. determine equipment run times and durations of events.
3. calculate operating setpoints.
4. start and stop equipment.
5. modulate or place dampers and valves in any calculated position.
6. enable/disable alarm functions.
7. enable/disable control loops and manipulate their bias values, gains and output ranges.

.2 The following UCL program formats are acceptable:

1. Traditional text based languages that are styled upon a line by line "high level" computer programming language such as C, Pascal, Fortran or BASIC. Low level assembler or macro style languages are NOT acceptable.
2. Block/object or graphic style languages that are formatted by linking predefined library modules, if and only if they allow the user to create and modify custom blocks/objects using a richly featured line by line text based "high level" computer programming language such as C, Pascal, Fortran or BASIC.
3. Any block/object or graphic style language, if the total number of terminal boxes served by each air system is less than 20, OR, if the total number of connected physical points is less than 80. Terminal Control Unit points or simple alarm only points are not to be included for the purpose of this determination.

.3 The UCL shall be modular in construction allowing a minimum of one independent program or graphic programming screen page, for every 8 physical points connected to the RCU.

.4 The UCL shall allow comments to be embedded anywhere in the source code or on a graphic programming screen page.

.5 The traditional text based "high level" language, used to create the operational sequences or custom blocks or library routines, shall allow expressions (i.e. a program lines) :

1. containing 5 levels of parenthesis
2. containing at least 10 mathematical and/or logical and relational operators in any desired order and combination.
3. containing mixed mode mathematics (combined use of math and logic operators), using normal order of mathematical precedence, not simply left to right.
4. with a minimum line length of 128 characters.

.6 Provide mathematical operators for:

1. addition, subtraction
2. multiplication, division
3. square roots, exponents

.7 Provide logical and relational operators for:

1. and, or, not
2. equal to, not equal to
3. less than, greater than

.8 Provide branching features for:

1. unconditional branching to another line, label or graphic entry point in the same program module.
2. conditional branching in the form of IF...THEN...ELSE statements that can be nested to a minimum of 3 levels or graphic objects with similar capabilities.
3. calling a subroutine, program module or graphic block/object with return to calling routine.

.9 Provide functions, procedures or graphic blocks/objects which calculate or obtain:

1. current time, day of week and date in decimal or integer format.
2. operational status of RCU network communications.
3. operational status of TCU sub-network communications.
4. operational status of any connected point (in/out of service, failed, alarm)
5. minimum, average and maximum values of a minimum group of 5 variables, points or numeric expressions.
6. value of a variable, point or expression, limited to a set range between limiting values or numeric expressions representing allowable minimum and maximum values.
7. an interpolated value from a user defined set of coordinates defining at least 5 line segments. This is in addition to the spanning and ranging capabilities provided in analogue point database.
8. the current value of a programmable count up/down seconds timer that can be reset or initialized under UCL control. Timers to be capable of counting a minimum of 10,000 seconds and shall hold when timed out.
9. next scheduled ON or OFF time/date of any point, annual or holiday schedule
10. duration that any binary point or status has been in the ON or OFF state.
11. runtime or totalized value of any point thus configured.
12. alarm status of any defined alarm point.

.10 Provide a minimum of ten local variables per control program module for use as temporary storage of intermediate calculation results. Variables shall be able to store 32 bit floating point numbers and are not to be global virtual points created by the user.

2.13 CONTROL SEQUENCE INTEGRATED DEVELOPMENT ENVIRONMENT

.1 Provide an integrated development environment for creating, modifying, interpreting/compiling, testing, executing and trouble shooting custom control sequences:

1. in any RCU on the network from any CCS.
2. in any RCU on the network from off-site via the control system's serial interface device
3. in a particular RCU from a PCS locally connected to that RCU.

.2 For editing traditional text based UCL programs, provide a full screen editor with the ability to:

1. insert, delete, overtype characters in any displayed line.
2. copy or cut a line, or block of lines, and insert these before any displayed line in the current UCL program or another UCL program.
3. search for an alphanumeric string and replace with another string.
4. produce a hard copy of the edited program.

.3 For editing block/object or graphic style UCL programs, provide a full screen graphic editor with the ability to:

1. insert or delete a graphic object anywhere on the screen.
2. edit object names and all parameters within the graphic objects.
3. copy or cut a graphic object, group of objects, or comment text and place these anywhere else on the screen or onto another graphic programming screen.
4. connect graphic object inputs or outputs by simply drawing a line between them. Invalid connections shall not be allowed to be created.
5. connect information across programming screens.
6. produce a hard copy of the edited graphic including all object parameters.

.4 The integrated development environment shall:

1. automatically change all program occurrences of a point mnemonic, if that point mnemonic is changed in data base.
2. flag undefined point mnemonics if a point with that mnemonic has not yet been created or if the respective point has been removed from data base. Flag or indicator to be displayed in an easily visible location close to where the mnemonic is used whenever the program is viewed, modified or printed.
3. detect syntax errors or unexecutable sequences and provide detailed English language messages and code flagging that allows quick localization of these errors.
4. provide notification of runtime errors.
5. allow values of physical or virtual points as well as local or global variables to be displayed during runtime to assist in trouble shooting.

.5 The complete development environment shall be available at every CCS as well as at every PCS, whether it be locally connected to an RCU or located off-site and connected via the control system's serial interface device.

.6 Provide at least [two] complete development packages, if the development environment software is not RCU resident. Install these on CCSs/PCSs as directed by the Minister. Provide all necessary interface hardware and cables to allow local or off-site connection.

2.14 CONTROL LOOPS

.1 Provide at least one, RCU resident, control loop for each available analogue output point or pair of digital outputs, plus one. All control loops shall be capable of three mode, proportional, integral and derivative, (PID) control.

.2 Provide the following parameters in each control loop:

1. Direct or reverse acting.
2. Output value
3. Set point
4. Proportional gain
5. Integral gain
6. Derivative gain
7. Sampling time – adjustable from 1 to 20 seconds.
8. Output low limit
9. Output high limit
10. Control loop bias

.3 Provide the ability to halt/resume loop calculation as well as change the set point, bias, gains and output limits in real time using custom control sequences created with the user control language (UCL).

.4 Provide a “bumpless” transfer between manual output override and automatic loop operation.

.5 Control loop algorithm shall be designed so as to limit integral windup. Internal integral offset value shall be manipulated so as to maintain calculated loop output value within bounds set by the output low and high limits.

3. Execution

3.1 INSTALLATION

.1 Each RCU shall be mounted so as to allow easy access for maintenance. There shall be no less than 1 metre between the RCU door and any obstruction. Door must be able to swing open 180 degrees or be removable. Mount RCU near eye level on vibration free walls or rigidly support RCU on free standing supports away from vibrating equipment. Confirm all locations with Minister.

.2 At every RCU location, install a line voltage duplex receptacle for powering operator devices such as the PCS. An individual receptacle is not required for every RCU so long as one is available within 2 meters of any individual RCU. A new receptacle is not required if an existing outlet meets these requirements.

.3 RCU and equipment cabinets located in an area with a known leak hazard or under or near piping with nearby fittings shall be drip proof with rain-tight fittings on all connected conduit.

.4 Transformers serving power supplies shall be sized such that output voltage droop is no greater than 10% with all connected devices powered up and output devices in motion. One transformer per RCU.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23 EMCS General Requirements and other related EMCS Sections.

.2 TCU's shall not be used to control major equipment such as boilers, chillers or air handling equipment over 1000 litres/sec

.3 Products

1.2 TERMINAL CONTROL UNITS GENERAL

.1 Each TCU shall:

.1 include a real time operating system that:

.2 executes control, timing and sequencing of all programs.

.3 performs multi-tasking to run programs and concurrently communicate with either RCU over sub-network or with RS 232C port, "intelligent" room temperature sensor or similar system/operator interface device.

.4 automatically restarts TCU when power is restored.

.5 has diagnostic software to test TCU integrity, and data transmissions.

.1 provide fully stand-alone operation by acquiring information from input points and locally processing this information to control output devices according to the User Control Language or configurable application-specific programmming.

.2 share information with the rest of the system via the local RCU as well as process and execute commands from RCU and from locally connected PCS or operator terminal.

.3 allow downloading of User Control Language strategies or configuration of application-specific programs and all related databases from the Central Control Station (CCS), or laptop computer (PCS) connected directly to the TCU or connected indirectly at the RCU.

.4 For TCU resident points, all trending, alarm reporting, runtime recording and all other reports and logs specified in Section 23 09 26, shall be supported in either the TCU or in the RCU that controls the sub-network on which the TCU resides.

.5 Only BACnet or Lon-Works compliant devices are allowed. Proprietary application-specific TCUs are not acceptable. Refer to Section 23 09 24 for additional network protocol requirements.

1.3 TERMINAL CONTROL UNITS FEATURES

.1 Minimum 32 bit full floating point mathematics.

.2 Onboard hardware, software and firmware as required to interface to the sub-network as defined in Section 230924.

.3 Firmware upgradable over the sub-network or via the interface port on the intelligent space sensor. Products requiring replacement of chips or requiring direct access to the TCU controller are not acceptable.

.4 Point configuration to suit application plus one spare universal input and one spare digital output.

.5 Watchdog timer. Failure of TCU shall automatically switch outputs to a pre-selected fail-safe condition and initiate a cold restart.

.6 Real Time Clock function. Clock to be synchronized to RCU real time at least every 24 hours. For clocks without battery backup, time shall also be synchronized after every power interruption or watch dog event.

.7 Sub-network monitoring routine. On failure of sub-network, TCU shall continue to control environment using last reliable setpoint and operating mode data received from the RCU.

.8 Permanently marked removable terminal block for the wiring of all sensors, control devices, network and TCU power.

.9 Removable metal or robust plastic enclosure.

1.4 INTELIGENT SPACE SENSOR AND INTERFACE

.1 Provide an "intelligent" room temperature sensor, with the following features as a minimum:

.1 Three digit LCD or LED display.

.2 Four programmable buttons providing setpoint increase/decrease and occupied/unoccupied mode operation.

.3 Ability to set device to continuously display room setpoint or current room temperature.

.4 Interface port to allow a laptop IBM-PC compatible computer to interface to TCU. Provide cables and all necessary software to allow:

.5 reading of all input/output point data.

.6 changing of setpoints, limits and calibration values as applicable.

.7 manually override of control outputs.

.2 Space temperature sensing shall meet the accuracy requirements of Section 23 09 29 device type Tr.

.3 Enclosure shall be neutral colour, vented, metal or robust plastic, with base to cover wall opening. In public areas where device will be subject to damage, provide vented resilient clear plastic tamper proof cover.

1.5 SIGNAL PROCESSING

.1 Analogue Input Processing:

.1 Each analogue input shall be converted to digital format at a minimum frequency of 1 conversion per second.

.2 Analogue to digital conversion shall have sufficient resolution to provide the minimum end to end accuracy defined in Section 23 09 29 plus one bit, but shall not be less than 10 bits.

.3 Relative errors between analogue inputs shall not exceed 0.25% of span.

.4 Each input shall be individually calibrated for zero and span in software.

.5 On board circuitry shall protect each input from short circuit and have a 500 volt minimum isolation.

.6 The following ranges are required:

.2 4 - 20 mA DC

.3 0 - 10 VDC

.1 A special range for direct input resistance temperature sensors is allowed.

.4 Analogue Output Processing:

.1 Each analogue output shall be converted to analogue format at a minimum frequency of one conversion per second.

.2 Digital to analogue conversions shall have 8 bit resolution minimum. The output signal shall be linear.

.3 Each output shall be individually calibrated for zero and span in software.

.4 On board circuitry shall protect each output from short circuit and have 500 volt minimum isolation

.5 The following ranges are required:

.5 4 - 20 mA DC

.6 0 - 10 VDC

.7 Digital Input Processing:

.1 Inputs shall accept dry contacts.

.2 Provide minimum 500 volt isolation for each point through use of optical isolators or equivalent on termination board.

.8 Digital Output Processing:

.1 Provide outputs capable of switching a 120 VAC external relay, or triac SCRs rated at 0.5 Amp 24 VAC minimum.

.2 Provide full protection to hardware and software from switching transients.

1.6 POWER SUPPLY

.1 Each TCU shall have a power supply with fused over current protection and power on indication.

.2 Transient surge suppression shall be provided as part of the power supply or as a separate device. Let-through voltages (L-N), when tested against ANSI/IEEE C62.41-1991 and C62.45, 1992 category A3, B3 and B3/C1 ring-waves, shall not cause damage to the TCU or associated transmitters and output devices. Provide documentation proving compliance.

1.7 DATA BASE

.1 Provide data base creation and modification in accordance with Section 23 09 26 EMCS Remote Control Units.

1.8 ALARMS

.1 Provide TCU operating system alarms for the following malfunctions:

.1 Watch-dog-timer activation.

.2 Input or output point failure.

.3 Control program execution error (divide by zero, etc.)

.4 Power interruption restore or other cold start

.2 Provide other alarming features in accordance with Section 23 09 26 EMCS Remote Control Units.

1.9 SCHEDULING

.1 The TCU shall operate in accordance with the schedules defined in the RCU.

.2 Provide a default weekly schedule that defines at least one start time and one stop time per day to a resolution of 15 minutes. This schedule is to become active on loss of communication with the host RCU.

1.10 CONTROL LOOPS

.1 Provide point control loop creation and modification in accordance with Section 230926 EMCS Remote Control Units.

1.11 PROGRAMMABLE TCU - USER CONTROL LANGUAGE (UCL)

.1 For UCL programmable TCUs, provide User Control Language program creation and modification in an integrated development environment in accordance with Section 23 09 26 EMCS Remote Control Units.

.2 The identical User Control Language shall be used in both the RCU and TCUs.

.3 Provide all engineering/programming tools required for the complete integrated development environment. Include all disks/CDs and manuals.

1.12 APPLICATION-SPECIFIC TCU

.1 Application Specific TCUs shall be BACnet compliant and configurable to suit application.

.2 TCU shall be configured to allow the following data to be: a) displayed on CCS/PCS graphic screens, b) manually accessed from the CCS/PCS via operator command, c) automatically accessed by the RCU under control of operating sequences created with the User Control Language:

.1 Operating mode (read/write/override)

.2 Occupied mode heating/cooling setpoints and limits (read/write/override)

.3 Unoccupied mode heating/cooling setpoints and limits (read/write/override)

.4 Operating Space temperature setpoint (read/write/override)

.5 Space temperature (read)

.6 Space temperature calibration offset (read/write)

.7 Control loop output value (read/write/override)

.8 Control loop proportional band (read/write/override)

.9 Control loop bias value (read/write)

.10 Box supply air temperature (read)

.11 Box supply air temperature calibration offset (read/write)

.12 Flow rate (read)

.13 Flow rate zero and span calibration factors (read/write)

.14 Damper and/or valve positions (read/write/override)

.15 TCU Time (read/write)

.16 All parameters required to set up internal schedule

.17 Intelligent sensor communications failure flag (read)

.18 TCU system alarms as per 2.7 above (read)

.3 Provide all engineering/set-up tools required to configure or re-configure these devices. Include all disks/CDs and manuals.

2. Execution

2.1 INSTALLATION

.1 Use one TCU for each terminal air volume/temperature control device.

.2 Terminal box TCUs shall be connected to the sub-network of the RCU that controls the air system serving the respective terminal boxes.

.3 Each TCU shall be mounted so as to allow easy access for maintenance. There shall be no less than 60 cm between the TCU cover and any obstruction.

.4 Each intelligent thermostat shall be securely fastened to wall in an easily accessible location not directly affected by supply air, radiant heat, sunlight, or heat from local equipment. Room furnishings shall not obscure device. Confirm all locations with Minister.

.5 Transformers serving power supplies shall be sized such that output voltage droop is no greater than 10% with all connected devices powered up and output devices in motion. No more than 8 TCUs are allowed per transformer.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23 EMCS General Requirements and other related EMCS Sections.

1.2 REFERENCE DOCUMENTS

.1 Canadian Standards Association (CSA)

.1 CSA C22.2 No. 45 M1981 Rigid Metal Conduit

.2 CSA C22.2 No. 75 08 Thermoplastic-Insulated Wires and Cables

.3 CSA C22.2 No. 83 M1985(R2008) Electrical Metallic Tubing

1.3 REGULATORY REQUIREMENTS

.1 Comply with Electrical Protection Act of Alberta and rules and regulations made pursuant thereto, including the Canadian Electrical Code.

.2 Unless otherwise indicated, all references to "Canadian Electrical Code" or "CEC" shall mean the edition of the Canadian Electrical Code, Part I, CSA C22.1, and the variations made thereto by Alberta regulation, which are in force on the date of bid closing for the Contract.

.3 All electrical products shall be approved by the Canadian Standards Association (CSA) and bear the CSA label. Alternatively, where a product does not bear a CSA label, it shall be approved in writing by the authority having jurisdiction.

.4 Submit to authority having jurisdiction and utility company, necessary number of drawings and specifications for examination and approval prior to commencement of work. Pay associated fees.

.5 Submit to Minister, copy of electrical permit obtained from authority having jurisdiction.

.6 If authority having jurisdiction conducts an electrical inspection, submit copy of certificate of acceptance provided by authority having jurisdiction.

2. Products

2.1 CONDUIT

.1 EMT: to CSA C22.2 No. 83. Provide rain tight fittings in weatherproof and damp areas.

.2 Rigid Metal: to CSA C22.2 No. 45.

2.2 WIRE

.1 Wiring: to CSA C22.2 No. 75, copper conductor, 600 V RW90 X link insulation. 300 V insulation allowed for conductors not entering enclosures containing line voltage.

.2 120 VAC Control Wiring: minimum #14 AWG.

.3 Low Voltage Field Wiring:

.1 Minimum #22 AWG.

.2 Twisted pairs.

.3 Stranded, except #18 AWG and larger may be solid.

.4 Shielded with drain wire, except for digital input/output wiring carrying less than 25mA and not installed in tray.

.5 Multiconductor wiring must have individually twisted and shielded pairs with a drain wire for each pair. Cable must have overall shield. Maximum 6 pairs.

.6 Exposed wiring in ceiling spaces to be rated for return air plenum use. Exposed wiring must utilize FT6 jacket. FT4 jacket is not approved**.**

.7 Aluminum wiring is not allowed.

2.3 IDENTIFICATION MATERIALS

.1 Wiring Identification Materials:

.1 Use one of the following:

.2 Heat shrink sleeves, with printed or legible hand written identifier.

.3 Snap on or slide-on sleeves, or crimp-on pins with integral sleeve. Length to suit number of characters required in identification code, 6 (six) characters minimum. Marking elements to be removable yet secure when inserted into sleeve. Standard of quality: Grafoplast Wiremarkers Inc.

.4 Factory coded slip-on identification bead markers or sleeves.

.1 Size of sleeves to be selected so that they do not slip off when wire is removed from termination and shaken.

.2 Wrap-on adhesive strips not allowed. Hand written identifiers not allowed.

.5 Point Identification Tags: 0.75 mm thick plastic laminated luggage style tags containing imprinted information label. Printing on surface of plastic not allowed. Printing shall be 14 point font or larger.

.6 Engraved Plastic Nameplate: self-adhesive composite laminated plastic nameplates with one smooth white surface and core of black plastic designed to leave black lettering on a white background. Engraved lettering height as follows:

.1 RCU, TCU and Equipment Cabinets: 20 mm.

.2 Magnetic contactors for EMCS controlled equipment: 20mm.

.3 All other: 8mm.

.7 Wiring Directories: for each RCU and TCU provide a laminated sheet with a cross reference listing of logical point mnemonic, descriptor, wiring label and hardware address for each wire terminated in cabinet. Order and placing of information shall mimic pattern of wiring terminations.

.8 Equipment Cabinet Directories: for each equipment cabinet provide a laminated sheet graphically showing location of each transducer, relay or other device in cabinet. Each device outline to be labeled and function of device indicated. Provide logical point mnemonic, descriptor, wiring label and hardware address for field wiring terminating at transducers and relays within cabinet.

3. Execution

3.1 CONDUIT

.1 Use EMT conduit:

.1 for all high speed communications trunk wiring between RCUs.

.2 for wiring that would be exposed to mechanical damage.

.3 for wiring in inaccessible areas.

.4 where indicated on drawings or otherwise required by CEC.

.5 Use rigid metal conduit for all wiring in areas designated as hazardous.

.6 Conduit sizing and installation shall comply with CEC requirements. Wire fill shall not exceed 50%.

.7 Wherever practical, conceal conduit in walls, floors and ceilings.

.8 Install conduit parallel or at right angles to building lines; minimize crossovers and conserve space and headroom.

.9 Do not install conduit in or under ground floor slabs.

.10 Do not use metallic or non metallic sheathed cable except where otherwise indicated.

3.2 WIRING

.1 Neatly arranged panduit with snap on covers shall be used to restrain wiring inside cabinets larger than 300mm square.

.2 Neatly train and cable tie wiring in cabinets smaller than 300 mm square. Adhesive backed twist ties or adhesive backed cable tie holders are not allowed. Wiring shall be secured to cabinet back with mountable cable ties fastened with #8 or larger sheet metal screws.

.3 Each field device shall have its own signal and return wire individually terminated in the panel. The use of a common return wire or ground for more than one control point is not allowed.

.4 Plenum rated cable:

.1 telecommunications cable tray is not permitted for use by EMCS wiring.

.2 shall follow building lines, close to the building structure, well above any ductwork or piping.

.3 shall be secured to the building structure at intervals not exceeding 2 meters with bundles wire-tied every 1 meter. Cable shall not be attach to ceiling support system, piping or ductwork.

.4 shall not be tied against sharp edges (sheet metal, redi-rod) without sufficient additional protection. Provide grommets at entry to boxes and into conduit.

.5 shall not be kinked or bent to a radius less than 100mm. Provide a full loop of slack at entry to boxes and conduits.

.5 A single continuous non-spliced cable shall be used for connecting each field device. Joining of cables is only permitted as follows:

.1 New points: Only one splice for every 100 meters of cable.

.2 Existing points where the existing wire is allowed to be reused: Only if the final length of unspliced run exceeds 10 meters.

.3 The type of wire, gauge, colour and number of conductors to any device, shall remain the same right from the device through to the termination connectors in the control panel.

.4 Splices are only allowed within equipment cabinets or junction boxes. The shield drain wire for each pair must be connected. Splices shall expose no more than 2cm of unjacketed wire.

.5 Except as indicated next, only properly sized insulated spring wire connectors with plastic insulating caps or solderless pressure connectors with insulated covers by Marr, Ideal or 3M are allowed for splicing. The use of screw type terminal blocks is required for splicing ALL wiring entering a cabinet or junction box when any one of the following conditions exists:

.6 The panel or junction box contains more than 10 connections.

.7 Multi-conductor cables with more than 4 wires are to be spliced.

.1 Terminal blocks must be screw mounted with #8 or larger sheet metal screws in panels or junction boxes no smaller than 150mm square.

.8 Where hand/off/auto (HOA) switches are available on the MCC or are provided under this contract, the digital output points shall be wired such that the equipment is under EMCS control when the HOA switch is in the auto position. Confirm proper operation of equipment under hand and off operation. Correct wiring as necessary.

3.3 GROUNDING

.1 Provide a complete ground system for all EMCS equipment, including panels, conductors, conduit, raceways, connectors and accessories. Grounding shall be by means of electrical supply conductor bonding method. Separate grounding conductors not permitted.

.2 Grounding between control panels and field devices shall have a star configuration. The shield for a field device shall be grounded at the panel only.

.3 The shield for communications wiring must be contiguous throughout its full length and shall be grounded at one point only. For TCUs, the ground shall be at the RCU. Except for this single ground connection, when splicing to an RCU/TCU the shield drain wire must be connected through and not to the RCU/TCU ground. Splices shall expose no more than 2cm of unshielded wire.

3.4 IDENTIFICATION

.1 Conduit:

.1 Apply paint or colour banding tape in fluorescent orange for control wiring conduit in 35 mm wide bands all around conduit as follows:

.2 At least once in each 10 m of conduit run.

.3 Where conduit enters inaccessible ceiling, wall and floor spaces.

.4 At least once in each room or area through which a conduit passes.

.1 Applying fluorescent orange paint to all conduit fittings prior to installation is an acceptable practice. However, additional identification banding shall be added as required to meet all requirements of this article.

.5 Wiring:

.1 Wiring more than 1 meter in length must be labeled at both ends.

.2 Labels for all system point wiring shall, as a minimum, contain the following information:

.6 Panel end: panel terminal number or hardware address.

.7 Device end: panel number as well as panel terminal number or hardware address.

.8 Label panel power supply wiring with the panel connector number.

.9 Label communications port wiring with panel connector number and device name (e.g. "J1-modem", "J2-printer").

.10 Label communications trunk wiring with the panel number, router number etc. to which the other end of the cable is connected.

.11 Wiring on each side of a terminal block or splice shall be labeled with the information required for the device end of the wire.

.12 In retrofit situations the above labeling requirements are in addition to any existing labeling.

.13 Point Tagging:

.1 Identify all input sensors and devices as well as all EMCS controlled output actuators, motors and equipment, with Point Identification Tags. Provide multiple tags as necessary. Additional requirements as follows:

.14 Tag control wiring for major mechanical equipment at equipment terminal strip.

.15 Tag any input/output transducers not identified on an Equipment Cabinet Directory.

.16 Tag electric motors on power cable near motor end.

.1 Point Identification Tags shall be attached using two nylon cable ties. One tie is to provide a loose loop through the tag while the other tie is to hold this loop to the wire or conduit.

.2 All Point Identification Tags shall include the following minimum information:

.1 Logical Point Mnemonic consisting of the system mnemonic and point mnemonic.

.2 Panel name and terminal number that the point is connected to.

.17 Point Hardware Address (RCU/TCU and connection terminal identifiers)

.18 Associated System Identification

.19 Point Description

.20 Nameplates:

.1 Identify the following with engraved plastic nameplates:

.21 Magnetic contactors and related local disconnect switches.

.22 Space temperature sensors and intelligent thermostats.

.23 RCU cabinets, TCU cabinets, associated equipment cabinets.

.24 Front panel mounted switches, displays and devices; identify function of each item.

.1 Nameplates shall include logical point mnemonic as per above.

.2 All nameplates to be easily visible without need to use ladder or extraordinary body position. Affix additional nameplates if necessary.

.3 Provide the Departmental Representative or Owner with an example of the contents of each type of nameplate as indicated in 3.2.1 above. Obtain approval prior to engraving.

.25 Directories:

.1 Permanently mount laminated Wiring Directories on door inside surface of each RCU and TCU cabinet.

.2 Permanently mount laminated Equipment Cabinet Directories on door inside surface of each equipment cabinet.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23 - EMCS General Requirements and other related EMCS Sections.

.2 The letters under the "Type" column in the following Schedule are the same used in Section 23 09 30 “Point Database Schedule” and also on the drawings.

2. Products

2.1 SENSING DEVICES

.1 Provide field instrumentation and sensing devices, analog or digital as applicable, which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc. and which input signals to the RCU or TCU terminal strip that conform to the input requirements specified in Sections 23 09 26 and 23 09 27, "Signal Processing" articles.

.2 The end-to-end accuracy called for in the following Schedule includes the combined effect of all the errors in all the interposing devices and components between the measured variable and the value displayed at the Central Control Station.

.3 For all sensors in piping, provide stainless steel wells and all required adaptors. Provide **rigid metal** nipples between well and sensor junction box. For retrofit projects, existing wells may be reused if they are no longer required for any other purpose, are in good condition and are compatible with the new sensors.

2.2 ACTUATORS

.1 Provide output devices, motors and actuators which convert the digital or analog output signal from the RCU or TCU to activate relays or open and close valves, dampers, etc., that conform to the output requirements specified in Sections 23 09 26 and 23 09 27 “Signal Processing” articles.

.2 The end-to-end accuracy called for in the following Schedule includes the combined effect of all the errors in all the interposing devices and components between the value entered at the Central Control Station and the position of the final control element. In retrofit situations, where the final control elements or actuators are allowed to be reused, end-to-end accuracy refers only to the signal sent to the final control element or actuator.

.3 Actuators shall be gear driven with spring return to "fail safe" in normally closed position as dictated by freeze, fire or temperature protection. Actuator shall include a manual override allowing end device to be positioned and locked into place should the actuator fail.

.4 For dampers provide actuator motor with 0.56 Nm per 0.929 m2 of damper area.

.5 Standard of quality: Belimo

2.1 CONTROL VALVES

.1 Provide valves in accordance with general valve specification. Provide position indicators on valves.

.2 Valves shall "fail safe" in normally open or closed position as dictated by freeze, humidity, fire or temperature protection as follows or as specified in Sections 23 09 30 “Point Database Schedule or 23 09 93 EMCS Control Sequences.

.1	Zone Perimeter Heat Valves	N.O.
.2	Force Flows & Unit Heaters Valve	N.O.
.3	Fan Coil Heating Valve	N.O.
.4	Fan Coil Cooling Valve	N.C.
.5	Air System Heating Valve	N.O.
.6	Air System Cooling Valve	N.C.
.7	Air System Humidifier Valve	N.C.
.8	Differential Pressure Control Valve	N.C.
.9	Main Heating System Valves	N.O.

.3 Two-way valves shall be pressure independent. Each valve shall be complete with PT ports. Pressure independent functionality shall operate between 5 to 58 PSI. Heating zone valves shall be spring return normally open and cooling valves shall be spring return normally closed. During contractor commissioning of valve, set and or verify that the adjustable CV or flow setting is set to the correct value.

.4 Three way valves shall have linear characteristics. Size valve operators to close valves against pump shut off head. Size three-way valves that are in series with a pump for a maximum of 10 kPa pressure drop. Heating valves shall be spring return normally open and cooling valves shall be spring return normally closed.

.5 NPS 2 and under: Screwed National Pipe Thread (NPT) tapered female connections. Valves to ANSI Class 250, valves to bear ANSI mark. Turndown 50:1 minimum.

.6 NPS 2.5 and larger: Flanged connections. Valves to ANSI Class 250 as indicated, valves to bear ANSI mark. Turndown 100:1 minimum.

.7 Butterfly Valves NPS 2 and larger:

.1 Body: for chilled water ANSI Class 150 cast iron lugged body, wafer body installed in locations as indicated. For steam and heating water ANSI Class 150 carbon steel lugged body, wafer body.

.2 End connections to suit flanges that are ANSI Class 150.

.3 Extended stem neck to provide adequate clearance for flanges and insulation.

.4 Pressure limit: bubble tight sealing to 170 kilopascals.

.5 Disc/vane: 316 stainless steel

.6 Seat: for service on chilled water PTFE (polytetrafluoroethylene). For service on steam and heating water RTFE (reinforced PTFE).

.7 Stem: 316 stainless steel.

.8 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.

.9 Flow characteristic linear.

.10 Maximum flow requirement as indicated on control valve schedule.

.11 Maximum pressure drop as indicated on control valve schedule: pressure drop not to exceed one half of inlet pressure.

.12 Normally open or Normally closed as indicated.

.13 Valves are to be provided complete with mounting plate for installation of actuators.

.8 Steam valves shall have modified linear characteristics with stainless steel seats. Provide separate valves on individual coils. Two valves in parallel shall have 1/3 - 2/3 load capacities sequenced so that smaller valve opens first. The larger valve shall start opening just before the small valve's fully open position.

2.2 DAMPERS

.1 Provide low leakage type dampers with hollow blades filled with extruded polyurethane insulation for outside air or exhaust air dampers. Damper assembly shall have a thermal insulation value of R 0.35 ^{o}C m2/W Tamco 9000 or equal.

.2 Blades shall be minimum 2.75 mm extruded aluminium. Blades shall be of air foil design, 150 mm wide. Maximum blade length 1200 mm.

.3 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

.4 Frames shall be minimum 2.75 mm extruded aluminium channel with grooved inserts for seal.

.5 Install blade linkage hardware in frame out of air stream.

.6 Arrange linkage and provide an adequate number of damper operators to ensure that the interconnected damper sections operate in unison without binding.

.7 Damper operators for outdoor or RTUs shall be supplied by controls contractor and installed by the Air Processing Unit manufacturer at the factory, in accordance with instructions from controls contractor. Extend drive and provide mounting bracket to place outdoor air actuators outside air stream. Check unit and room height to ensure adequate space if extended through top of cabinet.

.8 Jack shafts:

.1 25 mm diameter solid shaft, constructed of corrosion resistant metal complete with required number of pillow block bearings to support jack shaft and operate dampers throughout their range.

.2 Include corrosion resistant connecting hardware to accommodate connection to damper actuating device.

.3 Install using manufacturer's installation guidelines.

.4 Use same manufacturer as damper sections.

2.3 OUTSIDE AIR DAMPER/ FLOW STATIONS FOR MIXED AIR UNITS

.1 Provide an outside air damper assembly equivalent to Ebtron's Tamco/Ebtron AIR-IQ series.

.2 The assembly will include the following:

.1 A Tamco 9000 series damper complete with separately controllable minimum outside air section and an economizer section.

.2 Thermal dispersion airflow measurement station. Arrange the airflow station probes so that at least one of the probes measures the air stream through the minimum outside air damper section of the damper and the remaining probes measure the air stream through the economizer section of the damper. Install a sheet metal divider on the upstream side of the damper to separate the minimum outside air flow from the economizer air flow.

.3 A digital transmitter complete with analog output for connection to the BMS.

.4 A two position actuator on the minimum outside air damper section and an analog actuator on the economized section of the damper.

2.4 ANALOG INPUT SENSORS – TEMPERATURE

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Probe	Tp	0°C to 60°C	±0.3°C	Length to suit duct size.
Pipe Well	Tw	0°C to 50°C 0°C to 100°C 50°C to 150°C	±0.3°C ±0.5°C ±0.5°C	C/w stainless wells, range to suit application c/w rigid metal nipples and metal junction box
Averaging	Ta	-30°C to 50°C	±0.5°C	C/w supporting wire and brackets. Sensors to be covered with copper sheathing.
Room/Space	Tr	10°C to 30°C	±0.3°C	C/w tamper proof cover.
Outside Air	To	-50°C to 50°C	±0.5°C	C/w solar shield.
Surface	Ts	0°C to 50°C 0°C to 100°C 50°C to 150°C	±0.3°C ±0.5°C ±0.5°C	C/w anchor strap.

2.5 ANALOG INPUT SENSORS - RELATIVE HUMIDITY

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Probe	Hp	5 to 90% RH 0°C to 60°C	±3%	Must be usable over 0 to 100% RH range
Room/Space	Hr	10 to 90% RH 10°C to 30°C	±3%	C/w tamper proof cover.

Outside Air	Ho	5 to 90% RH-50°C to 50°C	±5%	C/w solar shield. Must be usable over 0 to 100% RH range

2.6 ANALOG INPUT SENSORS – PRESSURE

Application	Type	Operating Range	End to End Accuracy	Remarks
Static	Ps	as required: 25 - 50% greater than max design	±2% full scale	Materials to suit medium in contact with device
Differential	Pd	as required: 25 - 50% greater than max design	±2% full scale	Materials to suit medium in contact with device.
Velocity Pressure	Pv	as required: 25 - 40% greater than max design or max measured velocity pressure at full flow rate.	±1.0% full scale	Air: Multi-point static & total pressure sensing element, self-averaging manifold, air equalizer and straightener, max pressure loss 36 Pa @ 10 m/sec. Water & Steam: Annubar or orifice plate.

2.7 ANALOG INPUT SENSORS – ELECTRIC

Application	Type	Operating Range	End to End Accuracy	Remarks
Watt Meter	Kw	as required	±0.25% Full scale	3 current transformers 2 potential transformers as applicable for "Y" or "D" configuration.
Current Transformer	Kw	as required:	±0.25% full scale	
Current Transducers	Ct	as required:	±0.25% full scale	4 to 20 mA DC or 0 to 10 VDC.

2.8 ANALOG INPUT SENSORS – MISCELLANEOUS

Application	Type	Operating Range	End to End Accuracy	Remarks
Carbon Monoxide	Co	0 to 200 PPM	±5% Full range	Electrochemical devices ONLY Device must not be sensitive to ambient air temp or relative humidity.
Turbine Water Flow Meter	Fw	175:1 turn down from 0.052 to 9.14 m/s	±5% Full range	Onicon F-1100 or F-1200 series as required to meet minimum straight pipe requirements.
BTU Meter	BTU	Flow sensor 175:1 turn down from 0.052 to 9.14 m/s	±5% Full range	Onicon System-10 complete with flow and temperature sensors. Available with LONWORK, MODBUS, JCI N-2, Siemens P-1 and BACnet network cards.
		Temperature sensors 0-93.3°C	±0.08°C	
Thermal Dispersion	Fag	0 to 25.4 m/s	± 2% of reading	Ebtron Gtx116-P series # of sensors as required to meet C

Airflow Measurement				density at minimum straight duct requirements.
Thermal Dispersion Airflow Measurement	Fah	0 to 25.4 m/s	± 2% of reading	Ebtron HTx104-P series # of sensors as required to meet C density at minimum straight duct requirements.
Thermal Dispersion Airflow Measurement	Fas	0 to 25.4 m/s	± 2% of reading	Ebtron STx102 series # of sensors as required to meet C density at minimum straight duct requirements.
Thermal Dispersion Airflow Measurement	Fae	0 to 25.4 m/s	± 2% of reading	Ebtron ELF series.

2.9 ANALOG OUTPUT DEVICES – ELECTRIC

Application	Type	Operating Range	End to End Accuracy	Remarks
To Damper Motors	Dm	4 to 20 mA DC 0 to 10 VDC 0 to 5 VDC	±2% Full Range	Match range if existing
To Valve Motors	Vm	4 to 20 mA DC 0 to 10 VDC 0 to 5 VDC	±2% Full Range	
To Equipment Supplied By Others	Vo	4 to 20 mA DC 0 to 10 VDC 0 to 5 VDC	±2% Full Range	

2.10 ANALOG OUTPUT DEVICES – PNEUMATIC

Application	Type	Operating Range	End to End Accuracy	Remarks
To Damper Actuators	Da	20 - 104 kPa	±2% Full Range	I/P transducer, provide output pressure gauge.
To Valve Actuators	Va	20 - 104 kPa	±2% Full Range	I/P transducer, provide output pressure gauge.

2.11 DIGITAL INPUT DEVICES

Application	Type	Operating Range	End to End Accuracy	Remarks
Dry Contact	Dc	N/A	N/A	
End Switch	Esw	N/A	N/A	Adjustable position.
Level Switch	Lsw	N/A	N/A	Adjustable setpoint and differential. Pressure rating suitable to application.

Pressure Switch	Psw	as required	±1.5% Full Scale	Adjustable setpoint and differential.
Temperature Switch	Tsw	as required	±1°C	Adjustable setpoint and differential. Manual reset for freeze protection.
Current Sensitive Relay	Ri	as required	N/A	Adjustable trip setpoint and Differential.
P/E Relay	Pe	0 – 120 kPa	N/A	Adjustable setpoint and differential.

2.12 DIGITAL OUTPUT DEVICES

Application	Type	Operating Range	End to End Accuracy	Remarks
Relays	Ry	N/A	N/A	DPDT, plug-in type terminal base. Contacts rated to suit motor starter.
E/P Relays	Ep	N/A	N/A	

3. Execution

3.1 INSTALLATION

.1 All transducers and devices are to be mounted in equipment cabinets with hinged doors. Unless specifically approved in writing, equipment cabinets shall be installed near RCU cabinets, at eye level, in easily accessible areas, on solid walls or supported away from vibrating equipment. Cabinets not in mechanical rooms shall have lockable doors keyed the same as RCU cabinets.

.2 For all sensors in piping, confirm locations of wells and availability of any existing wells where applicable. Use thermal conductive compound when installing sensors to ensure proper thermal coupling of sensor to well. No more than 2 meters of flex shall be used between sensor housing and raceway. Flex to be secured within 1 meter of sensor.

.3 Install a pressure gauge on the signal line of each electro-pneumatic transducer (EPT) or pneumatic controller, excepting room temperature controllers.

.4 Install a brass tee in the high and low side lines of every air flow station and differential pressure transducer, excepting those on room VAV box controls. Cap off open end of tee with 10 cm stub and plug or brass coupling and rubber cap Tees to be located close to device in such a manner as to allow for easy access during commissioning procedures.

.5 Coordinate with mechanical contractor to ensure flow stations supplier minimum straight duct requirements are maintained.

END OF SECTION

1. General

1.1 INTENT

.1 Read this Section in conjunction with Section 23 09 23 - EMCS General Requirements and other related EMCS Sections.

1.2 DEFINITIONS

.1 A point is a specific software address which is resident in either the RCU or TCU and which is identified with a particular field sensor, instrument, relay or actuator.

.2 The point schedule contains a list and description of the points to be connected.

.3 The relationships between the points, systems and building are described in the control sequences, Section 23 09 93.

1.3 SCHEDULES

.1 Following is appended to and forms part of this Section:

.2 Energy Management Control System - Point Database Schedule.

2. ProductsExecutionPOINT SCHEDULES

.1 Digital Inputs; refer to Section 23 09 29, "Digital Input Devices Schedule" and input type designation in schedule.

.2 Digital Outputs; refer to Section 23 09 29, "Digital Output Devices Schedule" and output type designation in schedule.

.3 Analog Inputs; refer to Section 23 09 29, "Analog Input Sensors Schedule" and input type designation in schedule. Consult with minister's representative during the system start-up for limits and alarm values to be entered.

.4 Analog Outputs; refer to Section 23 09 29, "Analog Output Devices Schedule" and output type designation in schedule.

.5 Use Alberta Infrastructure “EMCS Guideline for Logical Point Mnemonics” to identify each physical and virtual point in data base and User Control Language software in each panel.

.6 All points included under the same group letter must reside within the same panel. Any form of inter panel communications link to accomplish this is not allowed except as explicity stated under Section 23 09 24 “Control Loop Configuration”.

.7 Consult with the Minister during the shop drawing stage to finalize the physical terminal address of each point within each RCU or TCU.

3.2 POINT INSTALLATION

.1 When two outdoor air temperature sensors are specified, locate the sensors so that the sun cannot shine on both sensors at once, and airborne waste heat cannot simultaneously affect both sensors.

.2 Locate duct temperature and humidity sensors a minimum of three metres downstream of humidifiers.

.3 Use averaging sensors for all mixed air temperature sensing applications.

.4 Use averaging temperature sensors for applications where the duct area is greater than 0.5 m2 AND the sensor is located downstream of a coil by a distance less than 4 times the diagional measurement of the coil.

.5 For all sensors in piping, use thermal conducting compound to ensure proper thermal coupling of sensor to well body.

1. Heating Water System

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Typical for Boilers B-1 & B-2									
Enable	Ry	1							
Status	St							X	Note #1
Flame Failure	St		X						
Supply Wtr Temp.	Tw						H/L	X	Note #1
Setpt Reset	Ao				X				
Firing Rate	Vi					X			
Typical for Pumps P-1 & P-2									
Enable	Ry	X							
Status	CT					X			
Field Points									
Return Water Temp	Tw					X	H/L		
Supply WaterTemp	Tw					X	H/L		

Note #1: Mapped point to BMS graphic via unit supplied BACnet card.

2. Secondary Heating System

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Typical for Pumps P-3 & P-4									
Enable	Ry	X							
Speed	VFD				X				
% Load	VFD					X			
Alarm	Dc		X						
KW	VFD							X	Note #1
Field Points									
Glycol Return Temp	Tw					X	H/L		
Glycol Supply Temp	Tw					X	H/L		
System Pressure	Ps					X	H/L		
Differental Pressure	Dp					X	H/L		
Note #1: Mapped point to BMS graphic via unit supplied BACnet card.									

3. Domestic Hot Water

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Return Water Pump									
Status	Ct					X			
Field Points									
Supply Water Temp	Tw					X	H/L		

4. Glycol Cooling System

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Chillers CH-1									
Enable	Ry	1							
Status	St							X	Note #1
Failure	St							X	Note #1
Supply Wtr Temp.	Tw						H/L	X	Note #1
Setpt Reset	Ao				1				
Cooling Module Status	St		2						
Free Cooling Module Status	St		1						
Pressure Drop	Dp					X	H/L		
Typical for Pumps P-5 & P-6									
Enable	Ry	X							
Speed	VFD				X				
% Load	VFD					X			
Alarm	Dc		X						
KW	VFD							X	Note #1
Field Points									
Primary Return Glycol Temp	Tw					X	H/L		
Primary Supply Glycol Temp	Tw					X	H/L		
Glycol Three-way Bypass Valve	Ry				X				
Minimum Flow Valve	Ry				X				
Cooling System Pressure	Ps					X	H/L		
System Flow	Fm					X	H/L		
Enf of Line Differental Pressure	Dp					X	H/L		

Note #1: Mapped point to BMS graphic via unit supplied BACnet card.

5. Energy Recovery Ventilator ERV-1

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Supply Fan									
Enable	Ry	X							
Speed Command	VFD				X				
% Load	VFD					X			
Alarm	Dc		X						
Air Flow						X			**Note #2**
KW								X	**Note #1**
Exhaust Fan									
Enable	Ry	X							
Speed Command	VFD				X				
% Load	VFD					X			
Alarm	Dc		X						
Air Flow						X			**Note #2**
KW								X	**Note #1**
Heat Wheel									
Enable	Ry	X							
Status	Ct					X			
Wheel Speed Control	Vo				X				
Exhaust Bypass Damper					X				
Supply Bypass Damper					X				
Field Points									
Summer Filter	Ps					X	H		
Preheat Coil Discharge Temp	Ta					X	H/L		
Preheat Coil Valve	Vm				X				
Winter Filter	Ps					X	H		
Heat Wheel Discharge Temp	Ta					X	H/L		
Final Filter	Ps					X	H		
Supply Air Temp	Ta					X	H/L		
Reheat Coil Valve	Vm				X				
Freezestat (Low temp Alarm)	Fz		X	X					
Return Air Filter	Ps					X	H		

5. Energy Recovery Ventilator ERV-1

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Building Relief Air Temp	Tp					X	H/L		
Heat Wheel Exhaust Air Temp	Ta					X	H/L		
Supply Air Humidity	Hd					X	H		
Return Air Humidity	Hd					X	H		
Humidifier Enable	Ry	X							
Humidifier Capacity Control	Vo				X				
Washroom Exhaust Fan EF-1									
Start/Stop	Ry	X							
Status	Ct					X			
Exhaust Fans EF-3, 4, 10, 11, 12, 13									
Status	Ct					X			
Fume Hood Exhaust Fan EF-14									
Status	Ct					X			
Air Flow	Fae					X			

Note #1: Mapped point to BMS graphic via unit supplied BACnet card.
Note #2: Provided by equipment supplier.

6. Typical Vehicle Pass Through

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Exhaust Fan									Note #1,2
Start/Stop	Ry				X				
Status	Ct					X			
Unit Heaters									Note #1
Start/Stop	Ry	X							
Field Points									
Space Temp	Ts					X	H/L		
Space CO	Co					X	H/L		

Note #1: Refer to mechanical drawings for quantities.
Note #2: Provide exhaust air and outside air dampers and hard-wire actuators as per section 23 09 93.

7. Fan Coil & VAV Box Zone Controls

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Fan Coil Units									Note #1
Fan Start/Stop	Ry				X				
Fan Status	CT					X			
Supply Air Temp	Ts					X	H/L		
Space Temp	Ts					X	H/L		
Space Temp Setpoint	Ts					X			
Occupancy Switch On Sensor	St		X						
Heating Valve	Vm				X				
Cooling Valve	Vm				X				
VAV Box									Note #1
Volume	Ps					X	H/L		
Damper	Dm				X		H/L		

Note #1: Refer to mechanical drawings for quantities.

8. Cell Zone Controls

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
Exhaust Fan EF-2									
Start/Stop	Ry				X				
Status	Ct					X			
Air Flow	Fae					X			
Exhaust Air Damper	Dm				X				
Exhaust Air Damper Position	Dm				X		H/L		
Fan Coil Units									
Fan Start/Stop	Ry				X				
Fan Status	CT					X			
Supply Air Temp	Ts					X	H/L		
Space Temp	Ts					X	H/L		
Space Temp Setpoint	Ts					X			
Occupancy Switch On Sensor	St		X						
Heating Valve	Vm				X				
Cooling Valve	Vm				X				
Return Air Damper	Dm	X							
Return Air Damper End-Switch	Dm		X				H/L		
VAV Box									
Volume	Ps					X	H/L		
Damper	Dm				X		H/L		

9. Miscellaneous Zone Controls

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
VAV Box Zones									Note #1
VAV Box Volume	Ps					X	H/L		
VAV Box Damper	Dm				X		H/L		
Radiant Panel and Radiation									Note #1
Space Temp	Ts					X	H/L		
Space Temp Setpoint	Ts					X			
Heating Valve	Vm				X				
Force Flow									Note #1
Fan/Valve Enable	Ry	X							
Space Temp	Ts					X	H/L		
Ductless Air Conditioner									Note #1
Space Temp	Ts					X	H/L		
Unit Alarm	Dc			X					

Note #1: Refer to mechanical drawings for quantities.

10. Miscellaneous Points

Point Description	Point Type	Digital			Analog			Mapped Points	Remarks
		Output	Input	Alarm	Output	Input	Alarm		
OAT - 1	To					X			
OAH - 1	Ho					X			
OAT - 2	To					X			
OAH - 2	Ho					X			
Car Receptacles	Ry	X							
Car Receptacles	Ry	X							
Normal Power	Dc	X							
Emergency Power	Dc	X							
Fire Alarm	Dc	X							
Oil Separator	Dc	X							Note #1

Note #1: Refer to mechanical drawings for quantities.

END OF SECTION

1. General

1.4 INTENT

.1 Read this section in conjunction with 23 09 23 General Requirements, 23 08 95 EMCS Start-up and Testing and other related EMCS Sections.

1.5 RELATED REQUIREMENTS

.1 General Commissioning Section 01 91 13

2. Products

Not Applicable.

3. Execution

3.4 GENERAL REQUIREMENTS

.1 Provide all programming required to implement the control sequences described in this section.

.2 Programming style is to be of a form that enables the control strategies to be easily followed. Clarity, simplicity and elegance are more important than program size.

.3 Programs shall be modular in nature and shall be as structured as the language will permit.

.4 All programs must include a sufficient number of comments to allow another person to make changes to the strategies at some later time.

.5 Additional programming may be provided by the Contractor as desired, so long as it does not affect the intended operation of the specified sequences. Ensure that all equipment will operate in a safe manner.

.6 All control loops shall be tuned such that they are stable through all seasons and operating conditions including startup.

.7 During the construction period through to the end of the warranty period, the Contractor shall be responsible for fine tuning the controls programming to ensure satisfactory operation.

3.5 MISCELLANEOUS REQUIREMENTS

.1 Staggered starting - Motors must not be allowed to start at the same time. Under all conditions of startup, return from power failure or panel reset, there must be at least a 15 second delay between the time one motor starts and another is allowed to start.

.2 Single phasing - If a phase monitor alarm contact has been provided in the main switch gear, provide routines to stop all 3-phase motors within 60 seconds of contact activation.

3.6 VERIFICATION OF CUSTOM CONTROL SOFTWARE

.1 Provide copies of trend logs that clearly indicate the:

.3 Stability of each control loop under various load conditions including modest step setpoint changes.

.4 Adequacy of system startup during summer and winter conditions.

.5 Proper operation of the outside air temperature prediction routines.

.6 Adequacy of space comfort conditions.

3.7 CONTROL SEQUENCES

.1 Primary Heating Water System

.1 The heating system consists of two condensing boilers B-1 and B-2, each sized for 100% of the normal heating load. The normal heating load is the connected load with ERV-1 heat recovery working.

.2 The boiler circulation pumps P-1 & P-2 are each sized for a 20°C delta T across the boiler but will be set for a 25°C delta T across the boiler. The flow through the boilers will be set by the balancing agent and is not adjustable via the EMCS. The initial flow will be set at 1.25 l/s.

.3 The boilers have been specified to have firing rate controls and BACnet cards. Provide a BACnet connection to each boiler and allow for mapping of 8 points per pump to the EMCS graphics.

.4 The ECMS shall provide boiler staging control, boiler supply temperature reset and boiler circulation pump enable.

.5 Provide all safety or operational interlocks to boiler control panels as required. Boiler low water cutoff switch, flow switch and temperature limit switches to be supplied by the boiler supplier.

.6 The boilers and their associated circulation pumps shall alternate lead/lag monthly (adjustable). If the outside air temperature is less than 15°C and any one of the terminal heating control valve is more than 15% open, the lead boiler shall be enabled. If the outside air temperature is less than 5°C (adjustable), the lead boiler shall be enabled on a continuous basis. Provide minimum on time of 60 minutes and a minimum off time of 5 minutes.

.7 The boiler supply water temperature setpoint shall be adjusted to maintain the secondary supply water temperature setpoint.

.8 When the heating system is enabled, the lead boiler circulation pump shall be started and shall operate continuously. Once the lead boiler circulation pump proves on, the lead boiler shall be enabled. When the secondary system flow rate rises above 1.51 l/s for more than 5 minutes, the lag boiler circulation pump shall be started. Once the lag boiler circulation pump proves on, the lag boiler shall be enabled. When the secondary system flow rate falls below 1.38 l/s for more than 5 minutes, the lag boiler shall be disabled. After a two minute delay to dissipate any residual heat in the boiler, the lag boiler circulation pump shall be commanded off.

.9 On the failure of the lead boiler or the associated pump, an alarm shall be generated at the EMCS graphics and the lead boiler and pump shall be alternated.

.10 Provide alarms for boiler ignition failure, low heating water temperature and pump failure. Disable heating alarms when outside air temperature is above the heating system shutdown setpoint.

.11 Provide an emergency disable red mushroom type latching push button at the exit of the boiler room and wire the dedicated switch contact to the gas isolation valve. Provide a dedicated contact for EMCS monitoring and alarming.

.2 Secondary Heating Water System

.1 The secondary heating system consists of two secondary heating water circulation pumps P-3 & P-4 each sized for 100% of the normal heating load.

.2 The pumps have been specified to have integral variable frequency drives (VFD) complete with BACnet cards. Provide a BACnet connection to each pump controller and allow for mapping of 8 points per pump to the EMCS graphics.

.3 The lead circulation pump speed shall be modulated to maintain the differential pressure setpoint as measured by a differential pressure sensor located on the supply and return lines at the end of the system. When the lead pump percent load rises to 100% and the differential pressure setpoint is not being maintain for 5 minutes, the lag pump shall be enabled and it's speed modulated in unisons with the lead pump. When both pump percent loads fall below 45% for 5 minutes, the lag pump shall be disabled.

.4 On the failure of the lead secondary pump, an alarm shall be generated at the EMCS graphics and the lead pump shall be alternated.

.5 When the lead pump is alternated bases on run time, the new lead pump status will prove before the old lead pump is disabled.

.6 A heating system pressure sensor will monitor the heating water system pressure. Provide alarms if the pressure increases above 135 kPa or decreases below 50 kPa.

.7 The secondary heating water temperature setpoint shall be reset by the outside air temperature as follows:

O/A Temp.	HWS
-30°C or less	60°C
10°C or higher	40°C

.8 The secondary heating water supply temperature setpoint shall be further reset ±5°C by the average space heating demand. Should the system call for both pumps to operate and one of the pumps fails, the secondary heating water supply temperature setpoint shall be increased by 10°C.

.3 Domestic Hot Water System

.3 The system consists of two domestic hot water heaters DHW-1 and DHW-2 and a recirculation pump P-7.

.4 The on board controls for domestic water heater maintain the water supply temperature setpoint. EMCS sensor monitors the domestic supply water temperature and P-7 status. Alarms are generated if the temperature is above or below alarm limits or on P-11 failure.

.5 DHW-1 is connected to emergency power.

.4 Glycol Cooling System

.1 The glycol cooling system has been piped as a primary only system.

.2 The system consists of a roof mounted chiller CH-1, two primary chilled glycol circulation pumps P-5 and P-6 each sized for 100% of the total cooling load.

.3 CH-1 consists of a free cooler module and two mechanical cooling modules each consisting of two compressors and an isolation valve.

.4 The chiller will come complete with a BACnet controller that performs all control functions for the mechanical cooling and free cooling modules.

.5 The EMCS shall enable the chiller, reset the chilled water temperature setpoint and monitor the number of modules that are operating via hard wiring points.

.6 The pumps have been specified to have integral variable frequency drives (VFD) complete with BACnet cards. Provide a BACnet connection to each pump controller and allow for mapping of 8 points per pump to the EMCS graphics.

.7 The glycol cooling system will normally be operated in either mechanical cooling mode or free cooling mode.

.8 When the ambient temperature allows, the chiller controls will enable the free cooling modules to precool the chilled glycol before mechanically cooling the glycol. During this mode of operation, the EMCS will control the systems to meeting the mechanical cooling mode of operation.

.9 Mechanical Cooling Mode

.1 When the chiller is operating in the mechanical cooling mode and at least 1 chiller isolation valve is open, the lead chilled glycol pump and lead secondary chilled water pump shall be enabled if not already operating.

.2 The lead chilled glycol pump speed shall be modulated to maintain the end of line differential pressure setpoint.

.3 The minimum flow valve shall be modulated to maintain the chilled glycol flow setpoint. The valve and differential pressure sensor shall be installed near the end of the line. The chilled glycol flow setpoint shall be set at XX l/s when one chiller isolation valve is commanded open and at XX l/s when two chiller isolation valves are commanded open. Control of the isolation valves is by the chiller controls.

.4 The primary glycol supply temperature setpoint shall be reset by the outside air temperature according to the following schedule:

O/A Temp.	CHGS
10°C or less	10°C
28°C or higher	5°C

.5 The glycol supply temperature setpoint shall be further reset 2°C by the average fan coil cooling demand. The glycol supply temperature setpoint will have a low limit of 5°C.

.10 Free Cooling Mode

.1 When the chiller is operating in free cooling mode and any one of the fan coil valves is more than 20% open, the EMCS shall start the lead chilled glycol pump if not already operating.

.2 The primary pump speed shall be modulated to maintain the end of line differential pressure setpoint.

.3 The minimum flow valve shall be disabled.

.4 The EMCS shall modulate the cooling bypass three-way valve to limit the primary chilled glycol temperature to a low limit of 6°C.

.5 The primary chilled glycol temperature setpoint shall be reset by the outside air temperature according to the following schedule:

O/A Temp.	HWS
-5°C or less	10°C
5°C or higher	7°C

.6 The primary chilled glycol temperature setpoint shall be further reset 2°C by the average fan coil cooling demand of the fan coils that are operating in the cooling mode. The glycol supply temperature setpoint will have a low limit of 5°C.

.7 The system is not connected to emergency power. When the emergency generator is operating and the normal power has failed, the system shall be disabled. On a return to normal power, the system shall be restarted as per the above sequence of operation.

.5 Energy Recovery Ventilator ERV-1

.1 Energy recovery ventilator ERV-1 is a variable volume, 100% outside air system providing ventilation air to the office and cell spaces.

.2 ERV-1 consists of a summer filter section, a glycol preheat coil, a winter filter section, a heat wheel section, a reheat coil, a supply fan, an exhaust filter section and an exhaust fan. BACnet compliant variable frequency drives (VFD) have been specified for both the supply and return fans.

.3 The exhaust for the washroom and janitors room air is ducted to exhaust fan EF1. The discharge of EF-1 is ducted to the exhaust suction side of ERV-1's heat wheel so that the cell exhaust can be heat recovered.

.4 The exhaust for the cells is ducted to exhaust fan EF-2. The discharge of the EF-2 is ducted to the exhaust suction side of ERV-1's heat wheel so that the cell exhaust can be heat recovered. The exhaust fan has been specified to come with an EC motor.

.5 The exhaust for rooms 156 and 157 is ducted to exhaust fan EF-3 which is located on the roof. The discharge of EF-3 is ducted to the outdoors. EF-3 is to operate continuously.

.6 The exhaust for the chemical storage cabinets in room 155 are ducted to exhaust fans EF-10 and EF-11. The discharge of the fans are ducted to the outdoors. EF-10 and EF-11 is to operate continuously.

.7 The exhaust for room 187 is ducted to exhaust fan EF-12 which is located on the roof. The discharge of the fan is ducted to the outdoors. EF-12 is to operate continuously.

.8 The exhaust for the PDS training suit cabinet in room 143B is ducted to exhaust fan EF-13 which is located on the roof. The discharge of EF-13 is ducted to the outdoors. A local switch near the cabinet in room 143B shall activate the fan.

.9 The exhaust for the fume hood in room 155 is ducted to exhaust fans EF-14 which is located on the roof. The discharge of EF-14 is ducted to the outdoors. A local speed control switch located in Room 155 controls the speed of the fan. The fan operates continuously.

.10 Heating and cooling for the individual zone is provided by fan coils or terminal heating units in each zone.

.11 Provide a BACnet connection to the fan VFDs and allow for mapping of points to the unit graphics.

.12 Provide supply air and exhaust air dampers complete with actuators for installation where the respective ducts inter the facility. Wire the dampers actuators to their respective VFDs so that the dampers are commanded open by the VFD and that the fans do not start until the dampers prove open.

.13 System Start/Stop

.1 ERV-1 will normally be energized via the Building Automation System when any one of the zones served by ERV-1 is operating in the occupied mode. Should the required design outside air volume of the occupied zones fall below the combined exhaust volume of the operating exhaust fans, the VAV boxes serving occupied zones shall be commanded to 100% open. Should the supply air volume remain below 25% of the supply fan design volume, additional VAV boxes shall be commanded open until the supply fan volume rises above 25% (fan coils for these zones shall remain in the unoccupied mode).

.2 When the unit is enabled, the supply fan and exhaust fan VFD shall be enabled.

.3 The hardwired wired outside air damper and exhaust air damper shall open.

.4 Once the hardwired wired damper end-switches prove that the dampers are open, the respective fans shall start and shall ramp to their minimum speeds.

.5 When both fans are at or above the base building exhaust volume plus EF-1 installed exhaust air volume, EF-1 shall be started. The base building exhaust volume is equal to the total design volume of the operating exhaust fans that are not controlled by the EMCS but are monitored by the EMCS and listed with ERV-1 points list.

.6 When both fans are at or above the base building exhaust volume plus EF-1 and EF-2 installed exhaust air volume and the cell are in the occupied mode, EF-2 shall be started.

.7 On a failure of either of ERV-1's supply fan or the exhaust fan, the system shall be disabled and an alarm shall be sent to the EMCS graphics.

.8 On system start-up during the heating season, the reheat and preheat valve shall modulate to a starting position based on outside air temperature.

.14 Fan Speed Control

.1 The supply fan speed shall be modulated to maintain the end of line pressure setpoint as measured by a pressure sensor located at 2/3 of the duct length form the unit.

.2 The return fan speed shall be modulated to maintain the return air volume setpoint as measured by the unit supplied air flow station. The return air volume setpoint shall equal the supply air volume minus 5% minus the base building exhaust air volume.

.15 Low Temperature Freezestat

.1 Install an auto reset low temperature freezestat after the reheat coil.

.2 If the low temperature freezestat trips during unit startup, an alarm shall be generated on the EMCS graphics, the supply and exhaust fans shall be stopped and the preheat and reheat valves will be modulated to maintain the respective discharge temperatures at 15°C. Provide a software time delay on system startup.

.3 Once the freeze alarm has cleared, the heating valve start position shall be increased by 25% and the unit will be restarted. Should the freezestat trip twice within 1 occupied cycle, the software low temperature lockout will prevent the unit from operating until the point is reset via the EMCS graphics.

.16 Temperature Control

.1 The glycol preheat coil valve shall be modulated to maintain the coil discharge temperature setpoint. The coil discharge temperature setpoint shall be reset between -17°C and -5°C to keep the heat wheel exhaust air temperature above 10°C.

.2 During the heating season, the heat wheel bypass dampers shall be commanded to 0% bypass, the heat wheel speed and glycol reheat coil valve shall be modulated in sequence to maintain the supply air temperature setpoint. The supply air temperature setpoint shall be set at 13°C.

.3 When the outside air temperature rises above the supply air temperature setpoint minus 2C°, the heat wheel outside air and exhaust air bypass dampers shall be opened 100% and the heat wheel locked out.

.4 When the outside air temperature rises above the return air temperature plus 4C°, the heat wheel outside air and exhaust air bypass dampers shall be closed and the heat wheel shall operate at 100%.

.17 Humidification

.1 The EMCS shall disable the humidifier when the air system is not operating in the occupied mode or the supply fan is off.

.2 When the return air relative humidity drops below the return air humidity setpoint as sensed by the return air humidity sensor, the humidifier will be enabled and its capacity modulated to maintain the return air humidity setpoint. Provide dead band and minimum off times to prevent excessive cycling of the unit.

.3 The return air humidity setpoint shall be reset by the outside air temperature as follows:

O/A Temp.	Return Air Humidity Setpoint
-40°C	15%
0°C	30%

.4 A supply air humidity sensor shall override the return air humidity controls to limit the supply air humidity to 75%.

.18 Filter Monitoring

.1 Differential pressure sensors monitor the filters on the unit. When pressure drop exceeds the filter specification, a maintenance alarm is to be generated on the EMCS graphics.

.19 Alarms

.1 The EMCS system to provide alarms for fan failure, temperature outside of alarm limit and filter loading.

.20 Occupant Override

.1 Provide manual override through room space sensors to energize ERV-1 during unoccupied mode. Activation of unit during unoccupied mode shall energize the unit for a period of 60 minutes (adjustable).

.2 Provide an override of this feature on the unit graphics.

.21 The system is connected to emergency power. When the emergency generator is operating and the normal power has failed, the system shall operate as per the above sequence of operation and will be restarted as per the emergency power startup sequence. On a return to normal power, the system shall continue to operate as per the above sequence of operation.

.6 Vehicle Areas

.1 Each vehicle bay is heated by a gas fired unit heater and ventilated by an exhaust fan and an outside air damper.

.2 System Start/Stop

.1 Exhaust fans will normally be energized via the Building Automation System when the CO level in the vehicle pass through rises above 30 ppm. A manual switch on the wall shall permit the system to be force the exhaust fan on. The switch will not be wired in a manner that will allow the occupant of the space to disable the fans.

.2 On system startup, the exhaust fan shall be energized and both the outside air damper and the exhaust air damper shall open. Once both dampers prove open via hard wired damper end-switches, the exhaust fan shall start.

.3 Temperature Control

.1 The unit heater fan and valve shall be cycled to maintain the space temperature setpoint.

.4 The unit heaters are connected to emergency power. When the emergency generator is operating and the normal power has failed, the equipment shall operate as per the above sequence of operation and will be restarted as per the emergency power startup sequence. On a return to normal power, the system shall continue to operate as per the above sequence of operation.

.7 Fan Coil Unit & VAV Box Zones

.1 The design intent of the VAV boxes is to have the ability to provide dedicated occupancy schedules for the different occupancy hours throughout the building.

.2 The VAV boxes will normally be enabled via the Building Automation System on a scheduled occupied/unoccupied basis or when any one of the occupancy switches located on the connected fan coil space temperature sensors is pressed. Provide an occupancy schedule for each VAV box. During occupied hours, the VAV box damper shall be modulated to maintain the design outside air volume to the connected fan coil units. During unoccupied hours, the VAV box damper shall remain closed. When the outside air temperature is below 15C and the heating coil valves in ERV-1 are closed, the VAV box maximum volume may be increased by 20% to provide free cooling to the fan coil that are operating in occupied mode provided the ERV-1 supply fan and return fan are not at full speed.

.3 Where CO2 sensors are shown on the drawings, the VAV minimum volume will be increased to limit the space CO2 levels to a maximum of 800 ppm.

.4 When a VAV box is operating in the occupied mode, the connected fan coil fan shall operate continuously and the heating and cooling valves shall be modulated in sequence to maintain the supply air temperature setpoint. The supply air temperature setpoint shall be reset between 21°C and 13°C by the space cooling demand and between 22°C and 27°C by the space heating demand to maintain the space heating and cooling occupied setpoints.

.5 When a VAV box is operating in the unoccupied mode, the connected fan coil fan shall operate when the space temperature rises above the night setup setpoint or falls below the night setback setpoint and will be stopped when the space temperature returns to the occupied heating or cooling setpoints. When the fan is operating, the heating and cooling valves shall be modulated in sequence to maintain the supply air temperature setpoint. The supply air temperature setpoint shall be set to 13°C by for night cooling and to 27°C for night heating. Provide minimum on/off times to prevent excessive cycling of the unit.

.6 Provide alarms for fan failure, low or high zone temperature.

.7 Implement optimum start heating and cooling for room temperature control. The program is self-adapting and starts equipment based on the calculated warm-up/cool-down time for the current indoor and outdoor temperatures.

.8 All of the fan coils are connected to emergency power. When the emergency generator is operating and the normal power has failed, the fan coils shall operate

as per the above sequence of operation and will be restarted as per the emergency power startup sequence. On a return to normal power, the fan coils shall continue to operate as per the above sequence of operation.

.8 Cell Zone Ventilation

.1 The cell area is designed to operated as one ventilation/heating zone.

.2 The system consists of a fan coil, an outside air VAV box, an exhaust fan EF-2, an exhaust air damper and an unoccupied return air damper that are all controlled by the EMCS.

.3 The fan coil consist of a supply fan complete with EC motor, a heating coil and a cooling coil.

.4 The EMCS shall control the occupancy of the cell area based on the position of a toggle switch mounted on the face of a control panel located in the guard station.

.5 When an occupancy switch is set to Occupied Mode, the fan coil return air damper will close. Once the damper proves closed, the fan coil fan will start, the outside air VAV box damper will be modulated to maintain the constant volume setpoint, the exhaust air damper shall open and once the exhaust air damper proves open, exhaust fan EF-2 will start and ramped to occupied air volume. During unoccupied hours, the VAV box dampers shall remain closed.

.6 The fan coil supply air temperature setpoint shall be reset between 21°C and 13°C to maintain the return air cooling setpoint initially set at 24°C and between 22°C and 27°C to maintain the return air heating setpoint initially set at 21°C.

.7 When the occupancy switch is set to Unoccupied Mode, the fan coil shall be disabled and EF-2 shall be ramped to the unoccupied air volume. Once both fans prove off, the return air damper will be commanded open and the exhaust air damper shall be damped to the minimum position as determined by the balancing agent. Once the return air damper proves open, the fan coil fan shall operate at low speed and the heating and cooling valves shall be modulated in sequence to maintain the supply air temperature setpoint. The supply air temperature setpoint shall be set at between 21°C and 13°C to maintain the unoccupied return air cooling setpoint initially set at 27°C and between 22°C and 27°C to maintain the unoccupied return air heating setpoint initially set at 17°C. Should the supply air temperature setpoint rise to 27°C or fall to 13°C and the return air temperature setpoints cannot be maintained, the supply fan speed shall be increased to the design volume.

.8 The fan coil and EF-2 are connected to emergency power. When the emergency generator is operating and the normal power has failed, the fan coils shall operate as per the above sequence of operation and will be restarted as per the emergency power startup sequence. On a return to normal power, the fan coils shall continue to operate as per the above sequence of operation.

.9 Terminal Heating Units

.1 The zone shall operate in the occupied mode whenever the fan coil serving the space is in the occupied mode.

.2 During occupied hours, the control valve shall be modulated to maintain the space occupied temperature setpoint.

.3 During unoccupied hours, the control valve shall be modulated to maintain the space night setback temperature setpoint.

.4 Implement optimum start heating for room temperature control. The program is self-adapting and starts equipment based on the calculated warm-up time for the current indoor and outdoor temperatures.

.10 Force Flow Heaters

.1 The force flows shall be controlled by the EMCS system. A space temperature sensor shall provide the signal to cycle the fan and two-way control valve to maintain the desired space temperature setpoint initially set at 15°C.

.2 An aquastat located on the return heating water line of entrance force flows shall stop the fan and open the 2-way control valve 100% upon sensing a low return water temperature.

.3 Should the heating system call for both heating water pumps to operate and one of the pumps fails, the unit heaters and force flows space temperature setpoint shall be reduced by 3°C.

.11 Server Room Ductless Split Air Conditioning Unit

.1 Provide a space temperature sensor for the server room. Provide high/low temperature alarms.

.12 Oil Separator

.1 The EMCS shall monitor the oil separator high oil level alarm provided with control panel.

.13 Power Monitoring

.1 The EMCS shall monitor the normal power and emergency power. On a return to normal power, all systems that have been disabled due to a loss of power shall be restarted as per their occupancy schedules and in a manner that reduces.

.2 When the generator is operating and the normal power has failed, the equipment connected to emergency power will be stager started in the following manner:

.1 Heating water pumps.

.2 Boilers.

.3 Glycol pumps.

.4 ERV-1, the fan speed shall be ramped up over 3 minute.

.5 Exhaust fans, the fan speed shall be ramped up over 1 minute.

.6 Fan coils, the fan shall be ramped up over 1 minute. Provide a global ramp time for the fan coils.

.7 UHs and FFs, the space setpoints shall be reduced by 2C°.

.14 Fire Alarm

.1 The EMCS shall monitor the fire alarm. Whenever a fire alarm has cleared, all systems that have been disabled by the fire alarm shall be restarted as per their occupancy schedules.

.15 OUTSIDE AIR TEMPERATURE

.1 An outside air temperature calculated value will be used for all control references. The calculated value will be determined from the two (2) outside air temperature sensors. Coordinate the final locations of the sensors with the mechanical consultant.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.

.2 ASTM International

.1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.

.2 ASTM A278/A278M, Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).

.3 ASTM A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.

.4 ASTM A536, Standard Specification for Ductile Iron Castings.

.5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.3 CSA Group

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

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 expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic specialties from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DIAPHRAGM TYPE EXPANSION TANK

.1 Vertical steel pressurized diaphragm type expansion tank.

.2 Size/Capacity: as indicated.

.3 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.

.4 Working pressure: 860 kPa with ASME stamp and certification.

.5 Air pre-charged to 84 kPa (initial fill pressure of system).

.6 Base mount for vertical installation.

.7 Supports: provide supports with hold down bolts and installation templates.

.8 Renewable diaphragm.

2.2 AIR SEPARATOR - IN-LINE

.1 Working pressure: 860 kPa.

.2 Size: as indicated

2.3 COMBINATION SEPARATORS/STRAINERS

.1 Steel, tested and stamped in accordance with ASME BPVC, for 860 kPa operating pressure, with galvanized steel integral strainer with 5 mm perforations, tangential inlet and outlet connections, and internal stainless-steel air collector tube.

2.4 PIPE LINE STRAINER

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

.2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, flanged connections.

.3 Blowdown connection: NPS 1.

.4 Screen: stainless steel with 1.19 mm perforations.

.5 Working pressure: 860 kPa.

2.5 SUCTION DIFFUSER

.1 Body: cast iron with flanged connections.

.2 Strainer: with built-in, disposable 1.19 mm mesh, low pressure drop screen and NPS 1 blowdown connection.

.3 Permanent magnet particle trap.

.4 Full length straightening vanes.

.5 Pressure gauge tapings.

.6 Adjustable support leg.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic specialties installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 APPLICATION

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

3.3 GENERAL

.1 Run drain lines to terminate above nearest drain.

.2 Maintain adequate clearance to permit service and maintenance.

.3 Should deviations beyond allowable clearances arise, request and follow Consultant's directive.

.4 Check shop drawings for conformance of tapings for ancillaries and for equipment operating weights.

3.4 STRAINERS

.1 Install in horizontal or down flow lines.

.2 Ensure clearance for removal of basket.

.3 Install ahead of each pump.

.4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.5 AIR VENTS

.1 Install at high points of systems.

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

3.6 EXPANSION TANKS

.1 Adjust expansion tank pressure to suit design criteria.

.2 Install lockshield type valve at inlet to tank.

3.7 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.8 SUCTION DIFFUSERS

.1 Install on inlet to pumps having suction size greater than 50.

3.9 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 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

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

.1 ANSI/ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 CSA Group

.1 CAN/CSA-B214-[12], Installation Code for Hydronic Heating Systems.

.3 Electrical Equipment Manufacturers Association of Canada (EEMAC)

.4 National Electrical Manufacturers' Association (NEMA)

.1 NEMA MG 1, Motors and Generators.

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 pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

.3 Shop Drawings:

.1 Submit drawings prior to ordering equipment.

.2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

.4 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.5 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.

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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hydronic pumps from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove as specified in Construction Waste Management Plan

Part 2 Products

2.1 EQUIPMENT

.1 Size and select components to: CAN/CSA-B214.

2.2 IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.

.2 Impeller: cast bronze or stainless steel.

.3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135 degrees C.

.5 Coupling: rigid self-aligning.

.6 Motor: to NEMA MG 1, resilient mounted, drip proof, TEFC, sleeve bearing

.7 Capacity: as indicated

.8 Design pressure: [860] kPa.

2.3 VERTICAL IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.

.2 Impeller: brass or bronze.

.3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.

.4 Seal assembly: mechanical for service to 135 degrees C.

.5 Coupling: [rigid self-aligning.

.6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing

.7 Capacity: as indicated

.8 Design pressure: 1200 kPa.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.

.1 Inform Consultant of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 APPLICATION

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

3.3 INSTALLATION

.1 Install hydronic pumps to: CAN/CSA-B214.

.2 In line circulators: install as indicated by flow arrows.

.1 Support at inlet and outlet flanges or unions.

.2 Install with bearing lubrication points accessible.

.3 Base mounted type: supply templates for anchor bolt placement.

.1 Include anchor bolts with sleeves. Place level, shim unit and grout.

.2 Align coupling in accordance with manufacturer's recommended tolerance.

.3 Check oil level and lubricate. After run-in, tighten glands.

.4 Ensure that pump body does not support piping or equipment.

.1 Provide stanchions or hangers for this purpose.

.2 Refer to manufacturer's installation instructions for details.

.5 Pipe drain tapping to floor drain.

.6 Install volute venting pet cock in accessible location.

.7 Check rotation prior to start-up.

.8 Install pressure gauge test cocks.

3.4 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; supplemented as specified herein.

.2 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting pump, check for proper, safe operation.

.3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.

.4 Check base for free-floating, no obstructions under base.

.5 Run-in pumps for 12 continuous hours minimum.

.6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.

.7 Eliminate air from scroll casing.

.8 Adjust water flow rate through water-cooled bearings.

.9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.

.10 Adjust alignment of piping and conduit to ensure true flexibility.

.11 Eliminate cavitation, flashing and air entrainment.

.12 Adjust pump shaft seals, stuffing boxes, glands.

.13 Measure pressure drop across strainer when clean and with flow rates as finally set.

.14 Replace seals if pump used to degrease system or if pump used for temporary heat.

.15 Verify lubricating oil levels.

3.5 PERFORMANCE VERIFICATION (PV)

.1 General:

.1 Verify performance in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Verify that manufacturer's performance curves are accurate.

.3 Ensure valves on pump suction and discharge provide tight shut-off.

.4 Net Positive Suction Head (NPSH):

.1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.

.2 Measure using procedures prescribed in Section 01 91 13 - General Commissioning (Cx) Requirements.

.3 Where procedures do not exist, discontinue PV, report to Consultant and await instructions.

.5 Multiple Pump Installations - Series and Parallel:

.1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.

.6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.

.7 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements reports supplemented as specified herein. Reports to include:

.1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.

.2 Use Report Forms specified in Section [01 91 13 - General Commissioning (Cx) Requirements]: Report Forms and Schematics.

.3 Pump performance curves (family of curves).

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 SCOPE

.1 Manual and automatic air vents.
.2 Air separators.
.3 Relief valves and fittings.
.4 Radiation valves.
.5 Pressure Reducing Valves.
.6 Quantity Meters.

2. Products

2.1 MANUAL AIR VENTS

.1 Provide manual air vents with 25 mm or line diameter pipe which ever is the greater, to form air collection chamber. Collection chambers to be a minimum of 150 mm high.

2.2 AIR SEPARATORS

.1 Provide centrifugal type with 861 kPa WSP steel tank, galvanized steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection.

2.3 RELIEF VALVES

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

2.4 HANDWHEEL RADIATOR VALVES

.1 Refer to Section 23 05 23, General Duty Valves and Strainers for HVAC Piping.

2.5 RADIATOR BALANCING VALVES

.1 Refer to Section 23 05 23, General Duty Valves and Strainers for HVAC Piping.

2.6 QUANTITY METERS

.1 Refer to Section 23 05 19, Meters and Gauges for HVAC Systems.

2.7 PRESSURE REDUCING VALVES

.1 20 mm pressure reducing valve complete with low inlet pressure check valve, removable strainer, Brass body and adjustable pressure of 175 kPa to 415 kPa. Bell & Gossett Model 7.

3. Execution

3.1 AIR VENTS

.1 Provide manual type at system high points and convection type heating units. Pipe air vent to servicable location.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

3.2 AIR SEPARATOR

.1 Provide on suction side of system circulation pump and connect to expansion tank.

3.3 RELIEF VALVES

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

.2 Pipe relief valve to nearest floor drain.

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

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

3.4 QUANTITY METERS

.1 Install where indicated on drawings complete with isolation valves and line size bypass.

3.5 SYSTEM CAPACITY RECORDING

.1 Contractor shall record quantity of water in system. Data to be recorded in Operating and Maintenance Manuals.

3.6 HANDWHEEL RADIATOR VALVES

.1 Provide on water inlet to terminal heating units such as radiation, unit heaters and fan coil units.

3.7 RADIATOR BALANCING VALVES

.1 Provide on water outlet from terminal heating units.

END OF SECTION

END OF SECTION

1. General

1.1 SCOPE

.1 Fill pump.
.2 Propylen glycol solution.
.3 Manual and automatic air vents.
.4 Air separators.
.5 Relief valves and fittings.
.6 Quantity Meters.
.7 Glycol charging tank.
.8 Expansion tank.

1.2 QUALITY ASSURANCE

.1 Thoroughly check system and make necessary corrections if system continually loses solution.

.2 Perform tests determining strength of glycol solution before system is turned over to the Owner. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

2. Products

2.1 MANUAL AIR VENTS

.1 Provide manual air vents with 25 mm or line diameter pipe which ever is greater to form air collection chamber. Collection chamber to be 150 mm high.

2.2 AIR SEPARATORS

.1 Provide centrifugal type with 861 kPa WSP steel tank, galvanized steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection.

2.3 RELIEF VALVES

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

2.4 QUANTITY METERS

.1 Refer to Section 23 05 19, Meters and Gauges for HVAC Systems.

2.5 GLYCOL SOLUTION

.1 Provide ethylene glycol/water solution (phosphate based) suitable for a range of -36°C to 104°C. Solution to be suitable for heating or cooling complete with
appropriate corrosion inhibitors. Solutions must be factory premixed. Dowtherm SR-1 heat transfer fluid

2.6 FILL PUMP

.1 Self-priming centrifugal all purpose portable pump, cast aluminum body. Three wire connector with polarized ground plug 115 V, 7 amps. 0.63 L/s at 193 kPa capacity. Provide hoses to suit transfer location. Gorman-Rupp handy pump, Model 80A.

2.7 GLYCOL CHARGING TANK

.1 Provide glycol charging tank and accessories as described in Section 15175.

2.8 EXPANSION TANK

.1 Provide glycol expansion tanks as described in Section 15175.

3. Execution

3.1 AIR VENTS

.1 Provide manual type at system high points and convection type heating units.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

3.2 AIR SEPARATOR

.1 Provide on suction side of system circulation pump and connect to expansion tank.

3.3 RELIEF VALVES

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

.2 Drain relief valve to glycol collection tanks. Do not waste glycol to floor drains.

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

3.4 QUANTITY METERS

.1 Install where indicated on drawings complete with isolation valves and line size bypass.

3.5 GLYCOL RECORDING

.1 Contractor shall record quantity of glycol/water mix in each glycol system. Data to be recorded in Operating and Maintenance Manuals.

3.6 GLYCOL FILL PUMP

.1 Provide one pump for each glycol charging tank. Obtain receipt from Owner at over.

3.7 GLYCOL CHARGING TANK

.1 Provide one glycol charging tank for each glycol system.

3.8 INSTALLATION

.1 Do necessary piping to complete installation as shown on the drawings specified.

.2 Thoroughly clean and flush system before glycol solution is added.

.3 Manually pump glycol to charging tank from premixed barrel. Pressurize charging tank with compressed air to feed system through make-up line with pressure regulator.

.4 Provide one extra 45 L drum of glycol, at turn over of the building to owner.

.5 Provide antifreeze solution lost from the systems from any cause other than neglect by the Owner during the first year of operation.

END OF SECTION

1. General

1.1 SCOPE

.1 Manual and automatic air vents.
.2 Air separators.
.3 Relief valves and fittings.
.4 Centrifugal filters.
.5 Centrifugal filter purge filter.
.6 Quantity Meters.

2. Products

2.1 MANUAL AIR VENTS

.1 Provide manual air vents with 25 mm or line diameter pipe which ever is the greater, to form air collection chamber. Collection chambers to be a minimum of 150 mm high.

2.2 AIR SEPARATORS

.1 Provide centrifugal type with 861 kPa WSP steel tank, galvanized steel 5 mm perforated strainer, perforated stainless steel air collector tube and drain connection.

2.3 RELIEF VALVES

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

2.4 RADIATOR BALANCING VALVES

.1 Refer to Section 23 05 23, Valves and Strainers.

2.5 QUANTITY METERS

.1 Refer to Section 23 05 19.

2.6 CENTRIFUGAL FILTERS

.1 Centrifugal Action Vortex Separator

.1 Separation efficiency 98% for particles 74 microns and larger, 75% for particles 5 microns and larger based on particle specific gravity of 2.6 and

.2 Fluid to Enter Separator

.1 Tangentially at the top of the vessel. Fluid passes through slots into a tubular separation chamber. Separated particles are collected at the bottom of the chamber and system fluid exits the separator out the top.

.3 Solids Recovery Vessel

.1 Separated solids to be continually purged under controlled flow to a vessel with 25 micron fiberfelt solids collection bag(s). Excess fluid to pass through the bag and return to system flow at suction side of system pump. System to include air/pressure relief valve, manual isolation vlaves, sight glasses, bag cleaning/service annunciator, flow control orifice, clamps tubing and specialty piping for complete package.

.4 Refer to schedule on the drawings.

3. Execution

3.1 AIR VENTS

.1 Provide manual type at system high points and convection type heating units. Pipe air vent to servicable location.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

3.2 AIR SEPARATOR

.1 Provide on suction side of system circulation pump and connect to expansion tank.

3.3 RELIEF VALVES

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

.2 Pipe relief valve to nearest floor drain.

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

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

3.4 QUANTITY METERS

.1 Install where indicated on drawings complete with isolation valves and line size bypass.

3.5 SYSTEM CAPACITY RECORDING

.1 Contractor shall record quantity of water in system. Data to be recorded in Operating and Maintenance Manuals.

3.6 CENTRIFUGAL FILTERS

.1 Follow manufacturer's installation instructions and system schematic drawings.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 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, 600, 900, 1500 and 2500.

.3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

.4 ASME B31.5, Refrigeration Piping and Heat Transfer Components.

.2 ASTM International

.1 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.

.2 ASTM B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 CSA Group

.1 CSA B52, B52 Package, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

.1 EPS 1/RA/1, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section in accordance with Section 01 31 19 - Project Meetings to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction subtrades.

.4 Review manufacturer's written installation instructions and warranty requirements.

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 refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit one copy of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements. Indicate VOC's for adhesive and solvents during application and curing.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

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

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 [refrigerant piping] for incorporation into 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect refrigerant piping, fittings and equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Develop Construction Waste Management Plan related to Work of this Section.

.5 Packaging Waste Management: in accordance with Section 01 74 21 - Construction/Demolition Waste Management.

Part 2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.

.1 Hard copper: to ASTM B280, type ACR.

.2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.

.2 Brazed:

.1 Fittings: wrought copper to ASME B16.22.

.2 Joints: silver solder, 15% Ag-80% Cu-5%P and non-corrosive flux.

.3 Flanged:

.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.

.2 Gaskets: suitable for service.

.3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:

.1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for refrigerant piping installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.3 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05 - Installation of Pipework.

3.4 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.

3.5 PIPING INSTALLATION

.1 General:

.1 Soft annealed copper tubing: bend without crimping or constriction, Hard drawn copper tubing: do not bend. Minimize use of fittings.

.2 Hot gas lines:

.1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.

.2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.

.3 Provide inverted deep trap at top of risers.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified.

.2 Small riser: size for 5.1 m^3/s at minimum load. Connect upstream of traps on large riser.

3.6 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.

.3 Test procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.7 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:

.1 Twice to 14 Pa absolute and hold for 4 hours.

.2 Break vacuum with refrigerant to 14 kPa.

.3 Final to 5 Pa absolute and hold for at least 12 hours.

.4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.

.5 Submit test results to Consultant.

.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 Consultant.

.9 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its product[s] and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately to Consultant.

3.8 DEMONSTRATION

.1 Instructions:

.1 Post instructions in frame with glass cover in accordance with Section 01 78 00 - Closeout Submittals and CSA B52.

3.9 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 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

1. General

1.1 SCOPE

.1 Provide for cleaning and degreasing of hot water heating, glycol and chilled water systems.

.2 Provide all necessary equipment and chemicals to treat hot water heating, glycol and chilled water systems.

.3 Isolate and bypass equipment listed in Clause 3.1.

.4 Do NOT use permanent building system pumps for leaning and piping. Provide temporary recirculating pumps.

.5 Provide bypass for heat exchangers during cleaning of systems.

1.2 ACCEPTABLE AGENCY

1.3 QUALITY ASSURANCE

.1 Perform the cleaning and degreasing operation on site in conjunction with the mechanical contractor and submit written reports on all situations found, actions taken and final results. Reports shall be signed by the contractor, chemical treatment agency, and commissioning agency. Inform the engineer and commissioning agency 15 working days prior to commencing of work.

.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 Chemical treatment agency shall provide directive and assistance to the mechanical contractor in the degreasing, cleaning and chemical treatment of all piping systems. Use of the permanent mechanical systems for pumping or heating of cleaning and dilution solutions is not permitted. Permanent systems shall be isolated and portable pumps and boilers utilized for the duration of the cleaning process. Permanent equipment shall be flushed, degreased and chemically treated independent of the piping systems.

.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.

1.4 SUBMITTALS

.1 Submit shop drawings with complete description of proposed chemicals, quantities, calculations, procedures, test kits and equipment to be supplied. Along with product shop drawings, provide copies of data sheets, procedure instructions and analysis reports to be used on this project. Shop drawings shall be submitted within 10 workings days of the award of contract.

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

.3 Submit written reports to the mechanical contractor and engineer containing results of tests taken seven days after completion of chemical treatment. Reports shall be done every seven days for a minimum time period of 35 days.

.4 Provide monthly site visits (12 minimum) within the warranty year to check the treatment, take samples, analyze and recommend proper addition of treatment. Provide written reports to the owner after each visit with a copy to the engineer.

2. Products

2.1 MATERIALS

.1 Provide sufficient chemicals to treat and test the systems from the time of activation and acceptance of the building for the first year of operation by the owner.

.2 Materials which may contact finished areas shall be colorless and non-staining. Chemicals used must comply with environmental and health standards applicable to the usage on this project.

.3 System Cleaner: Alkaline compound which in solution removes grease and petroleum products.

.4 Closed System Treatment: Sequestering agent to reduce deposits and adjust PH, and a corrosion inhibitor.

2.2 EQUIPMENT

.1 Solution Pumps: Provide positive displacement diaphragm type metering pumps for adding chemicals. Pumps shall have an adjustable flow rate and be suitable for chemicals to be pumped. Pumps shall be self flushing. Provide pumps with plastic solution tanks complete with agitator, pump mounting, cover, provision for fill line and pump strainer. Size the pumps and tanks to permit operation for three days at 50% pump capacity without refill of tanks. Provide agitator motor with terminals and junction box for electric wiring.

.2 Provide chemical pot feeder with a minimum of 10 L capacity, semi-sphere top and bottom, one pot feeder per system, located as shown on system schematics and floor plans. If location is in question obtain clarification from the engineer prior to installation.

2.3 BYPASS FILTER

.1 Unit to consist of cartridge filter, flow indicator, flow control valves and filter Cartridge filter; stainless steel shell of single centre bolt construction with cast nickel-plated brass head, drain plug and air vent. Flow indicator - cast bronze body with two sight glasses of high temper, thermo shock-resistant glass and nylon rotor on stainless steel pin.cartridges.

.2 Flow control valves shall be automatic regulating type.

.3 Spare filter cartridges to be turned over to the Owner: 10 each of 5 micron retention, and 25 micron retention.

2.4 CHEMICAL POT FEEDER

.1 150 mm diameter x 550 mm long feeder, suitable for 861 kPa operating pressure complete with isolation valves on 20 mm inlet and outlet lines. 20 mm drain valve and 40 mm fill complete with filling funnel.

2.5 TEST KITS

.1 Test methods shall be titration type utilizing automatic burettes capable of determining 0.1 ppm, where this type of method may be used.

.2 All test kits shall be provided with adequate chemicals and reagents for one year of testing.

.3 Provide test kits as required to determine proper system treatment consisting of but not limited to the following:

.1 heating water test kit to determine proper treatment.

.2 chilled water treatment test kits to determine proper treatment.

.3 glycol systems treatment test kits to determine proper concentration and glycol inhibitor, this shall include a hydrometer type tester.

.4 Provide test kits for hardness and chlorides in addition to those listed above.

.5 Provide a PH meter complete with three different calibration standard solutions.

3. Execution

3.1 SYSTEM CLEANING

.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. Utilize water meter to record capacity within each system

.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. Isolate and bypass the following equipment during flushing and chemical treating: Cooling towers, plate and frame heat exchangers.

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

.5 Add system cleaner and degreasant to flow systems at concentration of 1 kg per 1000 Lof water contained in systems for hot systems, 1 kg per 500 L of water for cold systems.

.6 For hot water heating systems apply heat while circulating, raise temperature to 71°C slowly and maintain at 71°C for a minimum of 12 hours. Remove heat and circulate systems to 38°C or less. Drain system, entirely at one time, including all low points and coils. Intermittent start/stop of drainage is not approved. The mechanical contractor to provide additional temporary pipe, pumps as necessary and drainage location for complete drainage. Refill the entire system with clean water, circulate for six hours at design temperature, provide complete venting and deairation, repeat the draining procedure. Refill complete system with clean water and retest.

.7 For chilled water systems utilize the same procedures specified above for hot water heating systems; however, circulate at ambient temperature for a minimum of 48 hours.

.8 For glycol systems utilize the same procedure for hot water heating systems specified above.

.9 Inspect, clean of sludge and flush all low points with clean water after cleaning and degreasing process is completed. Include disassembly of components as required. All cleaning and flushing of low points, coils, boilers, etc., shall be done prior to final fill and chemical treatment.

3.2 HEATING WATER, CHILLED WATER AND GLYCOL SYSTEMS

.1 Provide and install one pot feeder for each individual system. Install complete with isolating and drain valves and necessary piping. Install as indicated on schematics.

.2 Treat closed systems with closed systems treatment introduced through pot feeder when required or indicated by test.

.3 Provide and install one side stream micron filter (between pump suction and discharge) per system, complete with isolation valves, drain valve, union, site glass, and flow regulating valve to limit flow thru filter to manufacturers recommendations.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

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

.1 ASTM A480/A480M, 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 Department of Justice Canada (Jus).

.1 Canadian Environmental Protection Act (CEPA), 1999, c. 33 .

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

.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association (NFPA).

.1 NFPA 90A-[02], Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-[02], Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.3 NFPA 96-[01], Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition [1995] and Addendum No. 1.

.2 SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition.

.7 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 43 – Environmental Procedures: Construction and Section 02 81 01 - Hazardous Materials for the following:

.1 Sealants.

.2 Tape.

.3 Proprietary Joints.

1.3 QUALITY ASSURANCE

.1 Certification of Ratings:

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

1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Separate Steel, Metal, and Plastic waste in accordance with Waste Management Plan.

.4 Place materials defined as hazardous or toxic in designated containers.

.5 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, and Regional and Municipal regulations.

.6 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C
125	Unsealed

.2 Seal classification:

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

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant and tape.

.3 Class C: transverse joints and connections made air tight with gaskets, sealant] or combination thereof. Longitudinal seams unsealed.

.4 Unsealed seams and joints.

2.2 SEALANT

.1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.3 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

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

2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.

- .1 Rectangular: standard radius with single thickness turning vanes.
- .2 Round: Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

- .1 To 400 mm: with double thickness turning vanes.
- .2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

- .1 Rectangular main and branch: with 45 degrees entry on branch.
- .2 Round main and branch: enter main duct at 45 degrees with conical connection.
- .3 Provide volume control damper in branch duct near connection to main duct.
- .4 Main duct branches: with splitter damper.

.5 Transitions:

- .1 Diverging: 20 degrees maximum included angle.
- .2 Converging: 30degrees maximum included angle.

.6 Offsets:

- .1 as indicated

.7 Obstruction deflectors: maintain full cross-sectional area.

- .1 Maximum included angles: as for transitions.

2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.

.2 Fire stopping material and installation must not distort duct.

2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA

2.8 STAINLESS STEEL

.1 To ASTM A480/A480M, Type 304.

.2 Finish: No. 4.

.3 Thickness, fabrication and reinforcement: to SMACNA.

.4 Joints: to SMACNA.

2.9 ALUMINUM

.1 To SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA

2.10 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct].

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA and following table:

Duct Size	Angle Size	Rod Size
(mm)	(mm)	(mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp.

.3 For steel beams: manufactured beam clamps:

Part 3 Execution

3.1 GENERAL

.1 Do work in accordance with NFPA 90A, ASHRAE, and SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct. Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

.7 Install ducts with security bars when penetrating exterior walls/roof and interior secure walls.

3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA:

Duct Size	Spacing
(mm)	(mm)
to 1500	3000
1501 and over	2500

3.3 SEALING AND TAPING

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

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.4 LEAKAGE TESTS

.1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.

.2 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.3 Do leakage tests in sections.

.4 Make trial leakage tests as instructed to demonstrate workmanship.

.5 Do not install additional ductwork until trial test has been passed.

.6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.7 Complete test before performance insulation or concealment Work.

END OF SECTION

1. General

1.1 QUALITY ASSURANCE

.1 Firms shall be specialists in this field.

.2 Cleaning Equipment: 5.0 kPa suction capacity and 12,000 L/s minimum capacity.

.3 Submit list of five (5) past projects undertaken of same magnitude as this project.

.4 Submit a letter certifying that all systems have been completely cleaned and are ready for inspection.

.5 Acceptable contractors: Don's Pow-R Vac, Carson Pow-R-Vac, Modern Power Vac.

2. Products

2.1 MATERIALS

.1 Access Doors: Minimum 450 mm x 350 mm door, hinge and frame type, positive latching/locking mechanism. Refer to Section 23 33 13, Air Duct Accessories.

3. Execution

3.1 PREPARATION

.1 Isolate items to be cleaned so as not to contaminate unprotected work.

.2 Equip vacuum equipment with filters.

3.2 INSTALLING ACCESS DOORS

.1 Locate access doors and install as follows:

.1 At 12.0 m intervals in vertical ducts.
.2 Horizontal ducts at intervals of 6 m.
.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.

3.3 CLEANING

.1 When the duct systems are completely installed and before any systems are operated, clean all ductwork, plenums, coils, unit heaters, fan coil units and air handling equipment by compressed air and suction equipment.

.2 Cleaning is not required for exhaust ductwork systems that convey air directly to the outside exclusively without recirculation.

.3 Seal all ductwork outlets after ductwork has been cleaned.

.4 Seal all plenums after cleaning.

3.4 INSPECTION

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

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

END OF SECTION

1. General

1.1 SCOPE

.1 Access doors.
.2 Fire dampers.
.3 Combination fire/smoke dampers.
.4 Fire stop flaps.
.5 Balancing dampers.
.6 Flexible connections.
.7 Backdraft dampers.

1.2 QUALITY ASSURANCE

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S 112 "Fire Dampers".

.2 Fusible links on fire dampers shall be constructed to ULC Standard S 505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

.4 Access doors shall be ULC labeled.

.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 Prove all dampers to inspector at job completion.

1.3 SUBMITTALS

.1 Submit shop drawings of factory fabricated assemblies.

.2 Submit samples of shop fabricated assemblies as requested by the Engineer.

.3 Comply with requirements of Section 01 33 00, Shop Drawings, Product Data and Samples.

2. Products

2.1 DUCT ACCESS DOORS

.1 Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Duct access panels with screws are acceptable. Install minimum 25 mm thick insulation with suitable sheet metal cover

.2 Fabricated with two butt hinges and two sash locks for sizes up to 450 mm, two hinges and two compression latches with outside and inside handles for sizes up to 600 mm x1200 mm and an additional hinge for larger sizes.

2.2 FIRE DAMPERS

.1 Fabricate of galvanized steel or prime coated black steel weighted to close and lock in closed position when released by fusible link.

.2 Fire dampers shall be curtain type with damper blades retained out of air stream in a recess so free area of connecting ductwork is not reduced.

.3 Fusible links shall be set for 71°C.

2.3 COMBINATION FIRE/SMOKE DAMPERS

.1 Combination Fire/Smoke and smoke dampers, rated as a unit by ULC, shall be provided c/w actuators by the Mechanical Contractor. If controlled by the DDC, responsibility is by the control contractor. Coordinate and inform the electrical consultant. Mechanical Contractor shall install in locations noted.

.2 Fire/smoke and smoke dampers shall be wired by the electrical contractor.

.3 Coordinate correct size of smoke/fire and smoke damper with Control Contractor.

.4 Fabricate combination fire and smoke and smoke dampers of multiple blades readily adjustable in open position. Dampers shall be ULC rated.

.5 Fire and smoke and smoke damper free area opening shall not be less than internal duct size indicated on plans. If a multiple of blade sizes does not equal opening size, oversize damper and increase and decrease ductwork accordingly.

2.4 FIRE STOP FLAPS

.1 Fabricate of heat retardant fabric in galvanized or prime coated black steel frame, spring loaded action to close and lock in closed position when released by fusible link.

.2 Blanket shall be retained in a recess so free area of connecting ductwork is not reduced.

.3 Fusible links shall be set for 71°C.

2.5 SPLITTER DAMPERS

.1 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration.

.2 Fabricate galvanized steel, minimum 1.6 mm, 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.

2.6 BALANCING DAMPERS

.1 Fabricate of galvanized steel, minimum 1.6 mm. 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 400 mm deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425 mm and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275 mm deep construct of single blade (butterfly) type.

.5 On rectangular ducts 300 mm to 400 mm deep construct of two opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425 mm deep construct of multiple opposed blades, mechanically interlocked with blades no greater than 200 mm deep and pivots equally spaced.

.7 On round ducts construct of single blade (butterfly) type. On 500 Pa class and on all dampers over 300 mm 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.

2.7 FLEXIBLE CONNECTIONS

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 150 mm wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150 mm intervals. Flexible connection airtight at 500 Pa.

2.8 BACKDRAFT DAMPERS

.1 Construct of minimum 1.3 mm galvanized steel channel frame.

.2 Construct of minimum 0.6 mm aluminum blades, complete with stiffeners along trailing edge. Fabricate single blade dampers for duct sizes to 240 mm, multiblade dampers for ducts greater than 240 mm.

.3 Provide full blade-length shafts complete with brass or nylon bearings.

.4 Provide neoprene anti-clatter blade strips on pivot side of blades.

.5 Construct blade connecting linkage of minimum 2.0 mm aluminum rod with eyelet, pin bearings, and adjustable counter weight to assist blade opening action.

.6 Maximum blade length of 750 mm.

.7 Backdraft damper suitable for 10 m/s face velocity.

3. Execution

3.1 APPLICATION

.1 Provide access door minimum 450 mm x 350 mm or 50 mm smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:

.1 At 6.0 m intervals on all horizontal ducts.
.2 At 12.0 m 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.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.3 Coordinate with the General Contractor for correct size openings and proper fire guard sleeving for fire damper penetration.

.4 At each point where ducts pass through partitions, the opening around the duct shall be sealed with non-combustible material.

.5 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger ducts.

.6 Provide balancing dampers on medium and high-pressure systems where indicated. Splitter dampers shall not be used on medium and high-pressure system.

.7 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on drawing.

.8 For connections to medium and high-pressure fans, install 15 mm thick neoprene pad over fabric and hold in place with additional metal straps.

.9 All fire dampers and fire stop flaps are to be left in the closed position for balancing contractor to fix open.

.10 Support ceiling fire stops from the structure above the fire stop and not from air outlets on associated ductwork.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Sheet Metal and Air Conditioning National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect dampers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in construction Waste Management Plan

Part 2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.

.2 Single thickness construction.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height as indicated

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside bronze end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

.1 Factory manufactured of material compatible with duct.

.2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.

.3 Maximum blade height: as indicated

.4 Bearings: pin in bronze bushings

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

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

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements] [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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect dampers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan

Part 2 Products

2.1 MULTI-LEAF DAMPERS

.1 Opposed blade type as indicated.

.2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.

.3 Pressure fit self-lubricated bronze bearings.

.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.5 Performance:

.1 Leakage: in closed position less than 2% of rated air flow at maximum system pressure Pa differential across damper.

.6 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

.2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

2.2 DISC TYPE DAMPERS

.1 Frame: insulated brake formed, welded, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

.2 Disc: insulated spin formed, 1.6 mm thick, galvanized steel to ASTM A653/A653M.

.3 Gasket: extruded neoprene, field replaceable, with 10-year warranty.

.4 Bearings: roller self lubricated and sealed.

.5 Operator: compatible with damper, linear stroke operator, spring loaded actuator, zinc-aluminum foundry alloy casting cam follower.

.6 Performance:

.1 Leakage: in closed position less than 0.001% of rated air flow at system design pressure differential across damper.

2.3 BACK DRAFT DAMPERS

.1 Automatic gravity operated, aluminum construction with nylon bearings, centre pivoted, spring assisted/counterweighted where required.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install where indicated.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers are observable and accessible.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 National Fire Protection Association (NFPA)

.1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S112, Standard Test Method of Fire Test of Fire Damper Assemblies.

.2 CAN/ULC-S112.2, Standard Method of Fire Test of Ceiling Fire Stop Flap Assemblies.

.3 ULC-S505, Standard for Fusible Links for Fire Protection Service.

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 fire dampers and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate the following:

.1 Fire dampers.

.2 Fire stop flaps.

.3 Operators.

.4 Fusible links.

.5 Design details of break-away joints.

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

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for fire dampers for incorporation into manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Provide:

.1 6 fusible links of each type.

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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect fire dampers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan.

Part 2 Products

2.1 FIRE DAMPERS

.1 Fire dampers: arrangement Type A, B or C, bear label of ULC, meet requirements of authorities having jurisdiction and NFPA 90A. Fire damper assemblies fire tested in accordance with CAN/ULC-S112.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.

.1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated.

.2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.

.3 Top hinged: offset single damper, round or square; multi-blade hinged interlocking type; roll door type; guillotine type; sized to maintain full duct cross section.

.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 40 x 40 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Equip fire dampers with steel sleeve or frame installed disruption ductwork or impair damper operation.

.7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA Install Fire Damp HVAC and in manufacturer's instructions for fire dampers shall be followed.

2.2 FIRE STOP FLAPS

.1 Fire smoke flaps: ULC listed and labelled and fire tested in accordance with CAN/ULC-S112.2.

.2 Construct of minimum 1.5 mm thick sheet steel with 1.6 mm thick non-asbestos ULC listed insulation and corrosion-resistant pins and hinges.

.3 Flaps held open with fusible link conforming to ULC-S505 and close at 74 degrees C or as indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for fire and smoke damper installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.

.2 Maintain integrity of fire separation.

.3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Co-ordinate with installer of fire stopping.

.6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.7 Install break-away joints of approved design on each side of fire separation.

3.3 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 Waste Management: separate waste materials for in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.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.

.2 NFPA 90B, Standard for Installation of Warm Air Heating and Air-Conditioning 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 (UL)

.1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.

.5 Underwriters' Laboratories of Canada (ULC)

.1 CAN/ULC-S110, Standard Methods of Tests for Air Ducts.

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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate:

.1 Thermal properties.

.2 Friction loss.

.3 Acoustical loss.

.4 Leakage.

.5 Fire rating.

.3 Test and Evaluation Reports:

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

1.3 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect flexible ducts from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan

Part 2 Products

2.1 GENERAL

.1 Factory fabricated to CAN/ULC-S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - UNINSULATED

.1 Type 1: spiral wound flexible aluminum.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - INSULATED

.1 Type 2: spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and vinyl reinforced mylar/neoprene laminate jacket

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.4 NON-METALLIC - UNINSULATED

.1 Type 3: non-collapsible, coated mineral base fabric type, mechanically bonded to, and helically supported by, external steel wire, as indicated.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

2.5 NON-METALLIC - INSULATED

.1 Type 4: non-collapsible, coated mineral base fabric type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and vinyl reinforced mylar/neoprene laminate jacket, as indicated.

.2 Performance:

.1 Factory tested to 2.5 kPa without leakage.

.2 Maximum relative pressure drop coefficient: 3.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for flexible ducts installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 DUCT INSTALLATION

.1 Install in accordance with: CAN/ULC-S110, UL 181, NFPA 90A, NFPA 90B, SMACNA.

.2 Do not change direction with flexible ductwork.

.3 Maximum length of flexible ductwork to be 1m.

3.3 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 Waste Management: separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.2 ASTM C916Standard Specification for Adhesives for Duct Thermal Insulation.

.3 ASTM C1071Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.

.5 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.2 National Fire Protection Association (NFPA)

.1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 North American Insulation Manufacturers Association (NAIMA)

.1 NAIMA AH116, Fibrous Glass Duct Construction Standards.

.4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)

.1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible.

.2 SMACNA IAQ Guideline for Occupied Buildings Under Construction.

.5 Underwriter's Laboratories of Canada (ULC)

.1 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for duct liners and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for duct liners for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect duct liners from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan

Part 2 Products

2.1 DUCT LINER

.1 General:

.1 Mineral Fibre duct liner: air surface coated, mat facing.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.

.3 Fungi resistance: to ASTM C1338

.2 Rigid:

.1 Use on flat surfaces where indicated.

.2 25 mm thick, to ASTM C1071 Type 2, fibrous glass rigid board duct liner.

.3 Density: [48] kg/m^3minimum.

.4 Thermal resistance to be minimum 0.76 (m^2. degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

.5 Maximum velocity on faced air side: 20.3 m/s.

.6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.

.3 Flexible:

.1 Use on round or oval surfaces

.2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.

.3 Density: 24 kg/m^3 minimum.

.4 Thermal resistance to be minimum 0.74 (m^2.degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

.5 Maximum velocity on coated air side: 30.5 m/s].

.6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

2.2 ADHESIVE

.1 Adhesive: to NFPA 90A and NFPA 90B and ASTM C916.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.

.3 Water-based fire-retardant type.

2.3 FASTENERS

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

2.4 JOINT TAPE

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

2.5 SEALER

.1 Meet requirements of NFPA 90A and NFPA 90B.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for duct liner installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 GENERAL

.1 Do work in accordance with SMACNA HVAC Duct Construction Standard except as specified otherwise.

.2 Line inside of ducts where indicated.

.3 Duct dimensions, as indicated, are clear inside duct lining.

3.3 DUCT LINER

.1 Install in accordance with manufacturer's recommendations, and as follows:

.1 Fasten to interior sheet metal surface with 90% coverage of adhesive to ASTM C916.

.1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.

.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres to compress duct liner sufficiently to hold it firmly in place.

.1 Spacing of mechanical fasteners in accordance with SMAC HVAC Duct Construction Standard

.2 In systems, where air velocities exceeds 20.3 m/s, install galvanized sheet metal noising to leading edges of duct liner.

3.4 JOINTS

.1 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 2 coats of sealer over tape.

.2 Replace damaged areas of liner at discretion of Consultant.

.3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

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.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)

.1 ANSI/AMCA Standard 99Standards Handbook.

.2 ANSI/AMCA Standard 210/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans.

.4 ANSI/AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 The Master Painters Institute (MPI)

.1 Architectural Painting Specification Manual - current edition.

.1 MPI #18, Primer, Zinc Rich, Organic.

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 HVAC fans and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Provide:

.1 Fan performance curves showing point of operation, kW and efficiency.

.2 Sound rating data at point of operation.

.2 Indicate:

.1 Motors, sheaves, bearings, shaft details.

.2 Minimum performance achievable with variable speed controllers and EC motors.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.1 Provide:

.1 Matched sets of belts.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect HVAC fans from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards in force.

.2 Capacity: flow rate, total pressure, external static pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.

.4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

2.2 FANS GENERAL

.1 Motors:

.1 In accordance with Section 23 05 13 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.

.2 For use with variable speed controllers.

.3 Sizes as indicated.

.2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet and outlet safety screens as indicated and as

specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment, dampers and vanes and as indicated.

.3 Factory primed before assembly in colour standard to manufacturer.

.4 Scroll casing drains: as indicated.

.5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.

.6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

.7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

2.3 CENTRIFUGAL FANS

.1 Fan wheels:

.1 Welded steel or aluminum construction.

.2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.

.3 As indicated.

.2 Bearings: heavy duty, split pillow-block, grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 hours.

.3 Housings:

.1 Volute with inlet cones: fabricated steel for wheels 300 mm or greater, steel, for smaller wheels, braced, and with welded supports.

.2 For horizontally and vertically split housings provide flanges on each section for bolting together, with gaskets of non-oxidizing non-flammable material.

.3 Provide bolted airtight access doors with handles.

.4 Variable volume control devices:

.1 Mounted by fan manufacturer.

.2 Adjustable inlet vanes: operated from a centre mechanism linked to each damper vane. Support each vane at ends in bronze bearings. On DWDI fans interconnect vanes to operate in unison. Provide locking devices for manual operation.

.3 Variable speed drives: refer to Section 230514.

2.4 CABINET FANS - GENERAL PURPOSE

.1 Fan characteristics and construction: as centrifugal fans.

.2 Cabinet hung single or multiple wheel with DWDI centrifugal fans in factory fabricated casing complete with vibration isolators and seismic control measures, motor, variable speed direct drive.

2.5 IN-LINE CENTRIFUGAL FANS

.1 Characteristics and construction: as for centrifugal fan wheels, with axial flow construction and direct drive.

.2 Provide AMCA arrangements 1 or 9 as indicated with stiffened flanges, smooth rounded inlets, and stationary guide vanes.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for HVAC fans installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Provide sheaves and belts required for final air balance.

.3 Bearings and extension tubes to be easily accessible.

.4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

.1 Size anchor bolts to withstand velocity forces as specified.

3.4 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Basic terminal units.

.2 Pressure independent variable volume regulators complete with damper motor operator.

.3 Sound attenuator.

1.2 QUALITY ASSURANCE

.1 The terminal units shall be tested and certified in accordance with applicable ARI equipment test codes.

.2 Insulation materials, coatings, vapour barrier facings, tapes and adhesives: Composite fire and smoke hazard rating shall not exceed 25 for flame spread and 50 for smoke developed.

1.3 LABELLING

.1 Label units with capacities as factory adjusted including minimum maximum ratings of volume regulators.

1.4 SUBMITTALS

.1 Include discharge and radiated sound power level schedules with shop drawings, for each of second through sixth octave bands and inlet pressures of 250 Pa to 1000 Pa.

.2 Provide for inclusion in maintenance manuals, instructions for resetting constant volume regulators.

.3 Comply with Section 01 33 00, Shop Drawings, Product Data and Samples.

1.5 DAMPER OPERATORS

.1 Terminal unit damper operators shall be provided by the controls trade and factory installed by the terminal unit manufacturer.

Part 2 Products

2.1 FABRICATION

.1 Fabricate casing from 0.73 mm galvanized steel. Line casing with 25 mm thick 0.7 kg density minimum, neoprene or vinyl coated fibrous glass insulation and provide interior sound attenuator baffle. Casing leakage shall not exceed 2% design flow at rated internal pressure.

.2 Fabricate variable volume regulator sub-assembly of extruded aluminum and coated steel frame with extruded aluminum blades and stainless-steel springs. Factory set regulator for specified maximum and minimum air volume.

.3 Reset volume with damper operator attached to assembly allowing flow range modulation from maximum to minimum specified.

.4 Provide water coils mounted integral with casing as indicated.

.5 Provide unit complete with sound attenuator at discharge of unit where indicated.

.6 Provide access doors integral with casing suitable for providing access to regulators proportioning valves, operators and coils.

Part 3 Execution

3.1 INSTALLATION

.1 Arrange for suitable ceiling access to units. Provide access doors or locate above easily removable ceiling components.

.2 Install units individually from the structure. Do not support from adjacent ductwork.

.3 Provide a minimum of four inlet diameters of straight duct at inlet of units.

3.2 PERFORMANCE

.1 Noise Criteria: The maximum discharge sound power levels measured immediately after the unit with attenuator shall not exceed the values noted below. These values are based on a 125 Pa pressure drop through the unit. Sound power levels are in db re 10-12 W.

Active Band Center Frequencies (#2)

250 500 1000 2000

.2 The differential static pressure of the unit shall not exceed 30 Pa with inlet velocities of 10 m/s or less. With an attenuator but with no other accessories, the static pressure across the assembly with a 10 m/s or less inlet velocity shall not exceed 110 Pa.

.3 Unit operation shall be independent of inlet static pressure. Flow, (within the adjustable range) shall not vary by more than 5% for inlet static pressures between minimum specified and 1500 Pa.

.4 Volume regulators shall be capable of maintaining minimum set flows within 5% at inlet velocities down to 3 m/s.

.5 Unit coils, where indicated, shall be 1-row minimum, with minimum capacity indicated with 88°C entering water, 77°C leaving water and minimum air flow capacity.

END OF SECTION

Part 1 General

1.1 REFERENCES

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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate following:

.1 Capacity.

.2 Throw and terminal velocity.

.3 Noise criteria.

.4 Pressure drop.

.5 Neck velocity.

.6 Construction and finish.

1.3 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Include:

.1 Keys for volume control adjustment.

.2 Keys for air flow pattern adjustment.

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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity, as indicated.

.2 Frames:

.1 Full perimeter gaskets.

.2 Plaster frames where set into plaster or gypsum board.

.3 Concealed fasteners.

.3 Concealed manual volume control damper operators.

.4 Colour: as directed by Consultant.

2.3 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY GRILLES AND REGISTERS

.1 As indicated on drawings.

.2 Approved supply air grille models for secure areas are: Virtucom SCO, Chubb OP-20V, Simpson V-2, Eneround Security

2.5 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 As indicated on drawings.

.2 Approved exhaust air grille models for secure areas are: Virtucom SCO, Chubb OP-20V, Simpson V-2, Eneround Security

2.6 DIFFUSERS

.1 As indicated on drawings

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register and grille installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Install with stainless steel screws in countersunk holes where fastenings are visible.

.3 Provide security installation in secure areas with. Chubb or S&C flathead steel spanners or equivalent.

.4 Use security caulking or high yield grout to fill any space between the back of the grille face plate and the mounting surface in secure areas.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.2 National Fire Protection Association (NFPA)

.1 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.4 Society of Automotive Engineers (SAE)

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 louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Indicate following:

.1 Pressure drop.

.2 Face area.

.3 Free area.

.4 Construction, colour and mounting details.

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

.4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Performance Requirements:

.1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

2.2 GOOSENECK HOODS

.1 Thickness: to SMACNA.

.2 Fabrication: to SMACNA.

.3 Joints: to SMACNA.

.4 Supports: as indicated.

.5 Complete with integral birdscreen of 2.7 mm diameter aluminum wire. Use 12 mm mesh on exhaust and 19 mm mesh on intake].

.6 Backdraft dampers as indicated.

2.3 FIXED LOUVRES - ALUMINUM

.1 Construction: welded with exposed joints ground flush and smooth.

.2 Material: extruded aluminum alloy 6063-T5.

.3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm.

.4 Frame, head, sill and jamb: 150 mm deep one piece extruded aluminum, minimum 3 mm thick with approved caulking slot, integral to unit.

.5 Mullions: at 1500 mm maximum centres.

.6 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.

.7 Screen: 12 mm exhaust, 19 mm intake mesh, 2 mm diameter wire aluminum birdscreen on inside face of louvres in formed U-frame.

.8 Security bars as detailed on drawings.

.9 Finish: factory applied enamel. Colour: Consultant's approval.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for louvres, intakes and vents installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 In accordance with manufacturer's and SMACNA recommendations.

.2 Reinforce and brace as indicated.

.3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

3.3 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Boiler Manufacturers Association (ABMA)

.2 ASME

.1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.

.3 CSA Group

.1 CAN1-3.1, Industrial and Commercial Gas-Fired Package Boilers.

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

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

.4 ANSI Z21.13/CSA 4.9, Gas-Fired Low-Pressure Steam and Hot Water Boilers.

.4 Electrical and Electronic Manufacturers Association of Canada (EEMAC)

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 heating boilers]and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 General arrangement showing terminal points, instrumentation test connections.

.2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.

.3 Foundations with loadings, anchor bolt arrangements.

.4 Piping hook-ups.

.5 Equipment electrical drawings.

.6 Burners and controls.

.7 All miscellaneous equipment.

.8 Flame safety control system.

.9 Breeching and stack configuration.

.10 Stack emission continuous monitoring system to measure CO, O, NOx, SO, stack temperature and smoke density of flue gases.

.2 Engineering data to include:

.1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.

.2 Radiant heat loss at 100% design capacity.

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

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for heating boilers for incorporation into manual.

1.4 QUALITY ASSURANCE

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

1.5 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra materials:

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

.1 Special tools for burners, access opening, handholes and Operation and Maintenance.

.2 Spare parts for 1 year of operation.

.3 Spare gaskets.

.4 Spare gauge glass inserts.

.5 Probes and sealants for electronic indication.

.6 Spare burner tips.

.7 Spare burner gun.

.8 Safety valve test gauge.

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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect boiler and equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan

Part 2 Products

2.1 GENERAL

.1 Packaged boiler:

.1 Complete with burner and necessary accessories and controls.

.2 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance

.3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.

.4 Designed and constructed to ASME Boiler and Pressure vessel Code.

.5 CRN (Canadian Registration Number), to CSA B51.

.6 Boiler/burner package to bear ULC label.

.2 Performance:

.1 As noted on drawings

.3 Electrical:

.1 Power: 120 V, 1 phase, 60 Hz.

.2 Electrical components: CSA approved.

.4 Controls: factory wired. Enclosed in EEMAC [1] steel cabinet.

.5 Thermal insulation:

.1 50 mm thick mineral fibre. Seal insulation at handholes, access opening, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.

.6 Jackets: heavy gauge metal, finished with heat resisting paint.

.7 Mounting:

.1 Structural steel base, lifting lugs.

.8 Anchor bolts and templates:

.1 Supply for installation by other Divisions. Anchor bolts to be sized to Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment.

.9 Start-up, instruction, on-site performance tests: 3 days per boiler.

.10 Trial usage:

.1 Owner may use boilers for test purposes prior to acceptance and commencement of warranty period.

.2 Supply labour, materials and instruments required for tests.

.11 Temporary use by contractor:

.1 Contractor may use boilers only after written approval from Consultant.

.2 Monitor and record performance continuously. Keep log of maintenance activities carried out.

.3 Refurbish to as-new condition before final inspection and acceptance.

2.2 MODULAR HOT WATER BOILER, NATURAL GAS PULSE FIRED, CONDENSING TYPE

.1 Heating boiler seasonal efficiency rating: 90%. Flue gas exhaust temperature: 45 to 55 degrees C, when operating in condensing mode.

.2 Flue gas: individually direct vented. Combustion air: individually drawn from outdoors through plastic pipes as indicated and as recommended by manufacturer.

.3 Factory-assemble each module to include:

- .1 Combustion air inlet chamber.
- .2 Pre-purge blower assembly.
- .3 Air-gas fuel control valve.
- .4 Cast pulse combustion chamber.
- .5 Welded absorption chamber with spiralled fire tubes and exhaust chamber.
- .6 House assembly in insulated jacket which includes boiler mounted electrical control panel enclosure with operation sequence indicator lights.
- .7 Provide coupling on combustion air inlet and exhaust chambers for connections of plastic piping, PVC for outside air intake and PVC-XFR for outside exhaust.
- .8 Provide condensate drain fitting on exhaust chamber.
- .9 Boiler materials will enable operation with flue gas temperature below dewpoint without corrosion.

.4 Absorption unit: constructed in accordance with ASME Boiler and Pressure Vessel Code for Low Pressure Heating Boilers for 207 kPa working pressure.

.5 Controls for each module to include:

- .1 Solid state controller with auxiliary relay.
- .2 Fan prove pressure switch and pressure sensing flame safeguard system.
- .3 Provide combination gas control with:
  - .1 Manual shut off valve.
  - .2 System pressure controlled regulator.
  - .3 Automatic redundant shut off valves.
  - .4 High limit water temperature control with adjustable differential.
  - .5 ASME approved pressure relief valve and temperature/pressure indicator.

.6 Factory wire each module and operationally test.

- .1 Each module suitable for individual firing.
- .2 Step firing accomplished by firing individual modules without reducing their thermal efficiency.
- .3 Control system: designed and provided for heating plant by manufacturer.

2.3 AUXILIARIES

.1 Provide auxiliaries for each boiler and to meet ASME requirements.

.2 Hot water boilers:

.1 Relief valve: ASME rated, to release entire boiler capacity.
.2 Pressure gauge: 90 mm diameter complete with shut-off cock.
.3 Thermometer: 115 mm diameter range 10 to 150 degrees C.
.4 Low water cut-off: with visual and audible alarms.
.5 Auxiliary low water cut-off: with separate cold water connection to boiler.
.6 Isolating gate valves: on supply and return connections.
.7 Drain valve: NPS 2.
.8 Stack thermometer: range 65 to 400 degrees C.
.9 Outdoor controller: to reset operating temperature controller.
.10 1 set of cleaning tools.

.3 Pot type chemical feeder.

2.4 GAS BURNERS

.1 General:

.1 Forced draft with:

.1 Built-in blower to supply combustion air, complete with motor, silencer and damper.
.2 High voltage ignition transformer.
.3 Flame observation port.
.4 Easy access to nozzles and electrodes.

.2 Gas pilot:

.1 To building code and provincial regulations including solenoid gas valve, pressure regulator, pressure gauge, manual shut-off valve.

.3 Main gas train:

.1 To building code and provincial regulations including main shut-off valve, pressure regulator, motorized electric shut-off valve, downstream block-test valve with test connection and pressure gauge.

.4 Controls:

.1 Electronic combustion control relay with flame rod flame detector for combustion control and flame supervision.
.2 Control to shut off fuel within 5 seconds upon pilot flame or main flame failure or upon signal of safety interlock and to ensure, when restarted, in sequence:

.1 Pre-purge.
.2 Pilot ignition and supervision.
.3 Main gas valve opening.
.4 Pilot cut-off. Pilot-proving period not to exceed 10 seconds.
.5 Burner operation.
.6 Post-purge burner shut-down.

.3 Static pressure interlock. To shut off burner upon loss of combustion air pressure.
.4 Fuel-air mixture: control through:

.1 2-position motor with end switch to provide for low-fire start and high fire run.

.2 2-position motor with linkage to control fuel and air and with end switches to prove low-fire start and energize high fire solenoid valve for high-low fire operation.

.3 Modulating motor with end switch to provide for low-fire start and fully modulating operation down to 20% of design capacity.

.5 Immersion controllers:

.1 Operating: to start and stop burner and operating between adjustable setpoints.

.2 High-low: to shift burner operation to high or low fire.

.3 Modulating: to modulate burner output].

.4 High limit: manual reset.

.5 Controller range: 30 to 121 degrees C.

.6 Visual and audible alarms: to indicate burner shutdown due to flame failure, low water level, high pressure/temperature, low air pressure, low gas pressure.

.7 Selector switch: to permit manual and automatic firing at any rate between low and high fire.

.8 Pilot lights: to indicate:

.1 Normal burner operation.

.2 All stages of burner operation.

.9 Burner to start up in low fire position.

2.5 EMISSION CONTROL

.1 Rate of discharge of air contaminants from boiler not to exceed:

.1 For nitrogen oxides expressed as nitrogen dioxide:

.1 22 ng/J of heat input when fired with gaseous fuel.

.2 For carbon monoxide, 125 ng/J of heat input.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for heating boiler installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.3 INSTALLATION

.1 Install in accordance with ASME Boiler and Pressure Vessels Code, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.

.2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.

.3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.

.4 Mount unit level using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

.5 Pipe hot water relief valves full size to nearest drain.

.6 Natural gas fired installations: in accordance with CSA B149.1.

3.4 MOUNTINGS AND ACCESSORIES

.1 Safety valves and relief valves:

.1 Run separate discharge from each valve.

.2 Terminate discharge pipe as indicated.

.3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.

3.5 FIELD QUALITY CONTROL

.1 Commissioning:

.1 Manufacturer to:

.1 Certify installation.

.2 Start up and commission installation.

.3 Carry out on-site performance verification tests.

.4 Demonstrate operation and maintenance.

.2 Provide Consultant at least 24 hours notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.

.1 Leave Work area clean at end of each day.

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Air-Conditioning and Refrigeration Institute (ARI)

.1 ARI 550/590-98, Standard for Water Chilling Packages Using the Vapor Compression Cycle.

.2 Canadian Standards Association (CSA International)

.1 CSA B52-05 SMART, Mechanical Refrigeration Code.

.3 Environment Canada, (EC)/Environmental Protection Services (EPS)

.1 EPS 1/RA/2-1996, Environmental Code of Practice for Elimination of Fluorocarbons Emissions from Refrigeration and Air Conditioning Systems.

1.2 USE OF ENVIRONMENTALLY SAFE REFRIGERANTS

.1 Chiller shall use an environmentally safe refrigerant with an Ozone Depletion Factor (ODF) not exceeding 0.02. The reduction in cooling capacity shall not exceed 10%; and increase in energy consumption per unit of cooling shall not exceed 5%, when the chiller is filled with an environmentally safe refrigerant.

.2 The chiller manufacturer shall submit the following information with the tender:

.1 Name the refrigerant and its ODF value.

.2 Safety considerations for the use of the environmentally safe refrigerant.

.3 Name of substitute environmentally safe refrigerant and its ODF value.

.4 Expected decrease in cooling capacity and increase in energy consumption with the use of the proposed environmentally safe refrigerant.

.5 Compatibility information on the materials used in chiller construction with the environmentally safe refrigerant.

.6 Hardware changes required and the estimated cost of each change, at the time of refrigerant conversion. This cost shall include all necessary changes to make the chiller operational with the substitute refrigerant.

.7 Additional operational and maintenance requirements as a result of the use of substitute refrigerant.

1.3 SUBMITTALS

.1 Submit shop drawings for review.

.2 Shop drawings shall include the following product data:

.1 Manufacturer's printed product literature, datasheets, product characteristics, and performance criteria.

.2 Physical dimensions, weight, finish, required clearances, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.

.3 Dimensioned plan and elevation view drawings and location of all field connections.

.4 Required equipment including but not limited to connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.

.5 Summary of all auxiliary utility requirements, such as electricity, water, compressed air, etc. Summary shall indicate quality and quantity of each required utility.

.6 Single-line schematic drawing of the power field hookup requirements, indicating all items that are furnished.

.7 Schematic diagram of control system indicating points for field interface/connection.

.8 Diagram shall fully delineate field and factory wiring.

.9 Certification of factory-run test of chiller unit signed by company officer.

.10 Installation manuals.

.11 Type of refrigerant used.

.12 Part load power requirements performance data at 100%, 80%, 60%, 40%, 20% and 10% of the rated capacity.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for incorporation into manual specified in Division 1.

.2 Data to include:

.1 Description of equipment giving manufacturers name, model type and year, capacity and serial numbers.

.2 Details on operation, servicing and maintenance.

.3 Recommended spare parts list.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle in accordance with Division 1.

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

.3 Packaging Waste Management: remove for reuse and return of pallets, crates, and packaging materials in accordance with Division 1

.4 Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil by the manufacturer.

.5 Comply with the manufacturer's instructions for rigging and handling equipment.

Part 2 Products

2.1 GENERAL

.1 Provide complete modular air-cooled scroll type chiller package including: scroll type compressors; evaporator; condenser, motor and motor starter; controls; control centre; piping; wiring; refrigeration and oil change; ready for connection to chilled water circuit, interlocks, and electric power source, installed in a powder coated heavy gauge steel enclosure with removable access panels finished to manufacturers standard.

.2 Modules are to connected together to form a modular chiller bank for connection to a single point power connection, chilled water return pipe, chilled water supply pipe, and controls connection.

.3 Chillers shall incorporate scroll type compressors and consist of multiple independent refrigerant circuits. Each refrigerant circuit shall consist of an individual compressor set, evaporator, thermal expansion valve, liquid line solenoid valve, filter drier, fin and tube condenser, insulated suction line, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits.

.4 Chiller manufacturer to supply 2-year parts and labour warranty from start-up date.

.5 Chiller manufacturer to supply a minimum of two-year service agreement including start-ups, season checks, and shutdowns from time of start-up.

.6 Chiller Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236, and bear the ASME UM stamp on all water-to-refrigerant heat exchangers.

.7 Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment.

.8 Chilled Water Mains: Each module shall include supply and return mains for chilled water. Grooved or flanged end connections are provided for interconnection.

.9 Each refrigerant circuit shall include all refrigerant specialties including a properly sized refrigerant receiver to provide reliable operation down to 40°F Ambient.

.10 Modules shall have minimum 25mm flange connection on condenser fan outlet for ductwork connection.

.11 Modules shall be complete with internal chilled water isolation valves and a chilled control valve. The isolation valves shall be accessible from front panel to allow for

isolation of an individual module. The control valve shall be controlled by the chiller controller to open when the chiller module is in operation and close when the chiller module is not in operation. Flow should bypass the chiller when dry-cooler units are in operation and chiller modules are not.

.12 Chiller modules to be factory painted to colour specified by architect.

2.2 CAPACITY

.1 Refer to product schedules.

2.3 COMPRESSORS

.1 Hermetic scroll design.

.2 Unloaded start with capacity modulation by continuous linear modulation of slide valve in response to load change.

.3 Compressor to include suction and discharge shut-off valves; oil sight glass; separate circuit crankcase heater; and cylinder unloading device.

.4 Provide nameplate to show capacity at design temperature, type of refrigerant used and total weight in system.

.5 Each refrigerant system to include high discharge pressure and low suction pressure safety cut-outs.

.6 Sound reduction as required to meet Product Schedule requirements.

2.4 COMPRESSOR MOTOR

.1 Hermetic type with overload protection and manual restart: 600 V.

.2 Mounted complete with vibration isolation within unit.

2.5 EVAPORATOR

.1 Brazed plate heat exchanger constructed of stainless steel.

.2 Designed, tested and stamped in accordance with ASME for 350 psig water side working pressure.

.3 The evaporator heat exchanger shall not be mounted above the compressor to prevent the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

.4 Vent and drain connections shall be provide at the inlet and outlet chilled water piping by the installing contractor.

.5 The evaporator shall be insulated as per the chilled water piping insulation schedule.

2.6 CONDENSER

.1 Air cooled:

.1 Aluminum fins mechanically bonded to copper tube, pressure tested to 3.1 MPa.

.2 Condenser fans are to be direct drive, steel, aluminum, or plastic composite vane axial type fan, statically and dynamically balanced. Motor to be complete with overload protection, permanently lubricated ball bearings. Maximum RPM of 1150.

.3 Chiller modules are to be mounted indoors complete with ductwork connected to the condenser fan discharge. Fans to be rated for high static installation. Refer to product schedules.

.4 Condenser fan shall be pressure controlled based on compressor discharge pressure. The motors shall suitable for outdoor use and shall be capable of operating high static fans.

2.7 CONTROL CENTRE

.1 A centrally located weatherproof control panel shall contain the field power connection point, control interlock terminals, and control system (Master Controller). Power and starting components shall include factory circuit breaker of fan motors and control circuit, individual contactors for each fan motor, solid-state compressor three-phase motor overload protection, inherent fan motor overload protection and unit power terminal blocks for connection to remote disconnect switch.

.2 Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.

.3 The Master Controller shall monitor and report the following on each refrigeration system:

.1 Discharge Pressure Fault.

.2 Suction Pressure Fault.

.3 Compressor Winding Temperature.

.4 Suction Temperature.

.5 Evaporator Leaving Chilled Water Temp.

.4 The Master Controller shall monitor and report the following on each system:

.1 Entering Chiller Water Temperature.

.2 Leaving Chiller Water Temperature.

.3 Discharge Refrigerant Temperature.

.4 Chilled Water Flow.

.5 An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).

.6 Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.

.7 The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to fine tune the chiller to different existing building conditions.

.8 The chiller master control system shall have external inputs and outputs to be compatible with the building automation system to include:

.1 Remote Start/Stop capability.

.2 Reset of Leaving Chilled Water Temperature.

.3 Cooling Alarm output.

.4 Enable/disable of evaporator pumps (P-7, P-8, and P-9) corresponding to then number of chiller modules in operation.

.5 Flow switch.

.9 The building automation system BACnet protocol shall be supported by the chiller control system.

.10 The chiller safety controls shall be provided (minimum) as follows:

.1 Low evaporator refrigerant pressure.

.2 Loss of water flow through the evaporator.

.3 High condenser refrigerant pressure.

.4 High compressor motor temperature.

.5 Low suction gas temperature.

.6 Low leaving evaporator water temperature.

.7 Sensor failure.

.11 Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall be enunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable. An alarm signal shall also be generated to the building automation system.

.12 The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:

.1 Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.

.2 Provisions for connection to automatically enable the chiller from a remote energy management system.

.3 The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.

.13 When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load. The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

.14 The chiller control module shall be equipped with a BACNet communication card.

Part 3 Execution

3.1 INSTALLATION

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

.2 Coordinate electrical connections with electrical contractor.

.3 Coordinate controls with controls contractor.

.4 Install a field-supplied manufacturer approved strained in the chilled water return line at the evaporator inlet.

3.2 CLEANING

.1 Clean in accordance with Division 1.

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Division 1.

.3 Prior to connecting the chiller to the building chilled water loop, the piping shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organic residue. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.

.4 During the flushing a manufacturer approved strainer shall be in place in the system piping and examined periodically as necessary to remove collected residue. The flushing process shall take no less than 6 hours or until the strainers, when examined after each flushing, are clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturers instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

.5 Prior to operation, supply water for the chilled water circuit shall be analyzed and treated by a professional water treatment specialist who is familiar with the operating conditions and materials of construction specified for the chiller's heat exchangers, headers and associated piping. Cycles of concentration shall be controlled such that recirculated water quality for modular chillers using 316 stainless steel brazed plate heat exchangers and carbon steel headers is maintained within the manufacturer parameters.

3.3 START-UP

.1 Provide appropriate protection apparatus.

.2 Ensure adequate clearances for servicing and maintenance.

.3 Manufacturer to approve installation, to supervise startup and to instruct operators. Include 2 days per unit.

.4 Confirm refrigerant charge supplied from factory.

.5 Contractor to install flow switch and temperature sensor (supplied by chiller manufacturer) in chilled water piping.

.6 Provide testing and starting of chillers and instruct Owner in its proper operation and maintenance. The owner shall provide a leak test tag which shall be completed by the contractor and affixed to the chiller.

.7 A leak test is to be conducted on the chiller prior to project completion.

3.4 EQUIPMENT SERVICE

.1 Manufacturer trained service technician and product representative to have field offices located in the Province of Alberta. Location of field offices to be indicated on product shop drawings.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Outdoor air handling unit

1.2 QUALITY ASSURANCE

.1 It is the intent of this specification that the manufacturer provides air handling units designed and manufactured specifically to the requirements of this project. Overall dimensions and configuration are to be as shown on the plans and as described in the specifications. Take responsibility for the engineering and operational integrity of the air handling units.

.2 Unit construction shall be per the construction details included at the end of this section, and as described herein.

.3 Provide unit produced by a recognized manufacturer who maintains a local service agency and parts stock.

.4 Air flow rates, external static pressures, water flow rates, coil face velocities, filter face velocities, water and air side pressure drops shall be the same or better than specified for alternate selections.

.5 Fans shall be AMCA certified.

.6 Coils shall be ARI certified.

.7 Provide all motors with thermal overload protection.

.8 Obtain CGA/CSA approval and comply with Provincial Regulations

.9 Start-up of unit shall be executed by manufacturer's personnel. A complete manufacturer's check list of field start-up tests must be submitted with operations and maintenance instructions and shall be signed by start-up technician and mechanical trade, field supervisor as certified satisfactory for operation.

.10 All components, paints and lining shall have a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50.

.11 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 the requirements from balancing agency (Refer to Section 230593, Balancing)

.12 Sealing of all unit casing penetrations made on site as for piping, conduit, hanger rods, etc. shall be the responsibility of the mechanical contractor to the satisfaction of the ERV manufacturer. Sealing method and components shall be suitable to withstand 1.5 times the working pressure of the unit.

.13 Use the follow as a selection criteria and supply as specified:

- .1 Air flow rate
- .2 External static pressure
- .3 Water flow rate.

.14 The following are to be equaled or improved:

.1 Coil face velocities equal or better

.2 Filter face velocities equal or better

.3 Sound power levels equal or better

.4 Outlet velocities equal or better

.5 Water pressure drops equal or better

.6 Water flows equal or better

.7 External static pressure equaled or increased without any increase in listed fan motor requirements

1.3 TESTING

.1 All ERVs shall be have the following tests completed prior to duct connection to the units. Test results shall be included in the operation and maintenance manuals.

.2 All ERVs shall be leak tested to ensure that the unit meets a SMACNA Seal Class "A". The leak test shall be carried out at 150% of the total operating supply fan static pressure. Tests shall be carried out in accordance SMACNA HVAC Air Duct Leakage Test Manual. Tests shall be carried out with unit completely assembled and with duct connection locations sealed with temporary metal covers. Units shall be tested under positive and negative pressure conditions. Manufacturing company shall certify test results and forward to the consultant.

1.4 SUBMITTALS

.1 Shop drawings to include all general information defined by Division 01. Omission of any of the requirements identified in the above referenced section(s) and as specified herein will cause shop drawings to be immediately returned without review.

.2 Submit shop drawing which shall include the following minimum information.

.1 Unit Dimensions: Indicated outside dimensional drawing including service clearances.

.2 Construction details.

.3 Submit unit construction drawings for the following components:

.1 Side panels, including connection details

.2 Top panel, including connection details

.3 Floor, including connection details

.4 Doors, hinges, latch, viewing port

.5 Fan, motor and drive, mounting and isolation

.6 Cooling section

.7 Heating coil section(s) or gas fired section

.8 Pipe and conduit penetration through casing or floor

.9 Drain pan

.10 Damper, linkage and drive construction and mounting

.1 Exterior (top) rain drip gutter

.2 Air blender

.3 Heat recovery section

.11 Materials of Construction: Indicate material and gauge of all construction components.

.12 Mass Distribution Drawings: Show point loads, and recommended method of unit installation.

.13 Fan Performance Data: Submit fan performance curves as well as performance tables.

.14 Electrical voltages, phase and power requirements.

.15 Coils: Selection criteria indicating air side and fluid side capacities, in and out conditions, velocities, pressure drops and fouling factors. Submit a drawing showing headers, circuiting, arrangement, connection sizes, and materials of construction.

.16 Air Filters: Media, efficiency rating, velocity, pressure drop charts and capacities. Indicate mounting method and arrangement.

.17 Vibration Isolator Shop Drawings.

.18 Table indicating pressure drops through all components of the unit.

.19 Damper Shop Drawings. Outside air dampers shall be insulated and "RSI" value of the total damper as a unit shall not be less than 0.35□C m2/W.

.20 Detailed composite wiring diagrams showing factory installed wiring, including wiring of the control components.

.21 Sound Levels: Submit sound power levels generated by the air handling unit at the inlet and outlet of the unit and outside the fan section. List for individual octave bands in dB referenced to A rating.

.22 Neoprene lining specification including erosion resistance data.

.23 Variable frequency drive assemblies and motor shop drawings and data.

.24 Manufacturer catalogue information for humidifiers and variable frequency drives.

Part 2 Products

2.1 COMPONENTS

.1 Provide factory assembled air handling unit in configuration as indicated on the drawings. Unit shall include all specified components installed at the factory. Field fabrication of units and their components will not be accepted. All units shall be inspected by the Engineer prior to shipment. Inspection shall be of a completely assembled unit.

2.2 COMPONENTS

.1 Air handling units shall consist of but not be limited to the following components:

.1 Supply fan

.2 Exhaust fan
.3 Preheat coil
.4 Heating coil
.5 Cooling coil
.6 Prefilter section
.7 Final filter section
.8 Damper sections

2.3 CABINET

.1 Exterior Panels: Minimum 1.6 mm satin coat galvanized steel with air dried enamel finish.

.2 Walls and Ceilings: Interlocking construction with at least two breaks at each interlocking joint. Wall joints to be broken inward, ceiling joints to be broken outward. All panel joints to be caulked and roof to be pitched to prevent water pooling. Casing depth to match the specified insulation thickness. Inside surfaces shall be clean and flush, free of exposed flanges.

.3 Stiffeners of angle steel shall be supplied as required to maintain casing deflection criteria of 1/200 at 1.5 times the working pressure. If panels cannot meet this deflection, add addition internal reinforcing.

.4 Base: Construct from structural steel channel iron around perimeter with intermediate channel and angle iron supports. Provide a 12 gauge thick checker steel plate in all sections of the unit. Provide floor bracing channels at maximum 300 mm on centre. Maximum base deflection shall be 6 mm on 6.10 m unsupported span.

.1 Provide a 38 mm perimeter collar around the entire unit, and around each floor opening to ensure the unit is internally watertight. The entire base shall act as a drain pan and hold up to 38 mm of water.

.5 Insulation and Liner:

.6 Insulate all exterior walls and roof with 50mm thick rigid fibrous glass acoustic insulation, 72 kg/m³ density. Line interior of all panels with 18gauge perforated galvanized steel liner. Insulate underside of unit floor with 50mm thick rigid fibrous glass insulation 72 kg/m³5 lb/ft3 density. Hold in place insulation with welded pins 400 mm centre.

2.4 ACCESS DOORS

.1 Provide hinged man sized access doors. Door construction to be the same as casing. Provide minimum two (2) latches per door openable from both sides. Doors to be sealed with automotive type 13 mm closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame. (Neoprene or foam gaskets are not acceptable). Doors to be sealed with neoprene gasketing (foam gasketing not acceptable). Door hinge to be continuous stainless steel piano hinge. Door sizes to be 750 mm x 1800 mm or as limited by height of unit. Provide access doors for the following sections. All access doors must swing against the air pressure.

.1 Fan Sections

.2 Preheat Coil Section

.3 Heating Coil Section

.4 Cooling Coil Section

.5 Filter Sections

2.5 FINISH

.1 Entire exterior is to be painted with two (2) coats primer paint followed by minimum two (2) coats of exterior application of air dried enamel. Colour selection by the Architect.

2.6 MARINE LIGHTS

.1 Provide marine type lights in all sections having an access door on all units. Lights shall be factory installed and wired to a single switch located outside the supply fan access door. Marine lights shall have protective metal cage and glass globes.

.2 Wire power connection in metal conduit to all lights to one location for connection by Division 26. All wiring to be copper, minimum size #12 RW90.

.3 Light and power to be fed from a separate source so that the lights can operate when the unit is off

.4 Supplier shall retain and coordinate electrical contractor to provide labour for wiring between unit splits.

2.7 DRAIN PANS

.1 On units without stacked coils, provide a single fabricated 16 gauge Type 304 stainless steel drain pan under cooling coils. On units with stacked coils, provide a separate drain pan under each coil. On all units, provide a secondary drain pan extending under the entire fan section downstream of the cooling coil, and the humidifier section. Provide a stainless steel drain pan to drain the fresh air intake, mixing plenum or heat recovery sections. Pipe all drains to the interior of unit.

2.8 FAN

.1 Acceptable Fan Manufacturers: Trane, Chicago, Northern, Loren Cook, Twin City, Barry Blower. Engineered Air

.2 Fans to be centrifugal type. Fan to be both statically and dynamically balanced.

.3 Fan selection shall be based on actual air conditions at the geographical location of the unit. Select fans in the midrange of their performance capabilities such that increasing the RPM of the fan to achieve an additional 15% air flow delivery through the specified unit will not change the fan Class or require an increase in motor horsepower.

.4 Fan shafts are to be solid, ground and polished, carbon steel, SAE 1045 material, machined to close tolerances, keyed to the fan wheel. Coat the fan shaft with rust inhibitor after machining. Hollow shafts will not be acceptable.

.5 Fan bearings shall be in self aligning pillow block, grease lubricated, extra heavy duty spherical roller type, selected for an L10 life of 200,000 hours at design operating conditions. Bearings are to be mounted on the fan structural bracing. Provide extended

lubrication lines to permit lubrication for both bearings to be performed at the access door side.

.6 Provide variable sheaves for motors 11 kW and under and fixed sheaves for motors 15 kW and over. Exchange sheaves as necessary during balancing.

.7 Provide variable speed drives. Refer to Section 230514.

.8 Entire fan assembly including fan scroll, wheel and motor to be integrally mounted on an inertia base and to be separated from unit casing with flexible connections and spring isolators. Concrete may be poured into steel base on site but fan and base must be factory mounted.

.9 Provide belt guards where fan sections are accessible.

.10 Belt guards shall have sides of galvanized steel and faces of expanded metal. Provide a face on both the outside and the inside of the drive assembly. Provide openings in the faces for fan and motor tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes. Belt guards shall be in accordance with OSHA guidelines.

.11 Fan drives shall be of a multiple tooth polymer synchronous belt configuration. The belt shall have multiple teeth that mesh with compatible sheaves with multiple teeth. The drive system combination shall be of one manufacturer and shall be suitable for a centrifugal fan application and shall be rated by the drive manufacturer for the motor horsepowers and fan and motor RPMs provided by the Air Handling Unit manufacturer. Selection of the drive system shall be made by a synchronous drive system manufacturer regularly engaged in the manufacturer of these drive components. Drives shall be Gates Poly Chain or alternative acceptable to the mechanical sub-consultant.

2.9 MOTORS

.1 Motors shall be of high efficiency type. Refer to Section 230513. All motors to be by the same manufacturer.

2.10 VIBRATION ISOLATION

.1 Each fan and motor are to be mounted on an all welded, structural steel, prime coated, internal isolation base, completed with open spring isolators with an internal isolation efficiency of at least 99% from the building structure. Isolators shall be free standing with sound deadening pads and levelling bolts. Spring diameter to compressed operating height ratio shall be 1 to 1. Spring deflection shall be 50 mm. The outlet of the fan shall be separated from the unit casing by means of a factory installed flexible fabric connection.

.2 Manufacturer to provide independent data for internal isolation bases. If 99% efficiency cannot be met, cost of inertia bases shall be the responsibility of supplier.

2.11 FILTERS

.1 Refer to Section 234000 for detailed filter specifications.

.2 Filters containing urea formaldehyde or fibreglass are not acceptable.

.3 Prefilter: 50 mm, pleated filter, average efficiency 30-35% on ASHRAE Test Standard 52-76.

.4 Final Filter: 300mm, deep pleated filter, average efficiency 80-85% on ASHRAE Test Standard 52-76).

.5 Mounting racks to be galvanized, to suit specified filter type

.6 Limit filters velocity based on face area to 2.5 m/s.

.7 Provide one Dwyer 2000 magnehelic filter gauge for each bank of filters, including for each position of prefilter. Flush mount gauge on the exterior of the unit. Gauge shall be suitable for outdoor operation.

2.12 COIL SECTION

.1 Enclose coils in coil section with headers and U-bends fully contained within the casing.

.2 Extend the coil supply and return header connections, drain and vent fittings through casing. Coil connections shall be of same material as the coil headers.

.3 Coil racks to be angle iron, providing completely independent support for each coil. Each coil is to be separately removable without disturbing the other coils. Provide removable coil access panels in the unit casing.

.4 Limit coil face velocity to 2.5 m/s..

2.13 ENERGY RECOVERY WHEEL

.1 ERV unit shall have a total energy wheel sized per the ventilation requirement of the unit. The energy wheel should be an integral part of the air-handling unit. An additional outside air unit, or other field assembled and ducted energy recovery device, is not acceptable.

.2 The energy wheel shall be a total energy wheel, the sensible and latent effectiveness shall be reported and be within 5% of each other. The calculated total net effectiveness of the recovery device shall not be less than 70% when the specified ventilation flow rate equals the exhaust flow rate. The energy wheel's exhaust air transfer rate, EATR, shall be less than the value scheduled. The amount of outside sir transferred to the exhaust air shall also be reported to ensure proper fan and damper sizing. Wheel face velocity shall not exceed 4.5m/s and pressure drops shall be less than 300Pa.

.3 Wheel shall be constructed of alternate layers of corrugated and flat aluminum sheet material. All surfaces shall be coated with a non-migrating absorbent for transfer of water vapor.

.4 The rotor shall have smooth air channels to ensure laminar airflow for low pressure drops.

.5 The rotor media must be made of aluminum that is coated to prohibit corrosion.

.6 The rotor housing shall be constructed using a heavy-duty extruded and anodized aluminum tube frame with double wall galvanized sheet metal panels with fiberglass insulation.

.7 Adjustable brush seals must be provided along the periphery of the rotor and between the inlet and outlet air passages to prevent air leakage and cross-contamination between airflows.

.8 Provide a factory set, field adjustable purge sector to limit cross contamination.

.9 The rotor drive system shall consist of a self-adjusting belt around the rotor perimeter driven by an AC motor with gear reduction.

.10 Sensible and latent recovery effectiveness must be certified by the energy recovery wheel supplier through ARI in accordance with ARI standard.

2.14 DAMPERS

.1 Low leakage type dampers with hollow blades filled with extruded polyurethane insulation.

.2 Damper assembly shall have a thermal insulation value of R 0.35□C m2/W, Tamco 9000 or equal.

.3 Blades shall be minimum 12 gauge extruded aluminum. Blades shall be of air foil design, 150 mm" wide. Maximum blade length shall be 1200 mm.

.4 Damper seals shall be designed for minimum air leakage by means of overlapping seals.

.5 Frames shall be minimum 12 gauge extruded aluminum channel with grooved inserts for vinyl seal.

.6 Install blade linkage hardware in frame out of air stream. Use cadmium plated steel hardware.

.7 Arrange linkage and provide an adequate number of damper operators to ensure that the interconnected damper sections operate in unison without binding.

.8 The outdoor and exhaust dampers shall be at the building envelope and are not part of the air-handling unit.

.9 Damper operators shall be supplied by the controls contractor and installed by the air processing unit manufacturer at the factory in accordance with instructions from the controls contractor. Extend drive and provide mounting bracket to place outdoor air damper actuators outside of airstream. Damper actuators are to be supplied with the unit and pre-wired to the unit mounted VFDs.

2.15 CONTROLS

.1 Unit controls to be wired by controls contractor on site. Provide 20mm conduit throughout unit for controls contractor to installed wiring.

.2 Airflow measurement stations are to be provided integral to the ERV unit for connection to by the EMCS contractor. Refer to controls specifications.

Part 3 Execution

3.1 ASSEMBLY

.1 Units are to be one-piece construction.

.2 Pipe units to permit coil removal.

.3 Any piping or conduit passing through the unit casings must be sealed with rubber grommets and retaining plates to prevent air or water leakage.

.4 Entire air handling unit is to be levelled.

.5 Each drain connection shall be provided with a deep seal trap, and all connections piped to drain.

.6 Remove all internal hold-down bolts and shipping fasteners, and install any parts that were shipped loose. Level spring isolators.

.7 Check and re-align all access doors and dampers to ensure smooth operation through the entire range of travel.

.8 Upon start-up, each fan motor is to be checked for fan rotations, and amp draw for each phase.

.9 All belt drives are to be re-adjusted for tension and alignment.

.10 Provide a drain valve on each coil drain fitting, and a vent valve on each coil vent.

.11 Any floor penetrations of the unit are to be thoroughly sealed to ensure the water tightness and integrity of the entire floor of the unit.

.12 Air filter supplier shall conduct a field review to confirm filter installation is in accordance with manufacturer's recommendations. Submit report of findings.

.13 Refer to Unit Schedules for performance.

.14 The Contractor shall review all component sections for damage upon arrival to site, prior to acceptance for unpacking and reassembly. Any damages after unpacking are the responsibility of the Contractor.

.15 Gaskets and/or sealing components are to be supplied by the unit supplier. The reassembly of units shall be reviewed and instructed by supplier, to ensure factory quality reassembly.

.16 Contractor shall be responsible for onsite reassembly and onsite leak-testing of units as specified

3.2 ON SITE ALIGNMENT

.1 A qualified millwright shall confirm alignment of the fans and motors and submit a report for each. A vibration specialist shall perform vibration measurements on each fan/motor assembly at full operating performance. Adjustments in the fan balancing and alignment shall be conducted until the vibration measurements fall within the specified tolerances. Submit a report of the findings.

END OF SECTION

1. General

1.1 SCOPE

.1 Water coils.

.2 Glycol coils.

.3 Coil installation.

.4 Coil piping and accessories.

1.2 QUALITY ASSURANCE

.1 Coils shall be the product of manufacturer regularly engaged in production of coils who issues complete catalogue data on such products.

.2 Coil capacities, pressure drops, and selection procedures shall be certified in accordance with ARI Standards and bear ARI seal.

1.3 SUBMITTALs

.1 Shop drawings shall include dimensions, materials of construction and performance data to match specifications.

.2 Submit coil selection sheets or computer calculations with shop drawings.

2. Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Trane, Engineered Air, McQuay, Heat Craft.

2.2 GENERAL

.1 Provide extended surface type coils with tubes of copper or brass, and plate or helical type fins of copper or aluminum.

.2 Space fins 14 per 25 mm maximum. Helical fins may be crimped.

.3 Mount coil section in galvanized steel casing designed for bolting to other sections of ductwork.

2.3 WATER AND GLYCOL HEATING COILS

.1 Design for maximum operating limits of 1380 kPa and 104°C.

.2 Coil headers shall be cast iron, copper tube or steel pipe.

.3 Face length shall not exceed 3 m.

2.4 COOLING COILS

.1 Design for maximum operating limits of 1380 kPa at 104°C.

.2 Face length shall not exceed 3 m per section.

.3 Provide moisture eliminator of 0.70 mm galvanized steel where air velocity exceeds

.4 2.5 m/s.

.5 Provide drip pan and drain connection for each field assembled coil section.

.6 Coil headers shall be cast iron, copper tube or steel pipe.

.7 Refrigerant coils shall be serpentine type with brass or copper header arranged to prevent trappings of oil and to distribute liquid refrigerant to circuits. Silver soldered or brazed joints. Maximum operating pressure 1722 kPa.

3. Execution

3.1 INSTALLATION

.1 Support coil sections on steel channel or double angle frames and secure to casings. Arrange supports for cooling coils so they do not pierce or short circuit drip pans. Level serpentine coils and install drainable tube coils with pitch within casing. Arrange galvanized steel casings for bolting to other section, ductwork or unit casings. Provide airtight seal between coils and duct or unit cabinets.

.2 Make necessary connections to coils, including valves, air vents, unions and connections from drip pans. Provide gate valve on supply line and eccentric plug valve on return line to each water coil.

.3 Locate water supply at bottom of supply header and return water connection at top to provide self-venting and reverse return arrangement. Provide manual air vents at high points complete with stop valve. Ensure water coils are drainable and provide drain connection at low points.

.4 Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins unless required to be replaced.

.5 If turn over occurs during winter months, turn over systems to the owners with all chilled water cooling coils drained and valved off from the system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.2 ASTM C916Standard Specification for Adhesives for Duct Thermal Insulation.

.3 ASTM C1071Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.2 National Fire Protection Association (NFPA)

.1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

.3 Underwriters' Laboratories (UL) Inc.

.1 UL 2021, Fixed and Location-Dedicated Electric Room Heaters.

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 unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures.

.4 Shop Drawings:

.1 Indicate on drawings:

.1 Equipment, capacity and piping connections.

.2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect unit heaters from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan.

Part 2 Products

2.1 UNIT HEATERS

.1 Cabinet Unit Heaters: to UL 2021.

.2 Cabinet: type recessed, ducted, 1.6 mm thick steel with rounded exposed corners and edges, removable panels, glass fibre insulation and integral air outlet and inlet.

.1 Insulation Materials: to ASTM C1071; ensure surfaces exposed to airstream have aluminum-foil facing to prevent erosion of glass fibres.

.1 Thickness: 25mm.

.2 Thermal conductivity (k-Value): 0.037 W/m x K at 24 degrees C mean temperature.

.3 Fire-hazard classification flame-spread index of 25 maximum and smoke-developed index of 50 maximum to ASTM E 84.

.3 Finish with factory applied primer coat.

.4 Hydronic coils: hydrostatically tested to 1 MPa.

.1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.

.5 Fans: centrifugal double width wheels, statically and dynamically balanced, direct driven, sleeve bearings, resilient mounted.

.6 Motor: multi-speed, tapped wound permanent split capacitor type with sleeve bearings, built-in thermal overload protection and resilient rubber isolation mounting.

.1 Include spark free non-ferrous fan construction and explosion proof motor construction in bracket.

.7 Capacity: as indicated.

.8 Control:

.1 Control thermostat: electronic, rating to suit cabinet unit heater, locking cover, set point locking device, concealed adjustment.

2.2 HORIZONTAL UNIT HEATERS

.1 Horizontal Unit Heaters: to UL 2021.

.2 Casing: 1.6 mm thick cold rolled steel, gloss enamel finish, with threaded connections for hanger rods.

.3 Coils: hydrostatically test to 1 MPa.

.1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.

.4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish and fan guard.

.5 Motor: speed as indicated continuous duty, built-in overload protection, and resilient motor explosion proof supports.

.6 Air outlet: four-way adjustable louvres.

.7 Capacity: as indicated

.8 Control room thermostat: electronic, locking cover, set point locking device, concealed adjustment,.

2.3 FORCE FLOW HEATERS

.1 Force Flow heaters: to UL 2021.

.2 Casing: 1.6 mm thick cold rolled steel, glossed enamel finish, with threaded connections for hanger rods.

.3 Coils: hydrostatically test to 1 MPa.

.1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C

.4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish.

.5 Motor: speed as indicated, continuous duty, ball bearing motor with built-in overload protection, and resilient motor supports.

.6 Capacity: as indicated

.7 Control room thermostat: electronic, locking cover, set point locking device, concealed adjustment.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for unit heaters installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Include double swing pipe joints as indicated.

.3 Check final location with Consultant if different from that indicated prior to installation.

.1 Should deviations beyond allowable clearances arise, request and follow Consultant's directive.

.4 Hot water units: for each unit, install ball valve on inlet and lockshield globe balancing valve on outlet of each unit. Install drain valve at low point.

.1 Install manual air vent at high point.

.5 Clean finned tubes and comb straight.

.6 Provide supplementary suspension steel as required.

.7 Install thermostats in locations indicated.

.8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

3.3 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.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by unit heaters installation.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Horizontal cabinet fan coil units. Cabinet shall provide full access to internal components from the side of the cabinet for underfoot installations and side of the cabinet for ceiling installations. Two pipe single coil or four pipe dual coil type as specified.

.2 Vibration isolation.

.3 Controls.

.4 Shop drawings.

1.2 QUALITY ASSURANCE

.1 Each unit shall be CSA approved and labelled.

.2 Insulation and adhesive shall meet NFPA-90A requirements for flame spread and smoke generation.

.3 Radiated sound level from each until (measured at the unit without ceiling tiles or floor panels between the measurement device and the fan coil) shall not exceed the levels indicated as follows:

Frequency [Hz] Octave Sound	Pressure Level [dBa]
30	75
60	75
120	75
250	65
500	65
1000	60
2000	60
4000	55
8000	50

Part 2 Products

2.1 EQUIPMENT

.1 Factory assembled and tested, blow through type fan coil unit for ducted installation in the ceiling space or floor access space as specified. Unit shall be complete with heating water and chilled water coils, direct drive centrifugal fan, internal motor, drain pan, and filters

.2 Fan coil units shall be complete with multi- speed controller accessible from the side of the unit. The speed adjustment shall be done manually through a knob.

.3 For ceiling hung units provide and install vibration isolators, suitable for installing suspended from the structure. Suspension equipment is to be complete with levelers to ensure balanced installation.

.4 Access floor fan coils shall be mounted on vibration isolators. Isolators shall be mounted beside the fan coil cabinet to allow the unit to sit as close to the floor as possible.

.5 Condensate pans to be extended under the cooling coil connections and to have 16mm copper fittings. Ensure that pans are sealed against leakage from the cabinet. Pan to be lined with rubber insulation for sweat proof operation and corrosion resistance. Pan to be rated to be within an air plenum space.

.6 Provide condensate drains to the nearest floor drain (gravity) and empty indirectly into floor drain.

.7 Cooling and/or heating coils are to be designed for a maximum face velocity of 1.8 L/s (

.8 350 fpm) and mounted integral to the fan coil unit. The mounting of loose coils will not be accepted. Coil penetrations of the fan coil cabinet are to be sealed with rubber grommets. Coils are to be factory tested before shipping to site.

.9 Units to be air flow and sound tested prior to shipping.

2.2 UNIT CABINET

.1 Cabinet shall be constructed of 16-gauge galvanized steel or better.

.2 Interior surfaces of cabinet panels shall be lined with 25 mm thick elastomeric closed cell thermal/acoustical insulation. Seal all edges of insulation.

.3 Supply and return duct connections to be complete with flexible duct connections.

.4 Cabinet shall have access panels to allow access to internal components. Floor units shall have panels on the sides. Ceiling units shall have panels on the sides. Panel fasteners are to be stainless steel and panel contact with cabinet is to be lined to maintain air seal and prevent vibrational noise generation.

.5 Drain pan shall be constructed of 18-gauge galvanized steel, extending under the full length and width of the coils and pitched for positive drainage. The inside and outside of the pan shall be fully coated with a fire-retardant, closed-cell foam insulation.

.6 25mm disposable filters shall be furnished and installed in the unit. Filters shall be replaceable from the side of the unit for all ceiling mounted units. Filters are to be no larger than 750mm in any one dimension. Multiple filters are acceptable complete with a filter pull system to allow for filter maintenance from one side only/

.7 Exterior surfaces shall be factory painted.

2.3 FANS

.1 Fans shall be DIDW forward curved direct drive type, constructed of galvanized steel. Units shall have heavy-duty, 14-gauge fan board.

.2 Fan motors shall be ECM motors.

.3 Fan wheels shall be double-width type with forward-curved blades and shall be statically and dynamically balanced.

.4 Fan to be sized to deliver 120% of the specified airflow performance.

.5 All motors shall be 1-phase open drip-proof type, resiliently mounted, incorporating sleeve bearings and automatic reset internal overloads.

.6 For all fancoil units, provide 3-speed manual switch to vary the speed of the motor.

2.4

2.5 CONTROL

.1 Fan coil to receive start-stop signal from BAS system through a contactor switching the power to the fan coil motor. Fan coil units to be controlled via the EMCS system. EMCS contractor to provide fan coil controller.

.2 Refer to sequence of operations and points list in controls section for other controls requirements.

Part 3 Execution

.1 A mock-up installation for each type of fan-coil will be required. One mock-up per type. The installation will be reviewed by the consultant and owner to determine suitability. Any changes to the installation deemed to be required will be incorporated into the final installation of all fan-coil units at no additional cost to the owner.

.2 Coordinate access floor fan coil mock-up to coincide with the access floor system mock-up, as specified in section 10270, to ensure that potential conflicts can be identified and corrected prior to the commencement of full installation.

.3 Install drain line fabricated from type L copper tube. Slope drain away from unit and insulate.

.4 Install isolation valves in coil piping in accordance with valve manufacturer's instructions. Be sure valves are in proper operating position and are easily accessible for adjustment. Provide flow balancing valves on coil return pipes.

.5 Install ceiling mounted units on spring vibration isolators.

.6 Supports, piping, conduit, etc. shall allow for proper access to access panels, filters, etc.

.7 Install vibration isolation & flex connections on all ducts and pipes connected to the fan coil unit.

.8 This Contractor is to ensure that the cabinet or components of the fan coil unit do not make rigid contact with any architectural, structural, electrical, or mechanical components of the building.

.9 Provide in the O&M manual, an 11x17 sized record drawing of the fan coil installation plan overlain on the reflected ceiling plan or access floor grid. This drawing will illustrate the location of the ceiling or floor panels that can be removed for easiest access to fan coil unit for servicing.

.10 Contractor to inform consultant & owner of plans for final filter change one week prior to execution. Consultant & owner may choose to use this opportunity to perform fan coil portion of final inspection.

END OF SECTION

Part 1 General

1.1 REFERENCES

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 humidifiers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit shop drawings to indicate project layout, dimensions and extent of humidification system, and performance.

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

.5 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.6 Manufacturer's Field Reports:

.1 Submit manufacturer's field reports specified.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for humidifiers for incorporation into manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

.1 Extra Materials:

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

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing, for inclusion into operating manual.

.3 Provide following: one complete set of renewable evaporator media.

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 dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect humidifiers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: as specified in Construction Waste Management Plan.

Part 2 Products

2.1 PACKAGED, GAS FIRED, STEAM GENERATOR HUMIDIFIER

.1 Free standing, gas fired steam humidifiers as shown on Drawings.

.2 Components housed in factory fabricated UL/CSA listed enclosure cabinet with access panel and factory baked enamelled finish. Vapourizing chamber, cover fittings to be stainless steel with heli-arc welded seams.

.3 Controls:

.1 Solid state panels with automatic fill and level sensing and self diagnosis controls. Numeric display of setpoint, measured humidity, high limit setpoint, air proving. Keypad control for setpoint adjustments.

.2 Low water cutoff and skimmer bleed-off functions. Solenoid valve on water, skimmer and drain lines.

.3 Return air duct mounted humidistat.

.4 Airflow proving switch.

.5 Adjustable flush cycle timer, surface skimmer with field adjustable flow control.

.4 Duct distribution header complete with condensate drain and supply hose.

.5 Capacity: As indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for humidifiers installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

.1 Install in accordance with manufacturers instructions.

.2 Humidifier and evaporator media to be new and clean when project is accepted.

.3 Install humidistat as indicated

.4 Water service overflow drain: to manufacturers' recommendation.

.5 Install access doors or panels in adjacent ducting.

.6 When installing in ducting, provide waterproof duct up and downstream in accordance with Section 23 31 13 - Metal Ducts - Low Pressure to 500 Pa.

.7 Install capped drain connection at low point in duct.

3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its product[s] and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit immediately to Consultant.

.2 Performance Verification (PV):

.1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.

.2 Timing:

.1 After TAB of ducted air systems.

.2 At same time as PV of related air handling units.

.3 Gas fired steam generator.

.3 Start-up:

.1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.

.2 Verify:

.1 Steam lines are sloped to ensure steam condensate is drained away from the humidifier.

.2 Vapour lines and manifolds are sloped to ensure condensate is drained away from the duct system.

.3 Visually check distribution manifold to ensure:

.1 Even distribution of vapour.

.2 Freedom from water deposits.

.4 Commissioning Reports:

.1 General: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified. Include:

.1 PV results on approved PV Report Forms.

.2 Product Information Report Forms.

3.4 DEMONSTRATION

.1 Training: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel.

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.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 General requirements that are common to National Master Specification sections found in Division 26.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

.2 CSA C282-09, Emergency Electrical Power Supply for Buildings.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)

.1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

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

.1 Material Safety Data Sheets (MSDS).

1.3 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates and labels for control items in English.

1.4 SUBMITTALS

.1 Shop drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Canada.

.2 If changes are required, notify Departmental Representative and Consultant of these changes before they are made.

.3 Provide CSA certified equipment and material.

.4 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction inspection authorities for special approval before delivery to site.

.5 Submit test results of installed electrical systems and instrumentation.

.6 Permits and fees: in accordance with General Conditions of contract.

.7 Submit, upon completion of Work, load balance report as described in PART 3 - Load Balance.

.8 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

1.5 QUALITY ASSURANCE

.1 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.2 Supervise the work at all times through a full time competent electrical superintendent, who could coordinate with other trades.

.3 The installation shall be completely tested and obtain a letter of compliance from the electrical safety inspection authority.

1.6 WARRANTY

.1 The work shall be guaranteed for a period of twelve calendar months after final acceptance.

1.7 SYSTEM STARTUP

.1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.

.2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

.3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant will aspects of its care and operation.

Part 2 Products

2.1 MATERIALS AND EQUIPMENT

.1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - Submittals.

.2 Factory assemble control panels and component assemblies.

2.2 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

.2 Control wiring and conduit, wiring and connections below 50 V which are related to control systems and specified in mechanical sections and as shown on mechanical drawings.

2.3 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of authority having jurisdiction inspection authorities Departmental Representative Consultant.

2.4 WIRING TERMINATIONS

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

2.5 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: Lamicoid, black finish face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.

.2 Label of circuits on wiring devices (e.g. receptacles) shall be Brother Labels black letters on clear tape in occupied spaces. White tape in other areas.

.3 Sizes as follows:

NAMEPLATE SIZES

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

.2 Labels: embossed plastic labels with 6mm high letters unless specified otherwise.

.3 Wording on nameplates and labels to be approved by Consultant prior to manufacture.

.4 Allow for minimum of twenty-five (25) letters per nameplate and label.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

2.6 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

2.7 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15m intervals.

.3 Colours: 25mm wide prime colour and 20mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green

2.8 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint outdoor electrical equipment "equipment green" finish.

.2 Paint indoor switchboard and distribution enclosures ANSI 61grey to EEMAC 2Y-1.

2.9 FIRE-STOPPING

.1 Fire-stop all pipe, duct, conduit, and wire penetrations through floors and walls designated as fire and/or smoke separations.

.2 Fire-stopping materials to meet ULC CAN 2S115.

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per manufacturer’s instructions.

Part 3 Execution

3.1 INSTALLATION

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

.2 Do underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

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

.2 Label circuits on wiring devices. Brothers labels black letters on clear tape in occupied space; white tape in other space.

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.

.1 Sleeves through concrete: schedule 40 steel pipe sized for free passage of conduit, and protruding 50mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

.2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise.

.1 Local switches: 1400mm.

.2 Wall receptacles:

.1 General: 300mm.

.2 In mechanical rooms: 1400mm.

.3 Counter top and barrier free: refer to architectural elevation drawings.

.3 Panelboards: as required by Code or as indicated.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

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

3.7 FIELD QUALITY CONTROL

.1 Load Balance:

.1 The load of any three-phase service shall be reasonably balanced between phases. Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes; 10% to 15% in phase unbalance shall be considered reasonable.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - Submittals: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Conduct following tests:

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.4 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.3 Carry out tests in presence of Departmental Representative.

.4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.5 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

.2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

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

3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for wire and box connectors.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2No.18-98, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.2 CSA C22.2No.65-93(R1999), Wire Connectors.

.2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)

.1 EEMAC 1Y-2, 1961 Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

.3 National Electrical Manufacturers Association (NEMA)

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused wiring materials from landfill to metal recycling facility as approved by Engineer Consultant.

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper sized to fit copper conductors as required.

.2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 NEMA to consist of:

.1 Connector body and stud clamp for stranded copper conductors.

.2 Clamp for stranded copper conductors bar.

.3 Stud clamp bolts.

.4 Bolts for copper conductors.

.5 Sized for conductors as indicated.

.4 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

.1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.

.2 Install fixture type connectors and tighten. Replace insulating cap.

.3 Install bushing stud connectors in accordance with EEMAC 1Y-2 NEMA.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.2 REFERENCES

.1 CSA C22.2 No .0.3-96, Test Methods for Electrical Wires and Cables.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.2 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 BUILDING WIRES

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 1000 V insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

.3 VFD cables: size as indicated, to be used between VFD and motors. Coordinate with mechanical contractor for equipment with VFDs provided by mechanical. VFD rated cable to be minimum 1000 V rated.

Part 3 Execution

3.1 GENERAL CABLE INSTALLATION

.1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).

.2 Cable Colour Coding: to Section 26 05 00 Common Work Results for Electrical.

.3 Conductor length for parallel feeders to be identical.

.4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.5 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.2 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34.

.2 In ducts in accordance with Section 26 05 43.01.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for connectors and terminations.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No. 65-03. Wire Connectors.

.2 CSA C22.2 No.41-M1987(R1999), Grounding and Bonding Equipment.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.

Part 2 Products

2.1 CONNECTORS AND TERMINATIONS

.1 Copper compression connectors to CSA C22.2No.65-03 as required sized for conductors.

.2 2 way joint boxes dry location type in accordance with Section 26 05 32.

.3 Use VFD connectors between VFDs and motor connections.

Part 3 Execution

3.1 INSTALLATION

.1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.

.2 Install VFD connectors between VFDs and motor connections.

.3 Bond and ground as required to CSA C22.2 No.41.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 This section is related to all sections indicated in the Division 26 index.

1.2 COORDINATION

.1 Coordinate installation of ground rods and cables with ground level concrete work specified in Division 03, to provide a complete integrated system.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Submittals Section.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS

.1 Burndy. / Thomas & Betts

2.2 MATERIALS

.1 Grounding and bonding equipment: to CSA C22.2 No. 41-M1987 and as follows:

.1 Ground Rods: 20 mm x 3 m copper clad steel.

.2 Ground Conductors: as specified below.

.3 Ground Grid:

.1 No of ground rods: 3
.2 Interconnect conductors: 3/0 bare copper.
.3 Ground conductors: 3/0 bare copper to system neutral point.

2.3 EQUIPMENT

.1 All grounding components to be high conductivity copper alloy with high conductivity bronze alloy hardware.

.2 Rod electrodes, copper clad steel, 19 mm diameter x 3 m long.

.3 System, circuit, and equipment grounding conductors, bare stranded copper, soft annealed, size as indicated or required by Canadian Electrical Code.

.4 Insulated grounding conductors with green insulation.

.5 Main electrical room ground bus to be Ilsco Type PDB-412-500, quantity of two (2). No equivalents.

.6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Bonding jumpers, straps.

.5 Pressure wire connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Conform to CSA C22.2 No. 0.4-M1982 and Canadian Electrical Code.

.2 Install complete, permanent, and continuous system, circuit, and equipment grounding systems including electrodes, conductors, connectors, and accessories as indicated, to conform to requirements of Engineer, and local authority having jurisdiction over installation.

.3 Install connectors in accordance with manufacturer’s instructions.

.4 Protect exposed grounding conductors from mechanical injury.

.5 Make buried connections, and connections to conductive water main, electrodes, using copper mechanical connections.

.6 Use mechanical connectors for grounding connections to equipment provided with lugs.

.7 Protect exposed ground conductors from mechanical injury.

.8 Soldered joints not permitted.

.9 Install separate ground conductor in all underground ducts, and all conduits having "PVC" as part of run.

.10 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections. Switchgear should be grounded via both ends to a single ground point.

.11 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

3.2 ELECTRODES

.1 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails.

3.3 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of secondary 120/208V system.

.2 Provide ground conductor to water main line of water meter.

.3 Provide flexible copper bonding jumper around water meter, associated unions and valves to ground building side of water system.

.4 Provide ground grid with two ground conductors from grid to system neutral point.

3.4 PADMOUNT TRANSFORMER GROUNDING

.1 Provide the following:

.1 Grounding to utility requirement

3.5 GROUND CONDUCTORS

.1 Use bare ground conductors for the following:

		Size
.1	Service Entrance:	4/0
.2	Main Distribution Centre:	4/0
.3	Padmount Transformer:	Per utility requirement

.2 Use green insulated ground conductors for the following:

.1 Circuit Ground Conductors

.2 Bonding Jumpers

.3 Gas Pipe Grounding

.4 Post Light Grounding

.5 Metallic Waste Water Piping Grounding

.6 Fire Alarm System

.7 Public Address System

3.6 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment including but not necessarily limited to the following list:

.1 Service equipment, transformers, switchgear, duct systems, frames, motors, starters, control panels, building steel work, distribution panels, outdoor lighting, telephone system, fire alarm system, security system.

3.7 GROUNDING BUS

.1 Install copper grounding bus mounted on insulated supports on wall of electrical room.

3.8 PERMAFROST AND HIGH RESISTIVITY EARTH

.1 Bond non-current carrying metal parts together with size #6 AWG copper equipotential conductor. Run conductor from separate lug on electrical room ground bus to, but not necessarily limited to, following indoor systems and equipment:

.1 Hot water heating system.

.2 Water pipe.

.3 Main building drain.

.4 Oil line.

.5 Telephone, radio/TV, data, system conduits.

.6 Make connections to pipes on building side of main valves and tanks.

.2 Install insulated ground wire from service neutral bar to rods, and where buried, use bare copper not smaller than size #2 AWG, 7-strand, and buried at least 460 mm below ground. Bond ground conductor, or short tap from it, to outside metal sheathing of building (if applicable) close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut, and washers (not sheet metal screw or wood screw). Remove paint from sheathing for good contact. Conduit is required only on outside wall of building. Indoors, run bare and fasten as specified for equipotential bonding wire.

.3 Install electrode interconnections where metal parts, circuits, or grounding conductors and/or electrodes are in proximity to lightning rod conductors.

3.9 FIELD QUALITY CONTROL

.1 Perform ground continuity and resistance tests using method appropriate to site conditions, and to approval of Engineer and local authority having jurisdiction over installation.

.2 Perform tests before energizing electrical system.

.3 Testing to be done as follows:

.1 Test complete grounding system, connected as specified, from main service ground bus in electrical room to grounding points (rods and piles or footings).

.2 Tabulate data and present to Engineer for review.

.3 Ensure use of a recognized, commercially available ground resistance tester operator by trained personnel. Use the three-point method as described by IEEE Std. 141-1993.

END OF SECTION

Part 1 General

1.1 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused metal materials from landfill to metal recycling facility as approved by Engineer.

.4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 SUPPORT CHANNELS

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

.2 All threaded rods shall be galvanized.

Part 3 Execution

3.1 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 steel straps to secure surface conduits and cables 50 mm and smaller.
- .2 Two-hole steel straps for conduits and cables larger than 50 mm.
- .3 Beam clamps to secure conduit to exposed steel work.

.6 Suspended support systems.

- .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.7 For surface mounting of two or more conduits use channels at 3000mm on centre spacing.

.8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.10 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.

.12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General

1.1 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data for cabinets.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

.2 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

Part 3 Execution

3.1 JUNCTION AND PULL BOXES INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

.2 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.2 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name voltage and phase.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CAN/CSA C22.2 No. 18-98, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 CONDUIT BOXES

.1 Cast FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.4 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.

2.5 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.

Part 3 Execution

3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International), the latest version

.1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.

.2 CSA C22.2 No. 45, Rigid Metal Conduit.

.3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.

.4 CSA C22.2 No. 83, Electrical Metallic Tubing.

.5 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.

.6 CAN/CSA C22.2 No. 227.3, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 SUBMITTALS

.1 Product data: submit manufacturer's printed product literature, specifications and datasheets.

.1 Submit cable manufacturing data.

.2 Quality assurance submittals:

.1 Test reports: submit certified test reports.

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

.3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Place materials defined as hazardous or toxic waste in designated containers.

.2 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 CABLES AND REELS

.1 Provide cables on reels or coils.

.1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.

.2 Each coil or reel of cable to contain only one continuous cable without splices.

.3 Identify cables for exclusively dc applications.

2.2 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.

.2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.

.3 Rigid pvc conduit: to CSA C22.2 No. 211.2.

.4 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.3 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller.

.1 Two hole steel straps for conduits larger than 50 mm.

.2 Beam clamps to secure conduits to exposed steel work.

.3 Channel type supports for two or more conduits at 3 m on centre.

.4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

.1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.

.2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.

.3 Watertight connectors and couplings for EMT.

.1 Set-screws are not acceptable.

2.5 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Run extra 4" conduit in main run locations.

.3 Conceal conduits except in mechanical and electrical service rooms, and in unfinished areas.

.4 Use rigid galvanized steel threaded conduit in main electrical service from outside, to outdoor chillers/generator, and subject to mechanical injury.

.5 Use electrical metallic tubing (EMT) above 2.4 m not subject to mechanical injury.

.6 Use rigid pvc conduit underground in corrosive areas.

.7 Final connections to all mechanical and electrical equipment to be with liquid tight flex and approved liquid tight flex connectors. Drops to luminaires are to be with AC90 wire. Hook up all surface mounted fixtures with electrical metallic conduit.

.8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in all locations.

.9 Minimum conduit size for lighting and power circuits: 21 mm.

.10 Install EMT conduit from computer room branch circuit panel to outlet boxes located in sub floor.

.11 Bend conduit cold:

.1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.12 Mechanically bend steel conduit over 19 mm diameter.

.13 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.14 Install fish cord in empty conduits.

.15 Remove and replace blocked conduit sections.

.1 Do not use liquids to clean out conduits.

.16 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

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

3.4 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

3.5 CONDUITS IN CAST-IN-PLACE CONCRETE

.1 Locate to suit reinforcing steel.

.1 Install in centre one third of slab.

.2 Protect conduits from damage where they stub out of concrete.

.3 Install sleeves where conduits pass through slab or wall.

.4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed.

.1 Use cold mastic between sleeve and conduit.

.5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.

.6 Encase conduits completely in concrete with minimum 25 mm concrete cover.

.7 Organize conduits in slab to minimize cross-overs.

3.6 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

.1 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.

.1 Provide 50 mm of sand over concrete envelope below floor slab.

3.7 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

3.8 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.9 CONDUIT INSTALLATION SCHEDULE

Conduit Type	Application
Galvanized Rigid Steel	- All service entrance elbows. - Conduit stub-ups in concrete floors. - Hazardous areas.
PVC Externally Coated Rigid Steel	- Corrosive areas.
Epoxy Coated Rigid Steel	- Corrosive areas.
Rigid Aluminum	- Heating cables.
Rigid Type EB1 PVC	- Exterior or interior, concrete encased, within masonry walls, conduit runs
Rigid Type DB2/ES2 PVC	- Service entrances.
Rigid Fiberglass Reinforced Epoxy	- Service entrances. - Exterior, concrete encased, conduit runs
Flexible Metal	- Connections to luminaires. - Connections to control devices.

cont'd

3.7 CONDUIT INSTALLATION SCHEDULE (CONT'D)

Conduit Type		Application
Liquid-tight Flexible Metal	-	Connections to motors.
	-	Connections to equipment in damp locations.
Polyethylene Pipe or Flexible Plastic Underground Power Cable Ducting	-	Mechanical protection of direct buried conductors for car plug-ins.
EMT	-	All other applications.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.1 No.126.1-02, Metal Cable Tray Systems.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA FG 1-1993, Fibreglass and Cable Tray Systems.

.2 NEMA VE 1-2002, Metal Cable Tray Systems.

.3 NEMA VE 2-2001, Cable Tray Installation Guidelines.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.

.2 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.

.3 Cablofil or approved equal cable tray shall be used.

.4 Show actual cabletrough installation details and suspension system.

Part 2 Products

2.1 CABLETROUGH

.1 Cabletroughs and fittings: to CAN/CSA C22.1 No. 126.1.

.2 Wire mesh type, Class A, C1, D1 or E as per data cabling quantities installed in that tray to CAN/CSA C22.2 No.126.1.

.3 Trays: extruded aluminum, 600 mm wide with depth of 150 mm.

.4 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reducers where required, manufactured accessories for cabletrough supplied.

.1 Radii on fittings: 600 mm minimum.

.5 Solid covers for complete cabletrough system including fittings.

.6 Barriers where different voltage systems are in same cabletrough.

.7 Ground cable trays with #2 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.

.8 Provide fire stop material at firewall penetrations.

2.2 SUPPORTS

.1 Provide splices, supports for a continuously grounded system as required.

Part 3 Execution

3.1 INSTALLATION

.1 Install complete cabletrough system in accordance with NEMA VE 2.

.2 Support cabletrough on both sides.

.3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.4 Grounding bushing shall be used on EMT bonded to cable tray for grounding.

3.2 CABLES IN CABLETROUGH

.1 Install cables individually.

.2 Lay cables into cabletrough. Use rollers when necessary to pull cables.

.3 Secure cables in cabletrough at 6 m centres, with nylon ties.

.4 Identify cables every 30 m with size 2 nameplates in accordance with Section 26 05 00.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CSA C22.2 No.26-1952(R2009), Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for wireways and auxiliary gutters and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for wireways and auxiliary gutters for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect wireways and auxiliary gutters from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 WIREWAYS

.1 Wireways and fittings: to CSA C22.2 No.26.

.2 Sheet steel with hinged cover to give uninterrupted access.

.3 Finish: baked grey enamel in accordance with Section 26 05 00 - Common Work Results for Electrical.

.4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wireways and auxiliary gutters 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 INSTALLATION

.1 Install wireways and auxiliary gutters in accordance with manufacturer's written recommendations.

.2 Keep number of elbows, offsets, connections to minimum.

.3 Install supports, elbows, tees, connectors, fittings.

.4 Install barriers where required.

.5 Install gutter to full length of equipment.

.6 Ground metallic wireways and gutters as required.

3.3 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 Waste Management: separate waste materials for reuse & recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 Canadian Standards Association, (CSA International)

.2 Insulated Cable Engineers Association, Inc. (ICEA)

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Engineer.

.5 Do not dispose of preservative treated wood through incineration.

.6 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.

.7 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Engineer.

.8 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Execution

2.1 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.1 Do not pull spliced cables inside ducts.

.2 Install multiple cables in duct simultaneously.

.3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.5 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.6 After installation of cables, seal duct ends with duct sealing compound.

2.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.

.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 tests.

- .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 ICEA recommendations.
- .4 Leakage Current Testing.
  - .1 Raise voltage in steps from zero to maximum values as specified by ICEA for type of cable being tested.
  - .2 Hold maximum voltage for specified time period by ICEA manufacturer.
  - .3 Record leakage current at each step.

.7 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.

.8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C39.1-1981, Requirements, Electrical Analog Indicating Instruments.

.2 CSA International

.1 CAN3-C17-M84(R2008), Alternating - Current Electricity Metering.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with General Requirements Specification.

.2 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for metering and switchboard instruments and includes product characteristics, performance criteria, physical size, finish and limitations.

.2 Include meter, instrument, outline dimensions, panel drilling dimensions and installation cutout template.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect metering and switchboard instruments from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 METER

.1 Main customer meter in new main switchboard refers to drawing Single Line Diagram. Meter to be utility meter.

2.2 METER SOCKET

.1 Meter sockets to suit meters with automatic current transformer shorting devices when meter removed.

2.3 METERING INSTRUMENT TRANSFORMER CABINET

.1 Sheet steel CSA enclosure to accommodate potential and current transformers.

2.4 TEST TERMINAL BLOCKS

.1 Test terminal blocks: as required.

2.5 INDICATING INSTRUMENTS

.1 Indicating instruments: ANSI C39.1, 1% accuracy, switchboard mounting, flush.

- .1 Ammeter: average reading range as indicated.
- .2 Voltmeter: average reading range as indicated.
- .3 Wattmeter: range as indicated.
- .4 Varmeter: range as indicated.
- .5 Frequency meter: range as indicated.
- .6 Power factor meter: range as indicated.
- .7 Synchroscope: range as indicated.

2.6 INSTRUMENT SELECTOR SWITCHES

.1 Voltmeter Ammeter selector switches: rotary, multi-position, maintained contacts, panel mounting, round notched handle, rated to suit instruments, nameplate marked as indicated to coincide with each rotary position. Ammeter selector switches designed to preclude opening of current circuits.

.2 Four position ammeter selector switches identified "off-A-B-C".

.3 Four position voltmeter selector switches identified "A-B, B-C, C-A, off".

.4 Seven position voltmeter selector switches identified "A-B, B-C, C-A, off, A-N, B-N, C-N".

2.7 SHOP INSTALLATION

.1 Install meters and instrument transformers in separate compartment of switchboard.

.2 Install instruments on switchboard.

.3 Ensure adequate spacing between current transformers installed on each phase.

.4 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, electrical supplies.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metering and switchboard instruments 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 METERING INSTALLATION

.1 Install meters instruments in location free from vibration and shock.

.2 Make connections in accordance with diagrams.

.3 If applicable, ensure power factor corrective equipment connected on load side of meter.

.4 Connect meter and instrument transformer cabinets to ground.

.5 Locate meters within 9 m of instrument transformers.

.1 Use 32 mm conduit for interconnections.

.2 Use separate conduit for each set of current transformer connections, exclusive for metering.

3.3 FIELD QUALITY CONTROL

.1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical and in accordance with manufacturer's recommendations.

.2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.

.3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.

.4 Perform tests to obtain correct calibration.

.5 Do not dismantle meters and instruments.

3.4 CLEANING

.1 Progress Cleaning: 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 00 10 – General Requirements.

3.5 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by metering and switchboard instrument installation.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 The work covered in this section is subject to all of the requirements in the General Conditions of the Specifications. Contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system. All Labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery and installation of the work of this Section.

1.2 DESCRIPTION OF WORK

.1 Furnish and install a complete system for the control of lighting and other equipment as indicated on the plans, detailed in the manufacturer submittal and as further defined herein. Contractor is solely responsible to verify quantity, installation locations and wiring requirements for this project. Specific manufacturer's catalog numbers, when listed in this section are for reference only. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.

.2 The system shall include but not be limited by the following list: Pre-wired, microprocessor controlled relay or dimming panels with latching relays controlled via a complete list of communication based accessories including digital switches, digital photocells, Digital Time Clock (DTC) and interface cards to dimming systems, building automation systems, thermostats, and other devices. The type of lighting control equipment and wiring specified in this section is covered by the description: Microprocessor Controlled Digital Lighting Control system with RS 485 Bus communications. Requirements are indicated elsewhere in these specifications for work including, but not limited to, raceways and electrical boxes and fittings required for installation of control equipment and wiring. They are not the work of this section.

1.3 SUBMITTALS

.1 Shop Drawings: Submit dimensioned drawings of lighting control system and accessories including, but not necessarily limited to, relay panels, switches, DTC, photocells and other interfaces. Shop drawings shall indicate exact location of each device or a RFI to confirm location. Plans are diagrammatical. EC to verify all lighting control material requirements from approved shop drawings. "Cut Sheet" submittal not acceptable.

.2 Product Data: Submit for approval manufacturer's data on the specific lighting control system and components. Submittal shall be electronic format with hard copy available. To prevent departures from approved system operation, electronic files submitted shall be able to be directly downloaded to the specified system at manufacturer facility. Submit a complete bill of materials with part numbers, description and voltage specifications.

.3 Manufacturer shall provide free software that can be used to specify the system, detail all programming and generate a single line in a format that can be dropped into industry standard CAD packages.

.4 One Line Diagram: Submit a one-line diagram of the system configuration indicating the type, size and number of conductors between each component. Diagram is to include lighting control system showing the location of each zone and associated switches. Submittals that show typical riser diagrams are not acceptable.

1.4 QUALITY ASSURANCE

.1 Control wiring shall be in accordance with the CSA C22.1 requirements for Class 2 remote control systems and manufacturer specification.

.2 A licensed electrician shall functionally test each system component after installation, verify proper operation and confirm that all relay and dimming panels and switch wiring conform to the wiring documentation.

.3 Comply with CSA C22.1 and all local and provincial codes as applicable to electrical wiring work.

.4 Lighting control panels shall be UL 916 Listed. LCPs controlling emergency circuits shall be listed to C22.2 Nos. 250, 107.1, 141, 250. Relay panels shall also be listed to comply with CSA C22.2#205 Emergency source circuits controlled in normal operation by a relay panel shall fully comply with CSA C22.1. Electrical contractor is responsible for verifying compliance.

.5 The lighting control system shall be listed, approved and comply as required with all national, provincial and local energy codes.

1.5 MAINTENANCE MATERIALS

.1 Division 1 - Execution Requirements: Spare parts and maintenance products.

.2 Provide 10% spare relays per LCP, up to the maximum capacity of the LCP.

.3 Provide CD version of manufacturers operating software to include graphical interface software.

.4 Provide 2 extra sets of as-built and operating manuals.

1.6 SYSTEM DESCRIPTION

.1 The lighting control system is a networked system that communicates via RS485. The system must be able to communicate with fully digital centralized relay panels, small distributed relay panels (Available with 0-10Volt dimming outputs, Fully distributed fixture level control by bus connected relays or dimmers, digital switches, photocells, various interfaces and operational software. The intent of the specification is to integrate all lighting control into one system. Distributed lighting control shall be provided using networked micro relay panels or bus connected fixture level control. Lighting control system shall include all hardware and software. Software shall be resident within the

lighting control system. System shall provide local access to all programming functions at the master LCP and remote access to all programming functions via dial up modem and through any standard computer workstation. Lighting control system shall have the capability to be remotely controlled via the internet or building wide Ethernet LAN. Desktop computers are not part of this section and will be provided by others.

.2 System software shall provide real time status of each relay, each zone and each group.

.3 Lighting control system shall be able to be monitored by and take commands from a remote PC. At any time, should the remote PC go off-line all system programming uploaded to the lighting control system shall continue to operate as intended. Systems requiring an on line PC or server for normal operation are not acceptable

.4 All devices shall be pre-addressed at the factory. If required by the client the system may be specified without pre-addressing and simple software is to be provided to simplify addressing in place. This particularly applies to fixture level control where controls may be factory mounted on the fixture in advance to speed installation.

.5 All programs, schedules, time of day, etc, shall be held in non-volatile memory for an indefinite time exceeding ten years in the event of power failure. At restoration of power, lighting control system shall implement programs required by current time and date. Time of day shall be battery backed for at least ten years.

.6 System shall be capable of warning of an impending off sweep by flashing lights Off/On once or twice (programmable) by relay or by zone prior to the lights being turned off. The warning interval times between the flash and the final lights off signal shall be definable for each zone. Additionally an audible signal shall be able to be programmed that gives a mild note on the first flash and a more insistent signal on the second one. Occupant shall be able to override any scheduled Off sweep using local wall switches within the occupied space. Occupant override time shall be locally and remotely programmable and not exceed 2-hours.

.7 The system shall be capable of implementing On commands, Off commands, Raise (dimming) commands, Lower (dimming) commands for any relay, group or zone by means of digital wall switches, contact closure switches, time clock schedules including offsets from dusk and dawn by up to ten hours, photocell, pc software or other devices connected to programmable inputs in a lighting control panel.

.8 The lighting control system shall provide the ability to control each relay and each relay group per this specifications requirement. All programming and scheduling shall be able to be done locally at the master LCP and remotely via dial up modem or via the Internet. Remote connection to the lighting control system shall provide real time control and real time feedback.

.9 Micro relay panels shall be capable of taking inputs from contact closure switches and outputting up to 8 independent 0v to 10v dimming signals. All micro relay panels and all devices connected to micro relay panels (switches, photocells and occupancy sensors, etc) shall be wired per lighting control manufacturer’s instructions.

.10 Networked relays or dimming modules shall be fed from a router. Individual modules are fed from the LCP panel on a separate bus. Each router may feed two strings of up to 64 modules on a 2000ft string. Each Module may be a single relay, a dual relay or a dimming (0-10Volt) module. Relays in the modules are to be capable of being separately controlled in the same manner as an individual relay or dimmer in a relay or dimmer panel. Additionally multiple relays may be collected together to act together as a single multi-pole load or dimmer for ease of programming. Graphical software shall be available that does these assignments and reassignments in a straightforward and logical manner. Relays shall have the same specifications as laid out in 2.1.3. Modules with reduced current ratings may be supplied with Quick Connect connectors for more rapid installation.

Part 2 Products

2.1 MATERIAL AND COMPONENTS

.1 Relay Panels:

.1 All LCP's shall be in CSA Type 1 rated enclosure with screw cover or hinged Locking door. Other CSA rated types optional.

.2 A barrier shall separate the high voltage and low voltage compartments of the panel.

.3 LCP input power shall be capable of accepting 120Vac.

.4 Control electronics in the low voltage section shall be capable of driving 2 to 48 relays (rated as per Section 2.1.3), control any individual or group of relays, provide individual relay overrides, provide a master override for each panel, store all programming in non-volatile memory, after power is restored return system to the correct state for time of day, provide programmable dual blink warn timers for each relay or zone of relays, and be able to control Normally Open Latching (NOL) or Normally Closed Latching (NCL) relays.

.5 Lighting control system shall be digital and consist of a Master LCP, Remote LCPs, Micro LCPs with up to 8 individual relays, Router and associated relays or dimmers emulating standard or Micro LCPs, digital switches, digital interface cards and if required. All system components shall connect and be controlled via Category 5, 4 twisted pair cable with RJ45 connectors, providing real time two-way communication with each system component. All Micro LCP's shall provide multiple inputs for photocells and occupancy sensors. Analog systems are not acceptable.

.2 Micro Relay Panels

.1 Micro relay panels shall have from 2 to 8 relays (rated as per Section 2.1.3) and shall control all lighting in the designated area indicated on the plans and be part of the lighting control network. Each micro relay panel shall provide minimum 300ma at 12/24vdc for powering occupancy sensors. Micro relay panels that require a separate occupancy sensor power pack are not acceptable.

.2 Micro relay panel shall provide a minimum of 4-programmable photocell inputs, a minimum of 8-programmable occupancy sensor contact closure inputs. This requirement is to insure integration of entire lighting system into one networked, lighting control system.

.3 Micro relay panels shall be capable of outputting a minimum of 4 and up to 8 independent 0v to 10v dimming signals, one independent dimming signal per relay for each of 8 relays. In order to maximize daylight harvesting and minimize disruption to occupants, each dimming output shall provide adjustment for baseline, start point, midpoint, end point, trim, fade up rate, fade down rate, time delay and enable/disable masking. All photocell settings must be remotely accessible. Systems providing On, Off with Time Delay only, and system that do not provide remote access are not acceptable.

.4 MicroPanels shall have built in capability to take commands from a fully compatible wireless switch. Wireless switch shall contain no battery; have 32-bit unique ID and a minimum 90-foot range line of sight.

.3 Standard Output relays

.1 ULC Listed 30 Amp at 120VAC fluorescent and HID and 20 Amp at 120 Vac LED.

.2 Relays shall be individually replaceable. Relay terminal blocks shall be capable of accepting two (2) #8AWG wires on both the line and the load side. Systems that do not allow for individual relay replacement or additions are not acceptable. Relays to be rated for 250,000 operations minimum at a full 30a lighting load. Standard relay shall default to closed at normal power loss, Normally Closed Latching (NCL).

.3 Optional relay types available shall include: Normally Open Latching (NOL) relay rated for 250,000 operations, a 600v 2-pole NO and NC and a Single Pole, Double Throw (SPDT) relay.

.4 Low Voltage Switches

.1 All switches shall be digital and communicate via RS 485. Contact closure style switches, except as specified for connection to the micro relay panel programmable contact closure inputs, shall not be acceptable. The programming for a digital switch shall reside in the switch itself, via double EPROM memory. Any digital switch button function shall be able to be changed locally (at the DTC or a PC) or remotely, via modem, Internet or Ethernet.

.2 Digital low voltage switch shall be a device that sits on the lighting control system bus. Digital switch shall connect to the system bus using the same cable and connection method required for relay panels. Each button shall be capable of being programmed for On only, Off only, Mix (Some on some off), On/Off (toggle), Raise (Dim up) and Lower (Dim down). Further each button shall be able to be enabled or disabled over the bus. An audible alarm shall be available on all switches that can be programmed to beep on button push or with warning light blinks.

.3 Keyed switches shall be similarly programmable and connect to the lighting control system bus.

.4 Digital switches for high abuse areas (common areas, etc.) shall be vandal resistant, contain no moving parts, and be touch sensitive and available with up to two buttons in a single gang. Multi gang versions shall also be available. Touch pads shall be Stainless Steel and capable of handling both high abuse and wash down locations. High abuse switches shall connect to the lighting control system digital bus. Each high abuse touch button shall be able to be programmed

in the same way as other digital switch buttons. Switches must be capable of handling electrostatic discharges of at least 30,000 volts (1cmspark) without any interruption or failure in operation.

.5 Wireless Switches-System shall have the capability to accept inputs from 32-bit unique ID wireless switches. Wireless switches shall have no battery and be capable of On, Off, Raise and Lower commands. Wireless switches shall have a minimum 90 foot line of sight range

.6 DTC - Digital Electronic Time Clock

.1 A Digital Time Clock (DTC) shall control and program the entire lighting control system and supply all time functions and accept modem (RS232) inputs.

.2 DTC shall be capable of up to 32 schedules. Each schedule shall consist of one set of On and Off times per day for each day of the week and for each of two holiday lists. The schedules shall apply to any individual relay or group of relays.

.3 The DTC shall be capable of controlling digital devices at up to 127 addresses on a single bus and capable of interfacing digitally with other buses using manufacturer supplied interface cards.

.4 The DTC shall accept control locally using built in button prompts and use of an 8 line 21-space display or from a computer or modem via an on-board RS 232 port. All commands shall be in plain English. The DTC shall be run from non-volatile memory so that all system programming is retained indefinitely and time of day is battery backed for up to 10 years.

.5 Lighting control software shall provide via local or remote PC a visual representation of each device on the bus, show real time status and the ability to change the status of any individual device, relay or zone. Lighting control software shall provide for importing vector based graphics and a simple interface that allows users or a factory programmer to overlay color “controls” that are associated with relays or collections of relays. Clicking on the overlays changes the color and the status of the relays for visual display of large systems.

.6 System shall come with a pre-Installed modem that allows for remote programming from any location using a PC and free remote control software.

.7 DTC shall provide system wide timed overrides. Any relay, group or zone that is overridden ON, before or after hours, shall automatically be swept OFF by the DTC a maximum of 2 hours later.

.7 PHOTOCELL: Photocells to be mounted in location indicated on the plans. Photocells used for exterior lights shall provide multiple trip points from 1 roof mounted unit. All trip points shall be able to be changed remotely via Internet or dial up modem. Photocells requiring manual trip point adjustment are not acceptable. Photocell used for interior lighting control shall have multiple settings such as start-point, mid-point, off-point, fade-up, fade-down, etc. All settings shall be remotely accessible and adjustable. Systems providing local adjustment only are not acceptable. Photocells to be certified to comply with the current energy code covering this project at time of submittal of plans for building permit.

.8 Interfaces: For future expansion capability, systems are to have available all of the following interfaces. Verify and install only those interfaces indicated on the plans.

.1 A dry contact input interface card that provides 14 programmable dry contact closure inputs. Use shielded cable to connect input devices to interface card on runs over 200ft.

.2 Uplink Interface card that allows a single bus to be part of a greater system connected together by a Back Bone Bus. The back Bone bus requires a server for the Modem and Ethernet connections to such a large system.

.3 When Lighting control software is specified full graphic pages shall be designed to the owner's specifications. Owner is to provide to manufacturer all necessary files and criteria.

.4 Direct digital interface to DMX 512 based systems. DMX interface shall provide 14 global commands, each of which can be modified locally or remotely using lighting controls manufacturer supplied software. DMX interface shall be integral to the system bus and shall connect and be controlled via a single Category 5, 4 twisted pair cable, providing real time response from the lighting control system to DMX commands.

.5 Direct digital interface to building automation systems using DDC protocols such as BACnet that accept on/off commands, time schedules and report status of all relays in all panels in real time. Interface cards shall "self populate" each individual relay and each group to the BAS. All BAS system programming required shall be the responsibility of the BAS system provider.

Part 3 Execution

3.1 EQUIPMENT INSTALLATION

.1 Mount relay control cabinets adjacent to respective lighting panel board. Cabinet shall be surface or flush mount, per plans. Wiring between relay control cabinets and panelboards shall be in accordance with local codes and acceptable industry standards. Under no circumstances will any extra payment be authorized for the EC or GC due to the EC's lack of knowledge or understanding of any and all prevailing codes or specified manufacturer's installation requirements. Neatly lace and rack wiring in cabinets. During construction process, protect all interior components of each relay panel and each digital switch from dust and debris. Any damage done to electronic components due to failure to protect them shall be the sole responsibility of the installing contractor.

.2 Switches: Provide outlet boxes, single or multi-gang, as shown on the plans for the low voltage digital switches. Mount switches as per plans. Supply faceplates per plans and specifications. EC is specifically responsible to supply and install the required low voltage cable, Category 5, 4 twisted pair, with RJ45 connectors (commonly referred to as Cat 5 patch cable) between all switches and panels. Field-test all Cat 5 patch cable with a recognized cable tester. All low voltage wire to be run in conduit, per local codes.

.3 Lighting control system manufacturer to provide on all systems of more than 2 panels a crimping kit with sufficient approved EZ Brand RJ 45 connectors to populate the whole system. A simple manual that shows all the pitfalls of crimping RJ 45s and how to do it right must be both provided and read by the installing contractor.

.4 Wiring

.1 Do not mix low voltage and high voltage conductors in the same conduit.

.2 Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.

.3 Place manufacturer supplied “terminators” at each end of the system bus per manufacturer’s instructions.

.4 Plug in Category 5 patch cable with RJ45 end connector that has been field-tested with a recognized cable tester, at the indicated RJ45 connector provided at each lighting control device, per manufacturer’s instructions.

.5 Use Category 5 patch cable for all system low voltage connections. Additional conductors may be required to compensate for voltage drop with specific system designs. Use shielded cable for dry contact inputs on runs over 200ft.

.6 Do not exceed 4000ft-wire length for the system bus.

.7 All items on the bus shall be connected in sequence (daisy chained). Star and spur topologies are not acceptable.

.8 The specified lighting control system shall be installed by the electrical contractor who shall make all necessary wiring connections to external devices and equipment, to include photocell. EC to wire per manufacturer instructions.

3.2 INSTALLATION AND SET-UP

.1 Verify that conduit for line voltage wires enters panel in line voltage areas and conduit for low-voltage control wires enters panel in low-voltage areas. Refer to manufacturer's plans and approved shop drawings for location of line and low-voltage areas. This is especially applicable in jobs where back boxes are shipped in advance. It is the responsibility of the contractor to verify with lighting control manufacturer all catalog information and specific product acceptability.

.2 For approved contact closure switches, use #18 AWG stranded conductors. For all other digital switches, provide wiring required by system manufacturer.

.3 For classroom digital switches provide wiring required by system manufacturer

.4 Contractor to test all low voltage cable for integrity and proper operation prior to turn over. Verify with system manufacturer all wiring and testing requirements.

.5 Before Substantial Completion, arrange and provide a one-day Owner instruction period to designated Owner personnel. Set-up, commissioning of the lighting control system and Owner instruction includes:

.1 Confirmation of entire system operation and communication to each device

.2 Confirmation of operation of individual relays, switches, occupancy sensors and daylight sensors

.3 Confirmation of system Programming, photocell settings, override settings, etc.

.4 Provide training to cover installation, maintenance, troubleshooting, programming, and repair and operation of the lighting control system.

.6 Panels shall be located so that they are readily accessible and not exposed to physical damage.

.7 Panel locations shall be furnished with sufficient working space around panels to comply with the Canadian Electric Electrical Code.

.8 Panels shall be securely fastened to the mounting surface by at least 4 points.

.9 Unused openings in the cabinet shall be effectively closed.

.10 Cabinets shall be grounded as specified in the Canadian Electrical Code.

.11 Lugs shall be suitable and listed for installation with the conductor being connected

.12 Conductor lengths shall be maintained to a minimum within the wiring gutter space. Conductors shall be long enough to reach the terminal location in a manner that avoids strain on the connecting lugs.

.13 Maintain the required bending radius of conductors inside cabinets.

.14 Clean cabinets of foreign material such as cement, plaster and paint.

.15 Distribute and arrange conductors neatly in the wiring gutters.

.16 Follow the manufacturer's torque values to tighten lugs.

.17 Before energizing a panel, the following steps shall be taken:

.1 Retighten relay connections to the manufacturer's torque specifications. Verify that required connections have been furnished.

.2 Remove shipping blocks from component devices and the panel interior.

.3 Remove debris from panel interior.

.18 Follow manufacturer’s instructions for installation and all low voltage wiring.

.19 Service and Operation Manuals:

.1 Submit operation and service manuals. Complete manuals shall be bound in flexible binders and data shall be typewritten or drafted.

.2 Manuals shall include instructions necessary for proper operation and servicing of system and shall include complete wiring circuit diagrams of system, wiring destination schedules for circuits and replacement part numbers. Manuals shall include as-built cable Project site plot plans and floor plans indicating cables, both underground and in each building with conduit, and as-built color coding used on cables. Programming forms of systems shall be submitted with complete information.

.20 Comply with energy code lighting control system “Acceptance Requirements”. Acceptance tests are used to verify that lighting controls were installed and calibrated correctly. These tests may require that a responsible party certify that controls are installed and calibrated properly. This is the installing contractor’s responsibility. Verify requirements with building authority.

3.3 DOCUMENTATION

.1 Each relay shall have an identification label indicating the originating branch circuit number and panelboard name as indicated on the drawings. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.

.2 Provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate exact mounting location of each system device. This accurate “as built” shall indicate the loads controlled by each relay and the identification number for that relay, placement of switches and location of photocell. Original to be given to owner, copies placed inside the door of each LCP.

3.4 SERVICE AND SUPPORT

.1 Start Up: EC shall contact lighting control system manufacturer at least 7 days before turnover of project. The manufacturer will remotely dial into the lighting control system, run diagnostics and confirm system programming. EC shall be available at the time of dial in to perform any corrections required by manufacturer. EC is responsible for coordinating with GC and the owner the installation of a dedicated telephone line or a shared phone line with an automatic Fax/Modem switch. Phone jack to be mounted within 12” of Master LCP. Label jack with phone number. EC to connect phone line from jack to Master LCP.

.2 Telephone factory support shall be available at no additional cost to the EC or Owner both during and after the warranty period. Factory to pre-program the lighting control system per plans and approved submittal, to the extent data is available. The specified lighting control system manufacturer, at no added cost, shall provide additional remote programming via modem as required by the EC or Owner for as long as a phone line is available for the life of the system. Upon request manufacturer to provide remote dial up software at no added cost to system owner. No exceptions.

.3 Provide a factory technician for on-site training of the owners’ representatives and maintenance personnel. Coordinate timing with General Contractor. Provide one day of factory on-site training.

3.5 CLEANING

.1 Division 1 - Execution Requirements: Final cleaning.

.2 Clean photocell lens as recommended by manufacturer.

.3 Clean all switch faceplates.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 RELATED SECTIONS

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

1.3 REFERENCES

.1 CSA International

.1 CAN/CSA-C22.2 No.47-M90(R2007), Air-Cooled Transformers (Dry Type).

.2 CSA C9-02(R2007), Dry-Type Transformers.

.3 CAN/CSA-C802.2-06, Minimum Efficiency Values for Dry Type Transformers.

.2 National Electrical Manufacturers Association (NEMA)

1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for dry type transformers and include product characteristics, performance criteria, physical size, finish and limitations.

1.5 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for dry type transformers for incorporation into manual.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect dry type transformers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN DESCRIPTION

.1 Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2No.47, CSA-C9.

.2 Design:

.1 Type: Dry Type; energy efficient Harmonic Mitigating distribution transformer with zero sequence flux cancellation technology.

.2 3 phase, 225 kVA, 600 V input, 208/120 V output, 60 Hz.

.3 Voltage taps: standard.

.4 Insulation: Class 150, 80 degrees C temperature rise.

.5 Basic Impulse Level (BIL): 10 kV BIL.

.6 Hipot: standard.

.7 Average sound level: standard

.8 Impedance at 17 degrees C: standard

.9 Enclosure: CSA, removable metal front panel.

.10 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.

.11 Copper windings.

.12 Winding configuration to be as noted on drawings.

.13 Voltage Regulation to be 4% or better.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Label size: 7.

Part 3 Execution

3.1 INSTALLATION

.1 Transformer exceeds 45kVA shall be floor mounted.

.2 Ensure adequate clearance around transformer for ventilation.

.3 Install transformers in level upright position.

.4 Remove shipping supports only after transformer is installed and just before putting into service.

.5 Loosen isolation pad bolts until no compression is visible.

.6 Make primary and secondary connections in accordance with wiring diagram.

.7 Energize transformers after installation is complete.

3.2 EXAMINATION

.1 Verify that delivered transformers is free of physical defects and visible damage:

3.3 CLEANING

.1 Upon completion remove surplus materials, rubbish, tools and equipment.

.2 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect delivered products and components from damage during transportation.

.2 Repair damage to adjacent materials caused by dry type transformers transportation.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1	Common Work Results – For Electrical:	Section 26 05 00.
.2	Service Entrance Board:	Section 26 24 02.
.3	Panelboards Breaker Type:	Section 26 24 16.01.
.4	Moulded Case Circuit Breakers	Section 26 28 16.02.

1.2 REFERENCE DOCUMENTS

.1 CSA C22.1 – 15 (C.E.C.).

.2 IEEE 1584-2002 Guidelines for Performing Arc-Flash Hazard Calculations.

.3 ANSI Z535.4-2002 Product Safety Signs and Labels.

.4 CSA Z462.

.5 IEEE 519.

1.3 PRODUCT DATA

.1 Provide coordination study documents. Documents to include all graphs, data, breaker trip settings chart, etc.

.2 Documents to be signed and sealed by a Professional Electrical Engineer registered in the province of Alberta.

1.4 POWER DISTRIBUTION TO INCLUDE BUT NOT LIMITED TO:

.1 New normal and emergency power distribution system; existing power distribution system.

.2 Short circuit coordination.

.3 Overcurrent trip coordination.

.4 Ground fault trip coordination.

.5 Arc fault level coordination.

.6 Harmonic level confirmation.

Part 2 Product

.1 Signed coordination study document by professional engineer.

.2 Power distribution breakers short circuit interrupting capacity start (RMS symmetrical) for power distribution breaker panels for both 600V and 208V systems.

.3 Power distribution breakers recommended trip setting.

.4 Power distribution breakers ground fault trip settings.

.5 Power distribution equipment Arc Flash calculation with chart indicating available Arc-Flash levels for each power distribution enclosure.

Part 3 Execution

.1 Coordination study shall be done prior to submitting power distribution system shop drawings. Interrupting capacity ratings of all distribution equipment, brace buswork, and breakers will be based on coordination study results.

.2 Overcurrent devices trip settings will be based on the coordination study results.

.3 Ground fault devices trip setting will be based on the coordination study results.

.4 Electrical equipment "Arc Flash" signs will be based on the coordination study results. Supply and install “Arc Flash” labels.

.5 Manufacture to supplier detailed arc flash hazard analysis label as per CSA Z462-12 Figure Q.3. Contractor to install as required.

.6 Insert all Coordination reports in the “O & M” manual.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for service entrance board.

1.2 RELATED SECTIONS

.1 Section 26 05 00 - Common Work Results – For Electrical.

1.3 REFERENCES

.1 CAN/CSA-C22.2 No.31-M89(R2000), Switchgear Assemblies.

1.4 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Indicate on shop drawings.

- .1 Floor anchoring method and foundation template.
- .2 Dimensioned cable entry and exit locations.
- .3 Dimensioned position and size of bus.
- .4 Overall length, height and depth.
- .5 Dimensioned layout of internal and front panel mounted components.

.3 Include time-current characteristic curves for circuit breakers and fuses.

1.5 QUALITY ASSURANCE

.1 Submit electronic copy of certified test results.

1.6 CLOSEOUT SUBMITTALS

.1 Provide maintenance data for service entrance board for incorporation into manual.

.2 Submit electronic copy of maintenance data for complete assembly including components.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

Part 2 Products

2.1 SERVICE ENTRANCE BOARD

.1 Service Entrance Board: to CAN/CSA-C22.2 No.31.

.2 Rating: 208/120 V, 3 phase, 4 wire, 600 A, short circuit current (rms symmetrical) as per short circuit study.

.3 Cubicles: free standing, size as indicated.

.4 Barrier metering section from adjoining sections.

.5 Provision for installation of owner metering in barriered section.

.6 Owners metering.

.7 Distribution section.

.8 Hinged access panels with captive knurled thumb screws.

.9 Bus bars and main connections: copper.

.10 Bus from load terminals of main breaker via metering section to main lugs of distribution section.

.11 Identify phases with colour coding.

2.2 GROUNDING

.1 Copper ground bus extending full width of cubicles and located at bottom.

.2 Lugs at each end for size #4/0 AWG grounding cable.

2.3 GROUND FAULT UNIT

.1 Main Circuit Breaker is to complete with ground fault protection.

2.4 POWER SUPPLY AUTHORITY METERING

.1 Provide power supply authority metering as per Fortis requirements.

.2 Mounting accessories and wiring for owner metering:

.1 Owner meters to match existing owner meters on site. If existing owner meters were obsolete, new meters should be compatible with and able to communicate with existing owner meters.

.2 potential transformers.

.3 current transformers.

.4 Watthour meter.

.5 Demand meter with kW.h register.

2.5 FINISHES

.1 Apply finishes in accordance with Section 26 05 00 - Common Work Results – Electrical.

.1 Service entrance board exterior: match existing.

2.6 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results – Electrical.

.2 Nameplates:

.1 Style, text, size is to match existing.

.2 Complete board labelled as per Single Line Diagram.

2.7 SOURCE QUALITY CONTROL

.1 Departmental Representative to witness final factory tests if required.

.2 Notify Departmental Representative in writing 5 days in advance that service entrance board is ready for testing.

Part 3 Execution

3.1 INSTALLATION

.1 Locate service entrance board as shown on the drawings.

.2 Connect main secondary service to line terminals of main breaker.

.3 Connect load terminals of distribution breaker's to feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Run one grounding conductor #4/0 AWG bare copper in 25 mm conduit from ground bus to building ground bar.

.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CSA C22.2 No.29-11, Panelboards and Enclosed Panelboards.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for panelboards and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by manufacturer and contractors.

.2 Include on drawings:

.1 Electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for panelboards for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect panelboards from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2 No.20.

.2 250, 600 V panelboards: bus and breakers symmetrical interrupting capacity as indicated.

.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 Minimum of 2 flush locks for each panel board.

.6 Two keys for each panelboard and key panelboards alike.

.7 Copper bus with neutral of same ampere rating of mains.

.8 Mains: suitable for bolt-on breakers.

.9 Trim with concealed front bolts and hinges.

.10 Trim and door finish: baked enamel, ANSI 61 Grey.

.11 Isolated ground bus.

.12 Include grounding busbar with 3 of terminals for bonding conductor equal to breaker capacity of the panel board.

2.2 BREAKERS

.1 Breakers: to Section 26 28 16.02 - Moulded Case Circuit Breakers.

.2 Panelboards breakers shall be “bolt-on” type, plug-in breakers are not acceptable.

.3 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.4 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.5 Lock-on devices for 10% of 15 to 30 A breakers installed as indicated. Turn over unused lock-on devices to U of C facility maintenance personnel.

.6 Lock-on devices for fire alarm, door supervisory, intercom, and exit light circuits.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Nameplate for each panelboard size 4 engraved.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit, mounted in plastic envelope at inside of panel door.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for panelboards installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform Consultant 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 Consultant.

3.2 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards in accordance with Rough Carpentry Spec Section. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height specified in Section 26 05 00 - Common Work Results for Electrical.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by panelboards installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CAN/CSA C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non Environment Considerations.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA 250-2008, Enclosures for Electrical Equipment (1000 Volts Maximum).

.3 The Munsell System of Colour Notation

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by manufacturer and contractors.

1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for electrical cabinets and enclosures for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect electrical cabinets and enclosures from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

.1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA C22.2, Munsell Notation 7.5GY3.5/1.5, size as indicated.

.2 Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m^2 area without rupture of material.

.3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.

.4 Equip enclosure with hot dipped galvanized mounting rails 1 m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.

.1 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.

.2 Holes in side panel flanges in 60 mm increments for vertical adjustment.

.5 Cover: tamperproof, bolt-on, domed to shed water.

.6 Door: 3 point latching, with padlocking means.

.7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.

.8 Enclosure construction such as to allow configuration of single or ganged enclosures.

.9 Enclosure capable of being shipped in knocked-down condition.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure 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 INSTALLATION

.1 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.

.2 Mount equipment in enclosure.

.3 Label electrical cabinets and enclosure to Section 26 05 00 - Common Work Results for Electrical.

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 CSA C22.2 No.42-10, General Use Receptacles, Attachment Plugs and Similar Devices.

.2 CAN/CSA C22.2 No.42.1-00(R2009), Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

.3 CSA C22.2 No.55-M1986(R2008), Special Use Switches.

.4 CSA C22.2 No.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

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 wiring devices and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by manufacturer and contractors.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect wiring devices from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

Part 2 Products

.1 15, 20 A, 120 V, 347 V, single pole switches to: CSA C22.2 No.55, CSA C22.2 No.111.

.2 Manually-operated general purpose AC switches with following features:

.1 Terminal holes approved for No. 10 AWG wire.

.2 Silver alloy contacts.

.3 Urea or melamine moulding for parts subject to carbon tracking.

.4 Suitable for back and side wiring.

.5 Ivory toggle.

.3 Toggle operated locking fully rated for up to 80% of rated capacity of motor loads & heating loads.

.4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

.1 Duplex receptacles, CSA type 5-15 R/5-20R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and rivetted grounding contacts.

.2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 White urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.3 Other receptacles with ampacity and voltage as indicated:

.1 The color of standard receptacles and switches shall be coordinated with the architectural color scheme; for example, white, not ivory, devices shall be used if walls are white.

.4 Receptacles of one manufacturer throughout project.

2.3 FLOOR RECEPTACLES

.1 Refer to drawings for floor receptacle types and models.

2.4 COVER PLATES

.1 Cover plates for wiring devices to: CSA C22.2 No.42.1.

.2 Stainless steel thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.

.3 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.4 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

.5 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

2.5 SOURCE QUALITY CONTROL

.1 Cover plates from one manufacturer throughout project.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for wiring devices 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 INSTALLATION

.1 Switches:

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install switches in gang type outlet box when more than one switch is required in one location.

.3 Mount toggle switches at height as indicated in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Mount receptacles at height as indicated in accordance with Section 26 05 00 - Common Work Results for Electrical.

.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.4 Install GFI type receptacles as indicated.

.3 Cover plates:

.1 All cover plates are to be stainless steel.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse & recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers and ground-fault circuit-interrupters.

1.2 RELATED SECTIONS

.1 Section 26 24 02 - Service Entrance Board.

.2 Section 26 28 18 - Ground Fault Equipment Protection.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

1.4 SUBMITTALS

.1 Include time-current characteristic curves for breakers with ampacity of 1000 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.2 Separate for reuse and recycling and place in designated containers Steel, Metal, Plastic waste in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Moulded-case circuit breakers and Ground-fault circuit-interrupters: to CSA C22.2 No. 5

.2 Bolt-on, quick- make, quick-break type, for manual and automatic operation.

.3 Common-trip breakers: with single handle for multi-pole applications.

.4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

.5 Circuit breakers with interchangeable trips as indicated.

.6 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as per manufacturer conducted short circuit coordination study results.

2.2 SOLID STATE TRIP BREAKERS

.1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

2.3 OPTIONAL FEATURES

.1 Include:

.1 Shunt trip.
.2 Auxiliary switch.
.3 Motor-operated mechanism c/w time delay unit.
.4 Under-voltage release.
.5 On-off locking device.
.6 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Equipment, fabrication and installation for ground fault protection.

.2 Text to complete Section 26 24 02 - Service Entrance Board.

1.2 RELATED SECTIONS

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

1.3 PAYMENT PROCEDURES

.1 Payment for field testing of ground fault equipment performed by contractor and/or equipment manufacturer.

1.4 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2 No. 144-M91(R2001), Ground Fault Circuit Interrupters.

1.5 SUBMITTALS

.1 Submit product data and shop drawings.

.2 Submit test report for field testing of ground fault equipment to Consultant and certificate that system as installed meets criteria specified.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.

.4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 EQUIPMENT

.1 Ground fault protective equipment: components of one manufacturer.

.2 Ground fault unit to contain:

.1 Ground sensing relay suitable for operation at factory set.

.2 Three position sensitivity control switch to select value of leakage current at which relay will operate.

.3 Switch:

.1 SPDT contacts for alarm and trip.

.2 Mechanical target indication.

.3 Manually reset.

.4 Reset button for contacts and target.

.5 Suitable for panel surface mounting.

.3 Zero sequence transformer rectangular type with 300 - 3000 mA range.

.4 Neutral:

.1 For Delta ungrounded systems, use an artificial neutral and grounding resistor.

.5 System to operate instantaneously at ground current setting.

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.

2.3 RELATED EQUIPMENT

.1 Shunt trip breakers.

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 05 00 - Common Work Results – Electrical.

.2 Arrange for field testing of ground fault equipment by contractor and/or equipment manufacturer before commissioning service.

.3 Demonstrate simulated ground fault tests.

END OF SECTION

Part 1 General

1.1 PAYMENT

.1 Payment for field testing of ground fault equipment performed by Contractor.

1.2 REFERENCES

.1 CSA International

.1 CAN/CSA C22.2 No.144-M91(R2006), Ground Fault Circuit Interrupters.

.2 National Electrical Manufacturers Association (NEMA)

.1 NEMA PG 2.2-1999(R2009), Application Guide for Ground Fault Protection Devices for Equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for [ground fault circuit interrupters] and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by manufacturer and contractors.

.3 Test and Evaluation Reports: submit test report for field testing of ground fault equipment to Departmental Representative and certificate that system as installed meets criteria specified.

1.4 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 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, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect ground fault circuit interrupters from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse and return of pallets, crates, padding, packaging materials.

Part 2 Products

2.1 MATERIALS

.1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA C22.2 No.144.

.2 Components comprising ground fault protective system to be of same manufacturer.

2.2 BREAKER TYPE GROUND FAULT INTERRUPTER

.1 Refer to panelboard schedule for breaker ratings, 1 phase circuit c/w test and reset facilities.

2.3 GROUND FAULT PROTECTOR UNIT

.1 Self-contained with 15 A, 120 V circuit interrupter and duplex receptacle complete with:

.1 Solid state ground sensing device.

.2 Indication lamp for circuit status shall be integrated in the GFI receptacles.

.3 Facility for testing and reset.

.4 CSA Enclosure 1, flush mounted with stainless steel face plate.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for ground fault circuit interrupters 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 INSTALLATION

.1 Do not ground neutral on load side of ground fault relay.

.2 Pass phase conductors including neutral through zero sequence transformers.

.3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and co-ordinate with Section 01 45 00 - Quality Control.

.2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.

.3 Demonstrate simulated ground fault tests.

3.4 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse & recycling in accordance with Section 01 74 21 – Construction, Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for non-fused disconnect switches.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA C22.2 No.4-M89 (R2000), Enclosed Switches.

.2 CSA C22.2 No.39-M89 (R2003), Fuseholder Assemblies.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Separate for reuse and recycling and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.

.4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 Non-fusible, horsepower rated disconnect switch in CSA Enclosure, to CAN/CSA C22.2 No.4 size as required.

.2 Provision for padlocking in on-off switch position by three locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Quick-make, quick-break action.

.5 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

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

1.2 REFERENCES

.1 International Electrotechnical Commission (IEC)

.1 IEC 947-4-1-2002, Part 4: Contactors and motor-starters.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings.

.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.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for motor starters for incorporation into manual.

.2 Include operation and maintenance data for each type and style of starter.

1.5 EXTRA MATERIALS

.1 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.
.5 1 operating coil.
.6 2 fuses.
.7 10% indicating lamp bulbs used.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Place materials defined as hazardous or toxic waste in designated containers.

.2 Ensure emptied containers are sealed and stored safely for disposal away from children.

Part 2 Products

2.1 MATERIALS

.1 Starters: to NEMA rating; all starters are to be complete with 2 NO & 2 NC auxiliary contacts.

2.2 MANUAL MOTOR STARTERS

.1 Single /Three phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break.

.2 One /Three overload heater s, manual reset, trip indicating handle.

.2 Accessories:

.1 Toggle switch pushbutton: heavy duty labelled as indicated.

.2 Indicating light: heavy duty type and colour as indicated.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 CONTROL TRANSFORMER

.1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.4 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results - Electrical.

2.5 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

Part 3 Execution

3.1 INSTALLATION

.1 Install starters, connect power and control as indicated.

.2 Ensure correct overload devices elements installed.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical 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

Part 1 General

1.1 WORK INCLUDED

.1 Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic controls.

.2 Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.

.3 The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

.4 Generator warranty to be 5 years.

1.2 CODES AND STANDARDS

.1 The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.

.2 CSA 282, (Latest Edition) Emergency Electrical Power Supply for Buildings

.3 IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

.4 The generator set and supplied accessories shall meet the requirements of the following standards:

.1 NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.

.2 UL142 – Sub-base Tanks

.3 UL1236 – Battery Chargers

.4 UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

.5 The control system for the generator set shall comply with the following requirements.

.1 CSA C22.2, No. 14 – M91 Industrial Control Equipment

.2 EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial

.3 EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.

.4 FCC Part 15, Subpart B.

.5 IEC8528 part 4. Control Systems for Generator Sets

.6 IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions

.6 The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.3 ACCEPTABLE MANUFACTURER

.1 Kohler

.2 Finning /Caterpillar

.3 Cummins / Onan

1.4 RELATED SECTIONS

.1 . Automatic Transfer Switch Section 26 32 12

1.5 WORK BY OTHER SECTIONS

.1 Fuel tank supply piping to exterior for fuel fill.

.2 Installation of muffler including piping from engine manifold to muffler and to outside vent

.3 Insulation of Insulation of piping and muffler

1.6 STANDARDS AND QUALIFICATIONS:

.1 The emergency power equipment shall comply with all applicable ANSI specifications and shall be constructed to NEMA/EEMAC standards with CSA/UL/ULC approved panel components.

.2 The Diesel engine generator set shall comply, unless otherwise noted herein, with the Requirement of the Provincial/ National Environmental Authority with jurisdiction.

.3 CSA C282.09 Emergency electrical power supplies for Buildings.

1.7 SHOP DRAWINGS AND PRODUCT SUBMITTAL

.1 Submit electronic pdf shop drawings for all relevant items in this Specification. Include:

.1 Outline dimensions, configuration and identifications of components, floor anchoring method, details and dimensions of foundations, cable entry and exits locations, power and control diagram, panel layout, identification of panel components.

.2 Generator Nameplate Drawing including plan and elevation views with certified overall dimensions, as well as wiring interconnection details.

.3 Generator decrement curves.

.4 Generator capability curve.

.5 Generator damage curve for 3 phase, 2 phase and 1 phase fault.

.6 Detailed technical data for the governor.

.7 Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.

.8 Manufacturer's installation instructions.

1.8 QUALITY ASSURANCE:

.1 Qualified personnel shall be present at all times to supervise the work and shall be thoroughly familiar with the materials, standards, and specific requirements of this section.

.1 Codes and Standards:

.1 Comply with the Codes and Standards specified herein.

.2 Where provisions of pertinent codes and standards conflict with these specifications and drawings or each other, comply with the more stringent provisions.

1.9 OPERATION

.1 Sequence of Operation

.1 Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.

.2 The generator set shall complete a time delay start period as programmed into the control.

.3 The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

.1 The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate “fail to crank” shutdown.

.2 The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate “fail to start”.

.3 The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

.4 On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.

.5 When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

.6 On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

.7 Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

1.10 OTHER REQUIREMENTS

.1 Factory Testing.

.1 The generator set supplier shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance.

.2 Factory testing may be witnessed by the owner and consulting engineer. Costs for travel expenses will be the responsibility of the owner and consulting engineer. Supplier is responsible to provide two weeks of notice for testing.

.3 Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

Part 2 Products

2.1 GENERATOR SET

.1 Rating

.1 The generator set shall operate at 1800 rpm and at a voltage of: 208 Volts AC, Three phase, 4-wire, and 60 hertz.

.2 The generator set shall be rated at 200kW, 250kVA at 0.8 PF, based on site conditions of: Altitude 550 meters, ambient temperatures up to 40 degrees C. Breaker size is to be based on code and manufacturer requirements for the generator and is to be 100% rated.

.3 The generator set rating shall be based on emergency/standby service.

2.2 PERFORMANCE

.1 Voltage regulation shall be plus or minus 1.0 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 1.0 percent.

.2 Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5%.

.3 The engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.

.4 Motor starting capability shall be a minimum of 995 kVA. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

.5 The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

2.3 CONSTRUCTION

.1 The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails

.2 All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketted. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

.3 Provide spring type vibration isolation between the base and the floor support structure.

.4 Provide Sub Base Fuel Tank.

.5 Provide Sound attenuated weather proof Enclosure.

2.4 CONNECTION

.1 The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.

.2 Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.

.3 Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.5 ENGINE AND ENGINE EQUIPMENT

.1 The engine shall be diesel fueled, radiator and fan cooled. Minimum displacement shall be 8.3 liters, with 6 cylinders. The horsepower rating of the engine at it's minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine accessories and features shall include:

.2 An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various

isochronous or parallel states.

.3 Skid-mounted radiator and cooling system rated for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H2O external static head. Radiator shall be sized based on a core temperature that is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50-ethylene glycol/water mixture, or as required to prevent freezing at minimum ambient temperature of -45Degree Celcius. Rotating parts shall be guarded against accidental contact.

.4 Positive displacement, mechanical, full pressure, lubrication oil pump.

.5 Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

.6 Replaceable dry element air cleaner.

.7 Flexible fuel lines.

.8 Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

.9 Coolant heater

.1 Engine mounted, thermostatically controlled, coolant heater. Heater voltage shall 208 VAC, single phase. The coolant heater shall be UL499 listed and labeled. The heater shall be sized to maintain proper coolant starting temperature at -40C ambient temperature.

.2 The coolant heater shall be installed on the engine with high temperature silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

.3 The coolant heater(s) shall be sized as recommended by the generator set manufacturer to warm the engine to a minimum of 100F (40C) in a -40C/F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

.10 Oil Pan Heater

.1 Engine mounted, thermostatically controlled, oil pan heater. Heater voltage shall be 120 VAC. Oil heater shall be sized by generator set manufacturer.

.11 Provide vibration isolators.

.1 Spring/pad type or as recommended by the manufacturer, quantity as recommended by the generator set manufacturer.

.12 Provide exhaust silencer for engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer.

.1 The silencer shall be hospital grade.

.2 Exhaust system shall be installed inside of the generator set enclosure by the generator set manufacturer.

.3 Provide fire proof and heat resistant insulation on silencer, exhaust piping located within the enclosure and on the manifold flex hose.

.13 Starting System

.1 Starting system shall be 12V. DC or 24V. DC as recommended by the engine manufacturer

.2 Starting batteries should be heavy duty, maintenance free type capable of cranking the engine for 60 seconds continuously at 10 degrees C without the voltage dropping below 75% of nominal.

.3 Electric starter(s) capable of three complete 15 second automatic cranking cycles without overheating.

.4 Provide a minimum 12 amp battery charger for each generator set battery bank. Generator sets incorporating two battery banks shall be provided with two chargers connected together and operating in parallel, with alarm output(s) connected in parallel. The charger(s) shall include the following capabilities:

.1 Chargers shall be UL 1236-BBHH listed and CSA or CUL certified for use in emergency applications.

.2 The charger shall be compliant with UL991 requirements for vibration resistance.

.3 The charger shall comply with the requirements of EN61000-4-5 for voltage surge resistance; EN50082-2 for immunity; EN61000-4-2 for ESD; EN61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.

.5 The charger shall be capable of charging a fully discharged battery without damage to the charger. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be UL-labeled with the maximum battery amp-hour rating that can be recharged within 24 hours.

.6 The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100 percent of charge, and a float stage to maintain a fully charge battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.

.7 The DC output voltage regulation shall be within plus or minus 1%. The DC output ripple current shall not exceed 1 amp at rated output current level.

.8 The charger shall include the following features:

.1 Two line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display

alarm messages, and perform programming;

.2 LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red);

.3 AC input overcurrent, over voltage, and undervoltage protection;

.4 DC output overcurrent protection;

.5 Alarm output relay

.6 Corrosion resistant aluminum enclosure

.9 Battery charger input voltage shall be 120 VAC.

2.6 AC GENERATOR

.1 The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125 degrees Centigrade.

.2 The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

.3 The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

.4 The alternator shall be capable of operation with reverse kVAR of 0.15 per unit.

.5 A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

.6 Alternator Anti-Condensation Heater

.1 Alternator shall come with a thermostatically controlled anti-condensation heater. Anti-condensation heater voltage shall be 120 VAC. Alternator heater shall be sized by generator set manufacturer.

2.7 GENERATOR SET CONTROL

.1 The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.

.2 The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

.3 The generator set mounted control shall include the following features and functions:

.1 Control Switches

.1 Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. A separate push-button to initiate starting is acceptable. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.

.2 EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.

.3 RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

.4 PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

.2 Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:

.1 Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.

.2 The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.

.3 The control system shall log total number of operating hours, total kWH, and total control on hours, as well as total values since reset.

2.8 GENERATOR ALARM AND STATUS DISPLAY

.1 The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:

.1 The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).

.2 The control shall include green lamps to indicate that the generator set is running at

rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.

.3 The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.

.4 The control shall include an amber common warning indication lamp.

.2 The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:

- low oil pressure (warning)
- low oil pressure (shutdown)
- oil pressure sender failure (warning)
- low coolant temperature (warning)
- high coolant temperature (warning)
- high coolant temperature (shutdown)
- low coolant level (warning)
- fail to crank (shutdown)
- fail to start/overcrank (shutdown)
- overspeed (shutdown)
- low DC voltage (warning)
- high DC voltage (warning)
- weak battery (warning)
- high AC voltage (shutdown)
- low AC voltage (shutdown)
- under frequency (shutdown)
- over current (warning)
- over current (shutdown)
- short circuit (shutdown)
- over load (warning)
- emergency stop (shutdown)

- Fuel Leak (warning)
- (4) configurable conditions

.3 Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

.4 Provisions shall be made to allow for monitoring output to a remote annunciator.

.5 Engine Status Monitoring.

.6 The following information shall be available from a digital status panel on the generator set control :

- engine oil pressure (psi or kPA)
- engine coolant temperature (degrees F or C)
- engine speed (rpm)
- number of hours of operation (hours)
- number of start attempts
- battery voltage (DC volts)

.7 The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

2.9 ENGINE CONTROL FUNCTIONS

.1 The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods. After completion of 3 unsuccessful crank cycles, an alarm will be sent to indicate “Generator Crank Fail”.

.2 The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.

.3 The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

.4 The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

2.10 ALTERNATOR CONTROL FUNCTION

.1 The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase line to neutral RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

.2 Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445. The protection for this function shall be 3rd party certified to very performance.

.3 Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445. The protection for this function shall be 3rd party certified to very performance.

.4 Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

.5 A line to neutral sensing AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

.6 The generator set control cabinet shall include a 120VAC heater.

.7 Other Control Functions

.1 A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage. During engine cranking (starter engaged), the low

voltage limit shall be disabled, and DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

.2 Control Interfaces for Remote Monitoring:

.1 The control system shall provide three programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown.

.3 A fused 10 amp switched 12VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

.4 A fused 10 amp 12VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

.8 Other equipment to be provided with the generator set

.1 The generator set shall be provided with a 450amp mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

2.11 OUTDOOR WEATHER-PROTECTIVE SOUND ATTUNUATED ENCLOSURE

.1 The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing. The total assembly of generator set, enclosure, and sub-base fuel tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 38C. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions. All doors shall be lockable, and include retainers to hold the door open during service. Enclosure roof shall be cambered to prevent rainwater accumulation. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

.2 All sheet metal shall be primed for corrosion protection and finish painted with the manufacturers standard color using a two-step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:

.1 Gloss, per ASTM D523-89, 80% plus or minus 5%.

.2 Crosshatch adhesion, per ASTM D3359-93, 4B-5B.

.3 Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.

.4 Humidity, per ASTM D2247-92, 1000+ hours.

.5 Water Soak, per ASTM D2247-92, 1000+ hours.

.6 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

.3 Enclosure shall be constructed of minimum 12 gauge steel for framework and 14 gauge steel for panels. All hardware and hinges shall be stainless steel.

.4 A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections. Silencer and exhaust pipe shall be insulated with silver lined high temperature insulation.

.5 The enclosure shall include the following maintenance provisions:

.1 Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves

.2 External radiator fill provision.

.3 Exterior Fuel Tank fill provision

.6 The enclosure shall include hinged weather proof locking access doors to allow for full access to all the generator set components.

.7 Generator set supplier is to install a battery charger inside of the enclosure**.**

.8 Provide a factory mounted and wired single electrical connection for all of the enclosure heaters and battery charger in order to reduce time required on site to complete connection**.**

.9 The enclosure is to be ventilated which allows the generator set to operate at full rated load in an ambient temperature of up to 40C.

.10 The enclosure is to be sound insulate and shall reduce the sound level of the generator set while operating at full rated load to an average of 85 dBA at 7 meters from the generator set in a free field environment**.**

.11 The enclosure shall be insulated with non-hydroscopic materials.

2.12 FUEL TANK

.1 Skid mounted double wall diesel fuel tank mounted under the genset.

.2 Tank to conform to all safety standards and construction standards including UL142.

.3 Provide built-in fuel leak detector in the outer tank. Connect to the control panel. See section 2.04 (c)

.4 Size to a minimum 12 hours fuel supply at full load. Fuel tank to be 2499L or less.

.5 Provide the following level switches on the main tank

.1 Fuel full

.2 Low fuel

.3 Low fuel alarm for Emergency engine shutdown

.4 Main tank leak

2.13 REMOTE ANNUNCIATOR

.1 Provide Remote Annunciator Panel capable of displaying system status indication for emergency and other power systems. Locate at front desk.

.2 Visual indication of network conditions, generator alarm and network function status.

.3 Audible indication of any network condition – annunciator also includes pushbutton switch to silence the audible alarm.

.4 UL Listed and labeled; CSA certified; CE marked.

.5 Wall surface mount NEMA 1 enclosure.

2.14 REMOTE ALARM OFF BUTTON

.1 Red mushroom type “Emergency Shutdown” push button (push in to shut down / pull out to reset), push button may be provided independently of remote annunciator.

2.15 AUTOMATIC TRANSFER SWITCH

.1 To be included in the “Emergency Generator Set” tender package

.2 Refer to Section 26 32 12.

Part 3 Execution

3.1 INSTALLATION

.1 Installation to CSA C 282 (latest edition) requirements and standards

.2 Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable provincial and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of ULc listed products.

.3 Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier. Provide complete wiring diagrams and wiring instructions to the contractor. Include recommendations for wiring types.

.4 Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements

of the site.

.5 Equipment shall be initially started and operated by representatives of the manufacturer.

.6 All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 TESTING AND COMMISSIONING

.1 Provide fuel required for testing of the generator. After test, fill the fuel tank to its rated time capacity

.2 Provide portable Load bank

.3 Conform to CSA C282.09 requirements and standards

.4 After installation of the above equipment has been finalized, the Contractor shall arrange with the supplier for the provision of services of a qualified and experienced specialist who shall check the correctness of the installation, perform load test and calibrate the system before it is operated by others. Within 10 days thereafter, a complete report of this load test and inspection shall be submitted to the Engineer. All costs associated with this service shall be included in the Contract.

.5 For the purpose of determining if the electrical and mechanical equipment of a diesel generator set will function as expected, a minimum of 4 hours load test conducted by the supplier shall be performed.

.6 The load test shall be performed at 50% of rated load for 30 minutes and at 100% of rated load for the remaining time. Reading shall be taken every 15 minutes. Part of the load test shall be “No load to instantaneous full load” test.

.7 As a minimum, the following information shall be documented on load test sheet of each diesel generator set:

- .1 Engine serial no.
- .2 Engine model and manufacturer
- .3 Generator serial no.
- .4 Generator model and manufacturer
- .5 Generator rating in KW and KVA and power factor
- .6 Diesel generator set serial no.
- .7 Jots name and location
- .8 Safety switch setting for low pressure, cooling temperature, overspeed, overcrank
- .9 Name of person conducting test
- .10 Name of person witnessing the test

.8 As a minimum, the following reading shall be taken every 15 minutes during the load test:

.1 Date and time
.2 Volts and amps for all phases
.3 RPM, frequency
.4 Load in KVA and KW
.5 Oil temperature and pressure
.6 Fuel pressure
.7 Jacket water temperature
.8 Ambient temperature

.9 All alarm and shutdown functions are to be tested by shorting out contacts at the alarm sensors, or by other acceptable methods.

.10 Perform sound level test, to confirm compliance with specified maximum db levels

.11 Test All functions of the transfer switch.

3.3 OPERATION AND MAINTENANCE INSTRUCTIONS:

.1 Conform to CSA C282 requirements and standards

.2 The Contractor shall obtain the service of a technical representative of the equipment supplier to provide one day of instruction to the owner's representative. This instruction may be provided as an additional day during the same visit as the inspection work described above.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Supply, delivery, installation, testing and commissioning of automatic transfer equipment as shown on the drawings and in compliance with these specifications.

1.2 RELATED WORK

.1 Emergency Generator Section 26 32 11.

1.3 DESIGN CRITERIA

.1 Conform to CSA C282 (latest edition).

.2 Wall-mounted automatic load transfer equipment to:

.1 Monitor voltage of normal power supply (120/208 VAC, 3 Phase, 4 wire system)

.2 Current rating as shown on drawings.

.3 Initiate cranking of standby generator unit on normal power failure after a time delay

.4 Transfer load from normal supply to alternate supply when alternate supply reaches rated frequency and voltage.

.5 Transfer load from alternate supply to normal power supply after a time delay, when normal power is restored.

.6 Shut down standby unit.

1.4 Isolation Bypass Switch

.1 Manually isolate the automatic transfer switch to allow for full maintenance of the automatic transfer switch.

.2 Common enclosure with the automatic transfer switch, barrier between enclosures.

.3 Manual transfer switch on door mechanically interlocked to prevent energizing both sources at the same time.

.4 Two sources (utility/generator) by pass.

1.5 SHOP DRAWINGS

.1 Submit shop drawings for all relevant items in this specification. Include, but not limited to:

.1 Make, model and type.

.2 Certify in writing number of operations on-off, off-on under continuously normal load and rated voltage

.3 Certify in writing maximum withstand current in rms symmetrical kA and time in seconds, for the switch device alone, without association of any other upstream protection device.

.4 Certify in writing maximum turn off current at 208 V, as specified

.2 Single line diagram showing controls and relays.

.1 Automatic starting and transfer to standby unit and back to normal power.

.2 Test control.

.3 Manual control.

.4 Automatic shutdown.

.3 Complete installation instructions

1.6 OPERATION AND MAINTENANCE DATA

.1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into a manual.

.2 Detailed instructions to permit effective operation, maintenance and repair.

.3 Technical data:

.1 chematic diagram of components, controls and relays.

.2 Illustrated parts lists with parts catalogue numbers.\

.3 Certified copy of factory test results.

1.7 SOURCE QUALITY CONTROL

.1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Worldwide Fibre at manufacturer site.

.2 Tests:

.1 Conform to CSA C282 (latest edition).

.2 Operate equipment both mechanically and electrically to ensure proper performance.

.3 Check selector switch, in 4 positions (Test, Auto, Manual, Engine Start) and record results.

.4 Check voltage sensing and time delay relay settings.

.3 Check:

.1 Automatic starting and transfer of load on failure of normal power.

.2 Retransfer of load when normal power supply resumed.

.3 Automatic shutdown.

.4 Manual by pass, both sources.

1.8 QUALITY ASSURANCE

.1 Qualified personnel shall be present at all times to supervise the work and shall be thoroughly familiar with the materials, standards, and specific requirements of this section.

.2 Codes and Standards

.1 Comply with CSA C282 (latest edition).

.2 Comply with the Codes and Standards specified herein.

.3 Where provisions of pertinent codes and standards conflict with these specifications and drawings or each other, comply with the more stringent provisions.

Part 2 Products

2.1 MATERIALS

.1 Conform to CSA C282 (latest edition).

.2 Meters: to CAN3-C17-M84.

.3 Instrument transformers: to CAN3-C17-M83.

.4 Contactors: to NEMA ICS-1970

2.2 ACCESSORIES

.1 Pilot lights to indicate switch position, green for normal, red for standby, mounted in the front face of the panel.

.2 Plant exerciser: 168 h timer to start standby unit once each week for selected interval. Timer adjustable 0 168 h in 15 min intervals. Load transfer option site settable. Factory set on “no transfer”.

.3 Solid neutral bar, rated to the capacity of the switch.

.4 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote controls/indication; contacts to switch before connecting to standby and to switch back after connecting to normal supply.

.5 Six dry contacts form “C” for remote indication of each of the following conditions shall be provided.

.1 ATS fail to transfer.

.2 ATS on emergency.

.3 Commercial AC power fail.

.4 ATS on bypass.

.5 The contacts for commercial AC power fail shall be time delay to overcome momentary degradation or loss of power due to electric discharges in the atmosphere, etc.

.6 Control points for the following remote control and indication with two form “C” dry contacts:

.1 Engine start on load.

.2 Engine start off load.

.3 Engine stop.

.4 Engine start on load with timer. (time out)

.5 Engine start off load with timer. (time out)

.7 Solid State Electronic Monitors

.1 Voltage sensing, three phase with time delay and circuit closing arrangement.

.2 Voltage sensing relays (solid state) to be or to have:

.1 Monitor all three phases or both phases on 120/240 V, 1 phase system (normal & alternate source).

.2 Separate adjustable pick-up control for each phase. Minimum range at 85% to 105% of nominal voltage (set at 90%).

.3 Separate adjustable drop-out control for each phase. Minimum range 80% to 100% of nominal voltage or 80% to 90% of pick-up level (set at 90% of nominal voltage level).

.4 Alternative to (b) and (c): For each line, a fixed differential of up to 12% (between pick-up and drop-out) and a separate adjustable drop-out control with minimum range 80% to 100% of nominal voltage (set at 87%).

.8 Under / Over frequency sensing, with adjustable differential for nominal frequency of 60 Hz with adjustable time delay on trip for nominal frequency of 60 Hz, with circuit closing arrangement, with 2 N.O. and 2 N.C. contacts, repetitive accuracy plus or minus 0.2 0.5 Hz.

.9 Time Delay Relays:

.1 Provide relays of the pneumatic or electronic type, adjustable to the following ranges:

.1 Normal to emergency (alternate) (delay of engine start after hydro failure). Adjustable, minimum range 0-50 seconds (set at 15 seconds).

.2 Emergency (alternate) to normal (delay of retransfer of switch after hydro return). Adjustable, minimum range 0.5-3 minutes (set at 3 minutes).

.3 Engine cool off (delay of engine shutdown after retransfer). Adjustable, minimum range 0.5-5 minutes (set at 5 minutes).

.4 Inherent time delay during transfer sufficient to cause drop-out of motor starter, i.e. load bus disconnected for 12 cycles minimum.

.10 Phase sequence monitoring relay with indication LED on face of A75 auxiliary contact for remote monitoring. Connect relay to emergency generator side.

.11 Fully automatic in operation.

.12 Permanently held (latch type) main switches without automatic trips, single electric operator, energized only during the transfer operation (in both directions).

.13 Manual transfer facility for emergency and maintenance tests. Insulated shrouds for operator protection.

.14 Control transformers for normal and emergency supplies.

.15 One set of contacts, for external connection, to close after the failure of the hydro supply to initiate the engine start sequence.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification.

2.4 FABRICATION:

.1 Shop assemble transfer equipment including:

.1 Wall mounting enclosure with double door or ATS section size to be maximum 355 mm (14”) deep x 915 mm (36”) maximum.

.2 Transfer switched and operating mechanisms.

.3 Control transformers, relays and instruments.

.4 Accessories.

2.5 MANUFACTURERS:

.1 TTI - Thomson Technology Inc.

.2 Cutler Hammer (Robonic).

.3 ASCO.

.4 Approved equal.

Part 3 Execution

3.1 INSTALLATION

.1 Locate, install and connect transfer equipment.

.2 Check solid state monitors and adjust as required.

3.2 FIELD QUALITY CONTROL:

.1 Factory tests shall include, but not limited to, the following:

.1 CSA C282 and as follows

.2 Energize transfer equipment from normal power supply.

.3 Set mode selector in "Test" position to ensure proper standby start, running, transfer, retransfer. Return mode selector to "Auto" position to ensure standby shuts down.

.4 Set mode selector in "Manual" position and check to ensure proper performance.

.5 Set mode selector in "Engine start" position and check to ensure proper performance. Return selector to "Auto" to stop engine.

.6 Set mode selector in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 min, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.

.7 Repeat, at 1 h intervals, 3 times, complete test with mode selector in each position, for each test.

.8 Put isolation switch on bypass mode. Check that ATS is completely isolated.

.9 Check proper function of all auxiliary contacts.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

.2 ASTM International Inc.

.1 ASTM F1137-[00(2006)], Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.3 Canadian Standards Association (CSA International)

.4 ICES-005-07, Radio Frequency Lighting Devices.

.5 Underwriters' Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval by Consultant.

.2 Quality assurance submittals:

.1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer Requirements.

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

.3 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials.

.4 Divert unused metal materials from landfill to metal recycling facility.

Part 2 Products

2.1 LAMPS

.1 As indicated in luminaire schedule.

2.2 BALLASTS/DRIVERS

.1 As indicated in luminaire schedule.

2.3 FINISHES

.1 Light fixture finish and construction to meet ULC listing and CSA certification related to intended installation.

2.4 OPTICAL CONTROL DEVICES

.1 As indicated in luminaire schedule.

2.5 LUMINAIRES

.1 As indicated in luminaire schedule.

.2 Luminaires used in High Bay areas must have minimum of 10 years manufacturer material and labor warranty.

Part 3 Execution

3.1 INSTALLATION

.1 Locate and install luminaires as indicated.

.2 Provide adequate support to suit ceiling system.

3.2 WIRING

.1 Connect luminaires to lighting circuits:

.1 Install flexible or rigid conduit for luminaires as indicated.

3.3 LUMINAIRE SUPPORTS

.1 For suspended ceiling installations support luminaires independently of ceiling.

3.4 LUMINAIRE ALIGNMENT

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.5 CLEANING

.1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.141-02, Unit Equipment for Emergency Lighting.

.2 CSA C860-01(December 2002), Performance of Internally-Lighted Exit Signs.

.2 National Fire Protection Association (NFPA)

.1 NFPA 101-2006, Life Safety Code.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 81 01 - Hazardous Materials.

.4 Quality Assurance Submittals:

.1 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

Part 2 Products

2.1 STANDARD UNITS

.1 Exit lights: to CSA C22.2 No.141 and CSA C860.

.2 New Exit Lights to be green running man pictogram sign.

.3 Refer to luminaire schedule on the design drawing.

.4 Face plate to remain captive for re-lamping.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.

.2 Connect fixtures to exit light circuits.

.3 Ensure that exit light circuit breaker is locked in on position.

3.3 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SCOPE OF SERVICES

.1 **Electrical contractor** is to provide and install:

.1 Rack, patch panels, voice and data cabling, raceway and voice/data outlets related to communication services. Room 184-7’ patch, cables, all other rooms with data outlets-14’ patch cables to be provided.

.2 Cabling testing and commissioning.

.3 Phones in contract: Exterior phone by front door 100- Guardian Telecom Model ACR41. Phone in room 131-Model CIT-41.

.4 Service cable into building to be 100 pair copper.

.5 Analog telephone lines to Rooms 100, 131 and 147.

.2 **Government of Canada IT** is to provide and install:

.1 Switching hardware, rack mounted UPS.

.3 Telephone service provider to provide copper telephone service to building.

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 racks, patch panels, cabling and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect communications equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials.

Part 2 Products

2.1 TELEPHONE WIRE

.1 Cat 6A copper cables.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for communications equipment installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative and Consultant.

.2 Inform Departmental Representative and Consultant 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 and Consultant.

3.2 INSTALLATION

.1 Install VoIP telephone cabling as per data cabling.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by communications equipment installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute

.1 ANSI J-STD-607-A-2002, Joint Standard - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

.2 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)

.1 TIA/EIA-606-2002, Administration Standard for the Commercial Telecommunications Infrastructure.

.3 U.S. Department of Labor/Occupational Safety and Health Administration (OSHA)

.1 Nationally Recognized Testing Laboratory (NRTL).

1.2 SYSTEM DESCRIPTION

.1 Telecommunications grounding and bonding system consist of grounding busbars, bonding backbones, and other bonding conductors.

.2 Provides ground reference for telecommunications systems within building and bonding to it of telecommunications rooms.

.3 Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are bonded to telecommunications grounding and bonding system.

Part 2 Products

2.1 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

.1 Predrilled copper busbar, approved by NRTL, electrotin plated with holes 8 mm diameter for use with standard-sized lugs to: ANSI J-STD-607-A.

.2 Dimensions 6 mm thick, 50 mm wide, 450 mm long to: ANSI J-STD-607-A.

2.2 BONDING CONDUCTOR FOR TELECOMMUNICATIONS

.1 4/0 AWG copper conductor, green insulated to: ANSI J-STD-607-A.

2.3 WARNING LABELS

.1 Non-metallic warning labels in English to: ANSI J-STD-607-A.

.2 Identify labels with wording "If this connector is loose or must be removed, please call the building telecommunications manager".

Part 3 Execution

3.1 TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

.1 Install TGB in main terminal/equipment room and each telecommunications room.

.2 Install #4/0 AWG copper bonding conductor from TGB to alternating current equipment ground (ACEG) enclosure of serving electrical power panel (panelboard).

3.2 BONDING CONDUCTORS GENERAL

.1 When placed in ferrous metallic conduit or EMT longer than 1 m, bond to each end of conduit or EMT using #6 AWG copper conductor.

3.3 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

.1 Install TBBs from TMGB to each TGB as indicated on drawing grounding detail.

.2 Use exothermic welding, approved 2 hole compression lugs for connection to TMGB and TGBs.

3.4 BONDING TO TGB

.1 Bond metallic raceways in telecommunications room to TGB using #2/0 AWG green insulated copper conductor.

.2 For cables within telecommunications room having shield or metallic member, bond shield or metallic member to TGB as per cable manufacturer instructions.

.3 Bond equipment rack located in telecommunications room to TGB using #4/0 AWG green insulated copper conductor.

3.5 LABELLING

.1 Apply warning labels to telecommunications bonding and grounding conductors.

.2 Apply additional administrative labels to: TIA/EIA-606.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for communication raceway systems and include product characteristics, performance criteria, physical size, finish and limitations.

1.2 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect communications equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 Empty telecommunications raceways system consists of outlet boxes, cover plates, distribution racks, conduits, cable trays, pull boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts.

.2 Overhead and wall cable tray distribution system.

2.2 MATERIAL

.1 Conduits: EMT type, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Cable trays: Cablofil wire mesh type, in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.

.3 Junction boxes: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

.4 Outlet boxes, and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

.5 Outlet boxes and fittings in workstation furniture: provided as part of workstation furniture.

.6 Fish wire: polypropylene type.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for communication raceway systems installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative and Consultant.

.2 Inform Departmental Representative and Consultant 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 and Consultant.

3.2 INSTALLATION

.1 Install empty raceway system, including sleeves between floors, overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable tray, miscellaneous and positioning material to constitute complete system.

3.3 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by pathways for communications systems installation.

END OF SECTION

Part 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 Room 184 and other 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 Room 184 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 communications to be carried out by others.

1.3 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:

.1 TIA-569-B (2004) – Commercial Building Standard for Telecommunications Pathways and Spaces

.2 Grounding:

.1 ANSI-J-STD-607-A (2002) – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

.3 Cabling Systems:

.1 TIA/EIA-568-B.1 (2002) – Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements

.2 TIA/EIA-568-B.2 (2001) – Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components

.3 ANSI/TIA-568-B.2-10-2008 – Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 CablingANSI/TIA/EIA-568-B.3-2000 - Optical Fiber Cabling Components Standard

.4 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

.5 TIA/EIA-862 (2002) – Building Automation Systems Cabling Standard for Commercial Buildings

.4 Cabling Administration

.1 TIA/EIA-606-A (2002) – Administration Standard for Commercial Telecommunications Infrastructure

.5 Networking

.1 IEEE Standard 802.3an (2006) – *10GBASE-T* (10 Gb/s Ethernet operations over balanced twisted-pair cabling)

.6 Design

.1 BICSI Telecommunications Distribution Methods Manual (TDMM) – 11th edition

.7 Installation

.1 BICSI Information Transport Systems Installation Manual (ITSIM) – 4th edition (2004)

1.4 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.

1.5 QUALIFICATIONS

.1 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.

.2 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.

.3 Communications contractor shall supply and install a complete system for voice and data.

.4 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.

.5 The communications installer shall be a Communications Cabling Specialist certified by the Dept. Of Labour and obtain all required permits.

1.6 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.

1.7 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.

Part 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 MAIN COMMUNICATIONS ROOM

.1 General Equipment Installation:

.1 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 three racks required in Room 184, (1 rack for data, 1 rack for radio 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.
- Power outlets for racks and cabinets in the Room 184 are to be mounted on the cable tray. Conduit and outlets should be isolated from cable tray. If mounted to overhead cable tray, they should be mounted facing horizontally and be insulated from tray by ¾ " or 19mm plywood offsets. NSS racks require (2) 115V 20A services within 3ft or 1 meter of rack. The server/network cabinet requires a

115V 30A service within 3ft or 1 meter of server cabinet and the PTSS cabinet requires a 115V 30A service within 3ft or 1 meter of the PTSS cabinet. Additional courtesy 15A 120V outlets to be mounted on walls of Room 184 every 8ft or 2.5 lineal meters and on every wall 7ft or 2400 mm and longer.

- Outdoor Weatherproof Telephone – Backboard to be 350mm X 400mm X 25mm all-weather aluminum clad GIS spruce plywood or equivalent. Double sheeted 19mm would be acceptable. The mounting height is +1250mm on-center above finished sidewalk. The flush-mount jack box is to be mounted behind the board, with oversize full clearance hole in center of board for maintenance afterwards. The telephone unit is a Guardian Telecom # ACR-41 (formerly model # WP61HD) from Anixter Canada. The unit is to be supplied and installed by the data/telecom contractor. Phone to be c/w internal ringer and to be analog.

.2 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 Room 184 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 panel*s* 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, Horizontal Cable Section.

.5 Distance limitations – cabling system distances shall not exceed 295ft or 90m (not including patch cables) in any situation. Where a "MUTO" (multiple unit telecommunications outlet) assembly is utilized, the horizontal cable distance should follow Belden specifications. Since 50ft or 15m patch cables are being utilized at the terminal end for MUTO, and up to a 10ft or 3m patch cable at the patch panel end, the total horizontal cable distance shall not exceed 260ft or 79m.

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. Flush mounted. Belden 10GX or approved equal.

.2 Provide labelling as specified.

.3 Where telephone outlets are indicated to be wall mounted (1000mm or higher AFF) provide stainless steel cover plates with 2 stud mounting system for wall telephone equipment. For locations showing + 1500mm Tel outlets, the jack needs to be in a stainless steel 2 pin wall plate for hanging phone on jack. A 2 pin Stainless jack plate is Belden #AX102005, plus white keystone jack #AX101320.

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 Room 184 is to be at least the same amount as the number of ports on the horizontal patch panels. Length of the patch cables is as per section 27 05 13.

.3 Bring 50ft of patch cable from the ceiling MUTO boxes and then 10ft of cable for each outlet.

.4 Patch cables for the municipality/supernet are to be black. Patch cable for network to be sky blue. Patch cables for radio to be red.'

.5 Provide an additional 50 patch cables of 10ft length left in the room 184 for future use. These cables are to be yellow in color.

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 NSS cabinets are required. (See section 2.2. above)

Part 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.

.3 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.

.7 Fire stop systems used for data and communication cabling through rated and non-rated fire separations shall be re-penetrable designs which all for new cables to be pulled without having to re-install new fire stop materials.

.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:

3.2

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.	

.1 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.

.2 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).

.3 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.

.4 Identify each communication outlet with a permanent indelible label using standard numbering scheme.

.5 Identify each patch panel position with the room and outlet number to which the cable is connected.

.6 Network outlets to comprise 8 position connectors as further specified as Belden IBDN, blue in color. Radio outlets to comprise 8 position connectors as further specified as red in color. Municipal outlets to comprise 8 position connectors as further specified as Black in color.

3.3 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

.3 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.

.4 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.

.5 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

Part 1 General

1.1 REGULATORY REQUIREMENTS

.1 Restraints shall meet the requirements of the Alberta Building code for post disaster buildings.

1.2 SEISMIC RESTRAINT DESIGN AND INSPECTION

.1 The contractor is required to provide the services of a registered Professional Structural Engineer who specializes in the restraint of building elements. This structural engineer, herein referred to as the seismic engineer shall provide all required engineering services related to seismic restraints and anchorage for all equipment and services.

.2 The seismic engineer shall provide assistance to the contractor as necessary during the course of restraint of equipment.

.3 The seismic engineer shall inspect the completed seismic installation and shall submit a statutory declaration to the consultant stating that the complete seismic installation is installed in accordance with his drawings and instructions and it complies with the regulatory requirements.

.4 Contractor shall provide and submit Schedule B-C for Seismic Engineering.

.1 Schedule B-l: Letter of commitment by the Registered Professional

.2 Schedule B-2: Summary of Design and Field Review Requirements.

.3 Schedule C-2: Assurance of Professional Field Review and Compliance.

1.3 SCOPE OF WORK

.1 All equipment shall be tested in an independent testing laboratory or shall be certified by a registered professional engineer to demonstrate that the equipment meets the requirements of all codes and bylaws in terms of "withstanding" the lateral forces in any direction to be expected in the project seismic zone. "Withstanding" shall generally mean remaining in one piece and not breaking away from moorings.

.2 Provide certified, professionally sealed shop and placement drawings for all electrical equipment and equipment assemblies including runs of conduit/cable racks showing the methods of attachment to the particular structure for each piece of equipment and assembly and provide anchorage/attachment details approved and sealed by a registered professional engineer for review by the project structural engineer. Submit samples of materials required to complete the seismic restraint work for review if and when requested. Reports to the consultant throughout construction and to provide as required by the authorities having jurisdiction all required "letters of assurance and conformance" with the specified codes, standards and bylaws. If requested by the consultant, calculations sealed by a professional engineer registered in Alberta shall be provided for the seismic restraint design shown on the shop drawings. Shop drawings shall show the equipment type, manufacturer's name, model number and weight of the equipment restrained.

.3 Free-standing equipment shall be fastened to the basic structure using anchorage / attachments to overcome seismic overturning forces as designed by a professional engineer as noted above.

.4 Provide slack cable restraint systems as designed by a professional engineer as described previously but generally as follows:

.1 Connect slack cable restraints to suspended equipment in such a way that the axial projection of the wires passes through the centre of gravity of the equipment.

.2 Oriented restraint wires on suspended equipment at approximately 90° to each other (in plan), and tie back to the structure at an angle not exceeding 45° to the horizontal.

.3 Select each anchor in the structure for a load equal to twice the weight of the equipment with a safety factor of four.

.4 Install cable using appropriate grommets, shackles, thimbles, U-bolts, and other hardware to ensure alignment of the restraints and to avoid bending cables at connection points.

.5 Restraints shall be serviced at least 50 mm clear of all other equipment and services.

.6 Adjust restraint cables such that they are not visibly slack, but such that the flexibility is approximately 35 mm under thumb pressure for a l500 mm cable length (equivalent ratio for other cable lengths).

.7 Provide transverse and axial restraints within four metres of a vertical bend.

.8 Trapeze hangers for cables, cable trays and raceways shall be restrained utilizing a minimum of l0 mm diameter slack cable restraints which shall be provided at a maximum transverse spacing of l2.5 m and longitudinal restraints at 25 m maximum spacing, or as otherwise limited by anchor/slack cable performance. Adjacent spacing of restraints on a run shall vary by approximately 20 percent to avoid coincident resonances.

.9 Transverse bracing for one raceway section may also act as longitudinal bracing for the raceway connected perpendicular to it, provided the bracing is installed within 6l0 mmof the elbow or junction box. Branch runs shall not be used to restrain main runs.

.10 Install a 900 mm length of flexible conduit and a braided bonding jumper in each surface mounted conduit where it crosses a building expansion or seismic joint.

.11 Rigid support systems shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake.

.12 Provide loops in cables and flexible connections in raceways where such services leave a suspended trapeze rack or other support and extend down to floor braced equipment or wall mounted equipment. Freedom of movement shall be up to 300 mm in all directions.

.13 All recessed lighting luminaires in mechanical grid ceilings (i.e., t-bar) shall be restrained using at least two (2) #l6 ASWG stranded stainless steel aircraft cable security bridles per fixture tied to the basic building structure. Attach security bridles at ends of each fixture using a further attachment to each corner of the luminaire and in such a manner that the luminaire cannot fall lower than 300 mm beneath the ceiling.

.14 Surface-mounted lighting luminaires mounted on mechanical grid ceilings shall be attached to the ceiling system with positive clamping devices that completely

surround the supporting members. Security bridles shall be minimum #l6 ASWG stranded stainless steel aircraft cables and attached between the clamping devices and adjacent ceiling hanger or to their structure above in the same manner as described for recessed luminaire supports.

.15 Pendant-hung or chain-hung lighting luminaires shall be provided with minimum #l6 ASWG stranded stainless steel aircraft cables to the structure in the same manner as described for recessed luminaire supports.

.16 Electrical outlet boxes flush mounted in mechanical grid ceilings shall be anchored to ceiling grid.

END OF SECTION

Part 1 General

1.1 SCOPE OF WORK

.1 Access control system is to be rough-in only. Provide rough-in including conduit, wiring, junction boxes and door frame prep as per the details and specifications. Devices will be provided and installed by the owner with programming and testing done by the owner.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 CSA International

.1 Canadian Electrical Code 2015.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for security door supervision systems and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Shop Drawings:

.1 Submit drawings stamped and signed by manufacturer and contractors.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect communications equipment from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging.

Part 2 Products

2.1 DESCRIPTION

.1 System to consist of alarm control panel, door position switches located at door to be supervised.

2.2 CONTROL PANEL

.1 Control panel: DSX control panel surface mounted with modular design. "Power on" light, "reset" key switch, "acknowledge button", common "trouble light, buzzer and silencing switch". Separate alarm lamp, trouble lamp and deactivating key switch for each zone and necessary modules, and relays as required for operation as indicated. Power supply from 120 V ac emergency power circuit with UPS supply to operate complete system. Standby power of UPS sized to provide supervisory and trouble signal current for 4 hours. Capable of differentiating between open line condition and alarm.

Panel to display "trouble" conditions when fault occurs in wiring.

2.3 MAGNETIC DOOR SWITCHES

.1 Door switches: suitable for surface and flush mounting on door as indicated.

2.4 TERMINAL CABINETS AND BLOCKS

.1 Terminal cabinets: Type T. In accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

2.5 END-OF-LINE RESISTORS

.1 Mount end-of-line resistors to control supervisory current in each circuit, in control panel.

2.6 LOCAL ALARM

.1 Buzzer for local alarm at each door location and mount in single gang box as indicated.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for security door system installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Department representative and Consultant.

.2 Inform U of C Campus Security and Consultant 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 Department representative and Consultant.

3.2 INSTALLATION

.1 Install complete door supervision system as indicated and in accordance with manufacturer's instructions.

3.3 SEQUENCES OF OPERATION

.1 System operation: when supervised door is opened, zone indicating lamp flashes and operates audible alarm at control panel. When "acknowledge" button is operated, audible signal is silenced and flashing light changes to steady glow.

.2 System restored to normal when door is closed and "reset" key switch on control panel operated.

.3 Buzzer located at each door to give pulsating signal when door opened. Upon acknowledgment from control panel signal to change to continuous note. Buzzer at door location to be silenced only after door reclosed and "reset" key switch operated. Closing of door alone not to affect signal once it has started to sound.

.4 When deactivating switch is operated, supervised door on that zone opened without

causing alarm. Zone trouble lamp illuminated when zone is deactivated but audible trouble signal not to sound.

.5 Fault in wiring of one zone to cause audible signal to sound even if zone in deactivated position.

3.4 SITE TESTS

.1 Perform tests in accordance with Canadian Electrical Code.

.2 Test system components in presence of Department representative and Consultant to ensure correct operation of system. On completion of tests, submit to Department representative and Consultant commissioning forms and certificate listing components tested.

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by security door system installation.

END OF SECTION

Part 1 General

1.1 SCOPE OF SERVICES

.1 Electrical contractor is to supply and install a complete Panic Alarm system including front end equipment, system components, conduits, wiring, required hardware and software.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Contractor is to provide:

- .1 Product Data.
- .2 Shop Drawings completion.
- .3 Test and Evaluation Reports.
- .4 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .5 Manufacturer's Field Reports.

1.3 CLOSEOUT SUBMITTALS

.1 Operation and Maintenance Data: Contractor is to submit maintenance data for incorporation into Operating and Maintenance manual.

- .1 Include:
  - .1 System configuration and equipment physical layout.
  - .2 Functional description of equipment.
  - .3 Instructions of operation of equipment.
  - .4 Illustrations and diagrams to supplement procedures.
  - .5 Operation instructions provided by manufacturer.
  - .6 Cleaning instructions.

Part 2 Products

2.1 GENERAL

.1 Panic alarms shall be activated by a hardwired panic button(s).

.2 Panic buttons to be strategically located, suitably sized and identified/clearly labeled for “security emergency”.

.3 All panic buttons shall be clearly identified by a label (Brother P2000 or equivalent).

2.2 LOCAL RESPONSE SYSTEM (NOT MONITORED)

.1 The panic alarm system shall be a separate, standalone system and will not be monitored.

.2 Local panic systems will not be integrated into the main intrusion alarm panel.

.3 When the panic alarm push button is pressed, a flashing light and chime (or other unique audible signal) shall sound in designated areas shown on drawings.

.4 Multiple panic alarm locations are provided with the standalone panel shall be installed in Room 184.

.5 Each standalone panic alarm panel will be controlled by an LED keypad that will clearly identify the location of each panic button.

.6 Standard of Acceptance:

Multi-zone non-monitored panel: DSC 1832 or 4020

Panic button: Potter HUB-M (non-latching), HUB-DL-L (Latching LED), GE Sentrol 3045 (non-latching LED)

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for video surveillance installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative, Owner and Consultant.

.2 Inform Departmental Representative, Owner and Consultant 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, Owner and Consultant.

3.2 INSTALLATION

.1 Install a complete Panic Alarm system in accordance with drawings, specifications and manufacturer’s instructions.

.2 Install components secure, properly aligned and in locations coordinated with The Client.

.3 Install required boxes in inconspicuous accessible locations.

.4 Conceal conduit and wiring.

3.3 FIELD QUALITY CONTROL

.1 Schedule site visits to review Work at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 60% and 85% complete.

.3 Upon completion of Work, after cleaning is carried out.

3.4 ADJUSTING

.1 Adjust all components for correct function.

3.5 CLEANING

.1 Progress Cleaning: leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.1 Clean camera housing, system components and lens, free from marks, packing tape, and finger prints, in accordance with manufacturer's written cleaning recommendations.

3.6 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by Panic Alarm rough-in installation.

END OF SECTION

Part 1 General

1.1 RELATED WORK

.1 General Requirements: Section 26 05 00

.2 Conduits: Section 26 05 34

.3 Wiring: Section 26 05 21

1.2 REFERENCES

.1 National Building Code, 2015

.2 Alberta Fire Code, 2014

.3 NFPA 72, National Fire Alarm Code.

.4 NFPA 13, Installation of Sprinkler Systems.

.5 CAN/ULC Standards.

.6 CSA C22.1-15, Canadian Electrical Code, Part I.

.7 Local Jurisdictional Adopted Codes and Standards.

1.3 DESCRIPTION OF SYSTEM

.1 Provide complete, electrically supervised, single-stage, addressable fire alarm system.

.2 System includes:

.1 Fire Alarm Control Panel, to carry out fire alarm and protection functions including; receiving alarm signals, initiating general single stage alarm, supervising system continuously, actuating zone annunciators, initiating supervisory and trouble signals and activating relays, as per the sequence of operation.

.2 Trouble signal devices.

.3 Power supply facilities (including all required cabling, conduit, and circuit breakers).

.4 Manual alarm stations.

.5 Automatic alarm initiating devices.

.6 Audible signal devices.

.7 Isolation devices.

.8 Visual alarm signal devices.

.9 Ancillary devices.

.10 Remote annunciator (as required)

.11 Battery backup.

.12 Booster Circuit Panel (as required)

1.4 ACCEPTABLE MANUFACTURERS

.1 Manufacturers: The equipment and services described in this specification are those supplied and supported by Honeywell, Simplex or Chubb Edwards, and represent the base bid for the equipment.

1.5 SHOP DRAWINGS

.1 Submit shop drawings for final approval within three weeks of award of the project.

.1 Manufacturer's Submittals to include, but not limited to:

.1 Manufacturer's product data sheets for all components, modules and peripherals.

.2 If data sheets show more than one product, the proposed product shall be clearly indicated by arrows or other suitable means.

.3 Battery calculations listing amperage draw for standby and alarm conditions and supplied batteries amp/hour rating. For design criteria, de-rate Manufacturers listed battery capacity by 15%.

.2 Electrical Submittals to include but not limited to:

.1 Circuit loading calculations. (The contractor will be responsible for coordinating with the manufacturer to ensure that all power limited circuits do not exceed their power limitations).

.3 Ensure shop drawings adequately cover all requirements above, prior to submittal to the consultant as one package.

.4 Additional costs incurred to the owner, for subsequent review(s) of shop drawings due to failure to comply with the requirements will be deducted from the Contract amount. Based upon consultant's standard rates.

1.6 OPERATION AND MAINTENANCE DATA

.1 Provide two hard copy sets and one electronic file on either a CD or flash drive of Fire Alarm System operation and maintenance data for incorporation into the Operation and Maintenance manual.

.2 Include operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance, including the following:

.1 Index (Contractor).

.2 Numbered sections (Contractor).

.3 Work site as-built plans that show conduit runs including direction of the wiring provided to the consultant (Contractor).

.4 AutoCAD As-Built Drawings that show conduit runs including direction of the wiring (Consultant).

.5 Approved Shop drawings with technical data - illustrated parts lists with parts catalogue numbers (Contractor).

.6 Verification Inspection certificate signed and stamped by the Engineer-of-Record.

.7 Copies of Change Notices (Contractor).

.8 Copies of Proposed Notices of Change (Contractor).

.9 Site instructions (Contractor).

.10 Closed Permits (Contractor).

.11 Operation and Maintenance Manuals (Contractor).

.12 Fire Alarm manufacturer report(s) (Contractor).

.13 Device list if not included in the above (Contractor).

.14 Warranty certificate (from the VI date or Acceptance date, whichever is the later) (Contractor).

.15 List of contractors (Contractor and Sub-contractors).

.16 List of consultants (Consultant).

.17 Lien Search (Contractor).

.18 Copy of approved as-built drawings.

.19 Copy of all test reports (procedures and results).

.20 Training documents and list of personnel that attended the training orientation and information on maintenance, operation and servicing of all equipment supplied.

.21 A copy of the zone graphic approval drawing.

.22 A copy of the building and electrical permits.

.3 The manuals shall be assembled in a neat and orderly manner into fabric or durable plastic 3-ring binders, clearly identified as to the contents.

.4 All data must be in a neatly typed format and sectionalised.

1.7 MAINTENANCE

.1 Provide one year's free maintenance with one inspection by the manufacturer during the warranty period. Inspection tests to conform to CAN/ULC-S536 latest version. Submit inspection report to Owner and Consultant.

Part 2 Products

2.1 MATERIALS

.1 Equipment and devices: ULC listed and labelled and supplied by a 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 stations: to CAN/ULC-S528.

.7 Thermal detectors: to CAN/ULC-S530.

.8 Smoke detectors: to CAN/ULC-S529.

2.2 SYSTEM OPERATION

.1 Single stage operation: Operation of any alarm initiating device to;

.1 Activate horns (temporal pattern) and strobes throughout the building.

.2 Transmit alarm signal to Department identified monitoring station.

.3 Cause zone of alarm device to be indicated on control panel and any associated remote annunciator(s).

.4 Cause air conditioning and ventilating fans to shut down from the associated duct smoke detector or to function so as to provide required control of smoke movement.

.5 Cause fire doors and smoke control doors if normally held open, to close automatically, unless indicated otherwise.

.2 When a trouble or supervisory signal is detected, the signal shall sound and the device and zone shall be indicated at the control panel and any associated remote annunciator(s). The general building alarm shall not be activated.

.3 Other auxiliary relays will activate as required (where applicable).

2.3 CONTROL PANEL

.1 Single stage operation.

.2 Zoned with a minimum capacity to support all the devices shown on the drawings with the ability to add additional devices without the need to add additional hardware.

.3 New Enclosure: CSA Enclosure 1, complete with lockable concealed hinged door, full viewing window, flush lock and two keys.

.4 New Enclosure shall be surface mounted in the location indicated on the drawings.

.5 Supervised, modular design with plug-in modules:

.1 Fire Alarm Control Panel (FACP) with trouble and alarm indications for class “A” circuits.

.2 Spare zone annunciation: minimum two or 10% spare whichever is greater of existing for alarm and trouble indication.

.3 Space for future modules.

.4 Latching type supervisory inputs.

.5 Discrete indication for both off-normal and trouble.

.6 "Power on" LED (green) to monitor primary source of power to system.

.7 "Power trouble" indication (amber LED).

.8 "Ground trouble" indication (amber LED).

.9 "System trouble" indication (amber LED).

.10 “Alarm” indication (red LED)

.11 "System trouble" buzzer and silence switch c/w trouble re-sound feature.

.12 System reset switch.

.13 "LED test" switch.

.14 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.

.15 "Signals silenced" indication.

.16 All visual indicators shall be high contrast LED type or an LCD text display to meet the CAN/ULC-S527-09.

.17 Detection devices shall be capable of being interchanged without any changes required to the wiring or control equipment.

.18 Master power supply panel to provide 24-VDC to system from 120-VAC, 60-Hz input.

.19 Remote Monitoring Transmitter Connections Terminal.

.20 Plug-in module for shunt type terminal box.

.21 Individual Bypass switch (es) c/w indicator for trouble at panel as follows:

.1 Horn/Strobe (NAC)
.2 Mini Horn (NAC)
.3 Fan shutdown (where applicable)
.4 Door Hold Open Release (where applicable)
.5 Magnetic Lock Release (where applicable)
.6 Clock System
.7 Elevator Recall (where applicable)

.22 Minimum eighty (80) character text display.

.23 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit and c/w individual bypass switch.

.24 Contacts (remote): 2.0-amp, 120-VAC, for functions such as release of door holders or initiation of fan shut down.

.25 Contact terminal size: capable of accepting 22-AWG to 12-AWG wire.

2.4 POWER SUPPLY

.1 120-VAC, 60-Hz input, 24-VDC output from rectifier to operate alarm and signal circuits.

.2 The Contractor is to provide all circuit breakers, conduit, cabling and terminations for the power of the new fire alarm system (and disconnection of power to the existing fire alarm system).

.3 Standby nickel cadmium battery unit with automatic battery charger to provide supervisory and trouble signal current for 24-hours, plus general alarm load for minimum of sixty (60) minutes. Unit is to be sized to carry the complete fire alarm system.

.4 Connection to the new fire alarm system shall be made in accordance with the 2015 Canadian Electrical Code, Rule 32-108. The Circuit breaker for the control unit and any associated power supplies such a NAC booster panels shall not be supplied from a panel board that supplies other circuits such as lighting circuits. Refer to the CEC handbook for further explanation. Confirm with electrical SCO prior to installation.

.5 The related breaker shall be coloured red, labeled as "fire alarm" and have a lock to prevent accidental shut-off.

.6 On the exterior of the breaker panel, control panel and remote power supply door, rivet a lamicoid label with the words "Fire Alarm System is connected to panel #X, circuit #XX", where "X" is the panel number and "XX" is the circuit number to which the fire alarm panel is connected. The label is to have white letters on a red background.

.7 Provide additional NAC booster panel power supplies as necessary, based upon circuit loading calculations.

2.5 MANUAL STATIONS

.1 Manual stations: wall mounted semi-flush, single action with key-operated reset lock, break glass rod or visual activation indication type.

.2 Manual stations shall be of a type that does not have sharp edges or hard pointed corners.

.3 Manual station back boxes shall be colored red, and supplied by the fire alarm equipment manufacturer when surface mounted.

.4 Manual stations are to be supplied with addressable base modules. Such modules shall be integral to the station so that the installer does not have to connect the module first to the station and then to the initiating loop, leaving the module hanging loosely in the back box.

.5 In some high-risk locations, surface boxes are not acceptable. These devices shall be provided with a Plexiglas guard with rounded corners.

.6 Manual stations, shall be located on the latch side of the door within 1500-mm (where possible) immediately beside the door frame in such a way that the station faces down the corridor and is visible at a distance down the corridor. One exception to this rule is when a manual station is to be installed near a cross-corridor.

.7 Replace slot style screws which fasten the manual station assembly to the back box, with similar Robertson square head screws of the same thread size and length.

.10 Manual stations shall be located so that they can be easily seen when the door is open or closed. If in any doubt as to the correct location required, request clarification from the consultant.

.11 Manual pull stations requiring Allen keys or with tension spring retainers to access interior are NOT acceptable.

2.6 AUTOMATIC ALARM INITIATING DEVICES (HEAT DETECTORS AND SMOKE DETECTORS)

.1 Heat detectors shall be;

.1 Rate-of-rise of 8.3ºC (15ºF) per minute and 58ºC (136ºF) fixed temperature combination type: for most applications.

.2 Fixed temperature 58°C (136°F) type: for fan rooms, home economics rooms (if/where applicable – containing stoves and/or clothes irons in sewing areas or where sudden air temperature variations may occur).

.3 Fixed temperature 94°C (200°F) type: for boiler rooms or rooms containing cooking ranges or kilns.

.4 Detectors shall be addressable type, provided with a base suitable for installation of the chosen detector unit, including the following;

.1 Twist-lock Plug-in type with fixed base.

.2 Wire-in base assembly with integral red alarm LED and terminals for remote relay alarm LED.

.5 Where heat detectors are required in rooms that open to the exterior, (such as outside storage rooms) and are subject to inclement weather, use a fixed temperature conventional device and end of line, with an addressable monitoring module to be located in a heated location.

.6 Heat detectors shall be ULC approved for 15.24 m (50') spacing center to center.

.7 Spot type heat detectors shall not be installed directly above equipment that prevents easy access for maintenance. If in doubt as to whether the location is suitable, request clarification from the consultant.

.8 Provide trim skirt attachments to conceal base.

.2 Smoke Detectors;

.1 Addressable photoelectric type in all areas.

.2 Duct detectors shall also be addressable photoelectric type. The sampling tube shall be long enough to completely transverse the duct to provide a representative sample of the air passing through the duct.

.3 Ventilation systems shall not be shut down on general alarm by the fire alarm panel directly. Only the ventilation system in which the smoke is actually detected shall be shut down.

.4 Install a smoke detector in the supply air duct(s) of a multi-floor building where the air handling unit serves more than one floor or fire alarm zone.

.5 Where Duct smoke detectors are located above ceiling tiles or are located where the alarm indicator cannot be easily seen, provide and install a remote duct smoke indicator LED in a suitable location close to the ceiling where the LED can be observed from the floor level.

.6 Baffles shall be installed upon completion of verification of the duct detector (for those types of detectors that require a baffle in the detector unit).

.7 The Contractor shall pay all costs associated with obtaining the elevator contractor to provide shutdown of elevators for any work required in the shaft (including the installation of new detectors).

.8 Smoke detectors shall be ULC approved for 9.14 m (30') spacing center to center.

.9 Spot type smoke detectors shall not be installed directly above equipment that prevents easy access for maintenance. If in doubt as to whether the location is suitable, request clarification from the consultant.

.10 Provide trim skirt attachments to conceal base.

2.7 AUDIBLE/VISUAL SIGNAL DEVICES (HORNS/STROBES)

.1 Class A loop installation.

.2 Horn/Strobe shall be listed to UL 1971 and UL 464 and shall be approved for fire protective service. Horn/Strobe shall be wired as a primary signalling notification appliance and comply with the Americans with Disabilities Act requirements for visible signalling appliances, flashing at 1Hz over the strobe's entire operating voltage range. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. The horn shall have two tone options, two audibility options and the option to switch between a Temporal Continuous pattern. Strobes shall be powered independently of the sounder with the removal of factory-installed jumper wires. The horn shall operate on a coded or non-coded power supply (the strobe must be powered continuously)

.3 Horn/strobe and strobe devices shall be wall or column mounted at a height between 2100mm-2300mm on center and not closer than 150mm from the ceiling.

.4 Strobe type: flashing white, 24-VDC.

.5 Strobes Candela (cd) outputs as per noted on the drawings.

.6 Designed for semi-flush mounting on walls as indicated.

.7 All visual strobes shall be synchronized.

.8 The maximum number of devices connected to a signal loop shall be based on the current rating of the signal card, de-rated to 80%, allowing a minimum spare capacity of 20% for future additions.

.9 All visual strobes mounted outside shall be of weatherproof type and suitable for the location. Outside visual strobes shall be set at 75cd.

.10 NAC (audible and visual) devices shall operate simultaneously, and when the signal silence button is activated shall also stop simultaneously.

2.8 BOOSTER SIGNAL CIRCUIT PANEL

.1 Provide booster circuit panel to accommodate and maintain signal circuit voltage drop. Booster circuit panel as per manufacturer recommendation.

2.9 TAMPER ISOLATION SPRINKLER SWITCHES

.1 For fire protection system valves where a tamper switch is to be installed, supply and install the following, **coordinate with sprinkler contractor**:

- 'Potter' RBVS type tamper switch for Ball Valves;
- 'Potter' PCVS type tamper switch for Butterfly Valves, complete with appropriate butterfly valve kit, and Post Indicator Valves;
- 'Potter' OSYSU type tamper switch for Outside Screw & Yoke Valves;

- 'Potter' PTS-C plug type tamper switch for Non-Rising Stem Valves and where no other type of switch is available or practical.

.2 Unless otherwise noted, 'Potter' PTS-C cord and plug type switches, if used, shall connect to receptacle housings. The receptacle housing covers are to be equipped with a micro-switch or tamperproof screws.

.3 Tamper switches are to be connected to addressable modules with end of line devices installed in separate enclosures.

.4 Tamper switches are to initiate a latching supervisory signal when activated.

2.10 WATER FLOW SPRINKLER SWITCHES

.1 Shall be Simplex 2097 series or similar, sized to fit pipe on designated sprinkler system and with a time delay adjustable up to 90-seconds. **Coordinate with sprinkler contractor.**

.2 Water flow switches are to initiate a general alarm on the fire alarm system when activated. Set the time delay at 30-seconds to avoid nuisance tripping.

.3 Water flow switches are to be connected to addressable modules and each flow switch zoned separately as required by the Code, with end of line devices installed in separate enclosures at 1800mm on center.

.4 All flow switches shall be replaced unless otherwise noted.

2.11 ADDRESSABLE INPUT/OUTPUT MODULES

.1 Input modules shall be used to provide an address for devices that normally would not be supplied with this capability, including tamper switches and flow switches.

.2 Output modules shall be selected for the particular application which they are intended, such as disabling signaling circuits or for equipment control/switching. The contractor shall be responsible for confirming that the power ratings of the contacts are not exceeded.

.3 All modules shall be mounted in locations to minimize vandalism and immediately below standard height T-grid ceilings in close proximity to the controlled device.

.4 Modules shall be mounted in a separate device box and shall be equipped with a faceplate or cover. All addressable modules shall be identified using Brother PT-110 (or similar) identification on the faceplate.

2.12 ISOLATION MODULES

.1 Isolation modules shall be installed to provide separation between zones as indicated on the drawings or as per the Alberta Building Code Div B Article 3.2.4.8. The location of isolation modules will depend on the contractors suggested wiring route. A short circuit on the data communication link within a zone must not affect the operation of any of the other devices located within other fire zone boundaries. Utilize the CAN/ULC-S524-06 for further information as to where the isolation modules are required. If in any doubt as to where the isolation modules are required, request clarification from the consultant.

.2 Isolation modules shall be wired in the Class "A" system configuration.

.3 Isolation modules shall be identified and labelled with the zone numbers which wires are entering and exiting, using a Brother PT-110 (similar) label.

.4 Mount isolation modules in locations that will minimize vandalism and that are below the ceiling.

2.13 END-OF-LINE DEVICES

.1 End-of-line devices sprinkler devices.

.2 Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing off normal condition at main control panel and remotely as indicated.

.3 End-of-Line devices shall be mounted in separate device boxes, and not within signal device boxes, at a height less than 1.8-metres above floor level. Install at 1.6-metres above fixed floor (to the top of the device box), unless otherwise instructed. This also applies to where there is only one device on the circuit.

.4 End-of-Line resistor boxes shall include the fire alarm system manufacturer's cover plates (with clearly indicated resistor symbol) and fire alarm system manufacturer's back boxes painted in red.

2.14 PROTECTIVE GUARDS

.1 Simplex-Grinnell

1. Guard Model 2098-9829C

NOTES:

1. When installing model 2098-9829C, rotate guard so that conduit port is blocked by the perforated tab on the mounting plate.

2. Guard model to be able to handle air velocities greater than 3 meters per minute as a condition of ULC approval.

3. All protective cages must be stamped with manufacturer and model number on the face plate of the protective cage.

.2 Or, Chubb Edwards

1. Guard Model 6255-004

NOTES:

1. When installing model 6255-004, rotate conduit entrance cover 90 degrees to ensure no opening exists when installed.

2. Guard model 6255-004 must be used in air velocities greater than 9 meters per minute as a condition of ULC approval.

3. All grilles must be stamped with manufacturer and model number on the faceplate of the grille.

.3 Or, Vipond

.1 Model KSFDF-002 compatible with Notifier detector FSL-85A

.2 Guard model GIA-2.

.4 Or, Honeywell

.1 Guard Model Smoke Detector

.2 Guard model GIA-2.

2.15 AUTOMATIC SHUTDOWN OF HVAC SYSTEMS

.1 Where duct type smoke detectors are indicated on the drawings, they shall cause the related fan system (both supply and return fans) to shut down on smoke detection. The H.V.A.C. system involved shall be manually reset through the fire alarm panel for operation.

.2 The H.V.A.C. system shall automatically resume operation only when the fire alarm system is manually reset.

.3 Where code or the design requires the HVAC systems to be shut down on a fire condition, the electrical contractor shall be responsible for making the appropriate connections. Their wiring diagram must be reviewed and approved by the consultant before commencing any work. Electrical consultant must be copied on all correspondence.

.4 Install new duct smoke detector(s) in the supply air duct of air handling units (as indicated on the drawings) in accordance with CAN/ULC-S524-06 and manufacturers installation instructions. Confirm correct location with mechanical contractor on site prior to installation.

.5 The HVAC system shall shut down on general fire alarm.

2.16 REMOTE MONITORING TRANSMITTER CONNECTION

.1 Connection shall be verified.

2.17 DEVICE LABELLING

.1 All initiating devices shall be labelled with black letters on white background. Such labels shall be on the outside of the device, where the device is beyond the reach of students. Install labels inside manual stations.

.2 The identification shall be the programmed device number and zone to which it is connected.

.3 Brother P-Touch label system (or equivalent) is minimum standard.

.4 The fire alarm control panel and any remote power supplies must have Lamicoid identification labels.

2.18 GRAPHIC ZONE SCHEMATIC

.1 The Contractor shall install the site zone graphic at a location specified by the consultant. It shall be protected by Plexiglas provided by the Contractor.

.2 As a minimum the graphic shall show the building name and address, a plan of the building showing architectural room numbers, north arrow, “you are here”, Zone schedule and Fire alarm system zones (including duct smoke detector and sprinkler flow switch locations) shall be color coded throughout the zone.

.3 The location of the fire alarm panel, fire extinguishers, hose cabinets, the main electrical and gas shutoff and any Siamese hose connections shall be shown on the graphic, where these are not already shown on the consultant's drawings the contractor shall provide the information.

.4 The graphic is to be installed within three weeks of verification completion.

.5 The Contractor shall provide a temporary zone graphic whilst the new system is swapped over.

2.19 ANCILLARY DEVICES

.1 Remote relay unit to include (but not limited to) to initiate: fan shutdown, gas solenoid shutdown, door release etc., as required.

3.1 INSTALLATION

.1 Design and installation shall comply with CAN/ULC-S524.

.2 Any work or equipment that is necessary to meet manufacturer's specifications for the installation and operation of a code compliant fire alarm system shall be provided by the Contractor as if it were specified.

.3 All work shall be executed in a neat and professional manner by qualified tradespersons to the satisfaction of the consultant.

.4 Modify main control panel and batteries.

.5 Install manual alarm stations and connect to alarm circuit wiring.

.6 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 and provide air baffles as required. Measure the air velocity within the air duct and air pressure differentials between the duct smoke detector sample and exhaust tubes whilst the unit is running. Confirm they are within the manufacturers specified operating parameters for the duct smoke detector and then provide these readings to the consultant prior to wiring the duct smoke detector to the DCL.

.7 Connect alarm circuits to main control panel.

.8 Install remote annunciator panels and connect to annunciator circuit wiring.

.9 Reconnect all door releasing devices.

.10 Install remote relay units to control fan shut down.

.11 Install booster panels (as required) for horn/strobe circuits even not shown on the drawing.

.12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.

3.2 INSTALL SMOKE DETECTOR IN CELL

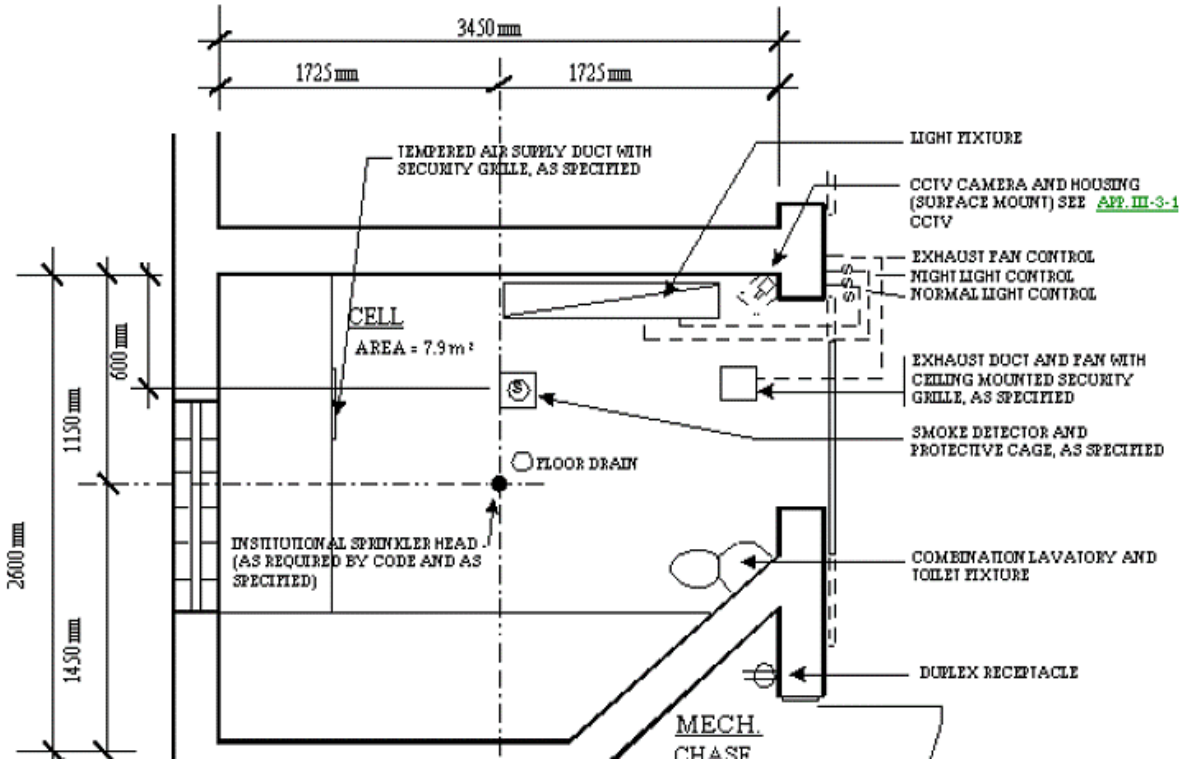
.1 At the location detailed on drawing "Cell Layout, Mechanical and Electrical" Section 1 or at a ceiling area which is less accessible to a detainee, install the following surface mounted equipment: one area-type smoke detector; protected by one RCMP-approved and ULC-listed protective cage.

NOTES:

1. During installation, use high yield grout material to fill any space between the back of the mounting plate and the ceiling surface.

2. ULC listing of protective cages is typically detector specific.

3. Surface conduit not approved.



3.3 WIRING

.1 Use manufacturer approved fire alarm wiring.

3.4 FIRE ALARM SCHEDULES AND PANEL DISPLAY – DEVICE DESCRIPTORS

.1 The contractor shall be responsible for supplying to the design engineer the device schedules with a description for each device with an "ID Tag #" shown on the drawings for approval prior to any programming. The device descriptors shall be provided in an excel file format prior to any programming using the following column headings (the contractor may request an excel file template from the engineer):

.1 DCL Device Descriptions

Device ID TAG #	Device Description (as per 3.3.2 format)

.2

Device ID TAG #	Device Description (physical location)

.2 All DCL descriptors shall be programmed in the following format:

Zone Number – Floor level, Description of Area, Room Number

Example: Z01 - Main flr - Office - RM112

.3 The contractor shall use appropriate abbreviations for the descriptions of areas in the case of limited character display and/or where necessary. Below is a list of approved abbreviations:

AHU	AIR HANDLING UNIT
BOIL	BOILER
BOYS	BOYS WASHROOM
BSMT	BASEMENT
CLOS	CLOSET
CMPR	COMPRESSOR
CONF	CONFERENCE
CORR	CORRIDOR
CTR	CENTRE
DD	DUCT DETECTOR
E	EAST
ED	EDUCATION
ELEC	ELECTRICAL
ENTR	ENTRANCE
FAC	FACILITY
FLR	FLOOR
FS	FLOW SWITCH
GEN	GENERAL
GIRLS	GIRLS WASHROOM
LIB	LIBRARY
INT	INTERSECTION
MEZZ	MEZZANINE
MID	MIDDLE
N	NORTH
NE	NORTHEAST
NET	NETWORK (COMPUTER)
OFF	OFFICE
OP	OPERATOR
OPP	OPPOSITE
PHYS	PHYSICAL
MS	MANUAL STATION
MECH	MECHANICAL
REL	RELOACATABLE CLASSROOM
RM	ROOM
S	SOUTH
S/A	SUPPLY AIR
SD	SMOKE DETECTOR
SE	SOUTHEAST
SPR	SPRINKLER
STAF	STAFFROOM
STAIR	STAIRWELL

STNP	STANDPIPE
STOR	STORAGE
SW	SOUTHWEST
TS	TAMPER SWITCH
VEST	VESTIBULE
W	WEST
W/C	WASHROOM(WATER CLOSET)
WG	WING
WRKRM	WORKROOM

.4 Exact device addressing shall be at the discretion of the fire alarm supplier and based upon their programming requirements. However, must be approved by the Consultant and U of C project manager prior to the verification.

.5 All addressable devices shall be programmed with a unique text identifier.

.6 Any changes to the plans shall be indicated on the as-built drawings, including recording the physical address of the addressable device/module as programmed in the control unit.

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with CAN/ULC-S537-13.

.2 Fire alarm system:

.1 Test each device and alarm circuit to ensure each manual alarm station, heat detector, and smoke detector transmits an alarm to the fire alarm panel and actuates general alarm and ancillary devices.

.2 Test detectors using the *Testifire multi-stimulus detector tester,* or approved equal. For further details refer to www.testifire.com.

.3 Spray-can testers and hairdryers will not be accepted under any circumstances.

.4 Check annunciator panel to ensure zones are displayed correctly.

.5 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.

.6 Class “A” circuits:

.1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near midmost point of circuit.

.2 Reset control unit after each alarm function and correct imposed fault after completion of each test.

.3 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed near midmost point of circuit.

.4 Reset control unit after each alarm function and correct imposed fault after completion of each test.

.7 As part of the field quality control test in accordance with the CAN/ULC-S537-13, the contractor shall coordinate the functional test of the Notification Appliance devices with HDL facility manager to be performed after hours. This

test is to include measuring the sound levels of the speakers in accordance with the CAN/ULC-S537-13 using a calibrated dBA sound level meter, fire alarm speakers' intelligibility shall be measured as well. Provide a record to the consultant of the areas tested with the measurements taken identifying both ambient and alarm sound level readings. Report any areas of concern in writing to the consultant and U of C project manager prior to scheduling the fire alarm verification to be witnessed by the consultant required by item 3.6.

3.6 VERIFICATION AND CERTIFICATION

.1 The manufacturer shall make an inspection of the fire alarm equipment, including those components necessary to the direct operation of the system such as detectors and controls, whether or not manufactured by the manufacturer added under this contract. The inspector shall perform an examination of such equipment for the following:

.1 The type of equipment installed is that designated by the specification.

.2 The wiring connections to all equipment components have met ULC and CSA requirements.

.3 Equipment has been installed in accordance with the manufacturer's recommendations and that all signalling devices have been operated or tested to verify their operation.

.4 The supervisory wiring of equipment connected to a supervised circuit meets code requirements to the satisfaction of the inspection authority. Such wiring will be tested to show the circuit is operating correctly.

.5 To assist the contractor in preparing his bid, the manufacturer shall indicate the number of hours necessary to complete this inspection prior to closing of tenders, and the number of hours necessary to provide a training seminar on the system for the building owner.

.2 The complete verification procedure will be under the control and supervision of a Professional Engineer registered with APEGA and in accordance with the CAN/ULC-S537-13. The services of the contractor and representatives of the fire alarm manufacturer are required for the verification. **Allow for professional engineer's fire alarm verification fee in tender cost**.

.3 The following is a rough breakdown of the responsibilities of each party participating in the verification. This list does not necessarily note all the required work. The contractor and fire alarm manufacturer shall provide equipment and manpower as necessary to complete the verification to the Consultant's requirements and approval.

.1 Contractor:

.1 The Contractor shall have minimum of one (1) electricians and one (1) fire alarm system technician available for the entire verification and for the AHJ inspection.

.2 Provide one pair of radios.

.3 Provide all hand tools and ladders (as required).

.4 Remove/reinstall devices.

.5 Activate alarms with the appropriate detector test equipment, as indicated above.

.6 In the event that the Contractor (or sub-contractor) is not sufficiently equipped, the Verification Inspection will be cancelled at the Contractor's expense.

.7 Activate trouble alarms.

.8 Correct deficiencies.

.9 Adjust fire alarm horn/strobe output setting where required.

.10 Any changes to the BMS/HVAC system must be tested and verified as operational prior to the actual Verification Inspection. The contractor shall include a schematic wiring diagram with the O&M manuals and inside the control box where the changes were made. The company will provide the date, contact name, and number on these documents.

.11 When the Verification Inspection is being completed there must be a supplementary record to confirm the proper operation of the HVAC system (hand, off, auto, BMS controls).

.12 Verification Inspection documents; as-built drawings, O&M manuals, close out letters, certificates, closed permits, etc. must be provided within **one month** of the Verification Inspection date.

.2 Manufacturer:

.1 Ensure correct operation of all alarms, signals, auxiliary functions, trouble indication.

.2 Record all data and issue report similar to that shown in the CAN/ULC-S537-13 Appendix C.

.3 Correct any deficiencies.

.4 Check, calibrate, adjust and confirm correct operation of control panels, annunciator.

.5 Generally assure that all aspects of system function properly.

.6 Provide all test equipment, including but not limited to; manometer, anemometer, dBA sound pressure level meter, speaker intelligibility meter, volt meter, clamp on dc ammeter and fire detector tester.

.7 Record the dBA readings throughout the facility new expansion areas during final verification.

.3 Witness Professional Engineer:

.1 Witness and supervise verification.

.2 Check and ensure that system is installed to all applicable codes and operates properly.

.3 Review test documentation, give to the owner and contractor for forwarding to the fire authorities (where requested).

.4 Issue signed and stamped verification certificate.

3.7 CLEANING AND ADJUSTING

.1 Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

.2 Occupancy Adjustments: When requested, within 1 year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.8 TRAINING

.1 Provide the services of a factory authorized service representative to demonstrate the system, and train Owner's maintenance personnel as specified.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 21 00 – Allowances.

.2 Section 31 05 16 – Aggregate Materials.

.3 Section 31 20 10 – Earthwork General Requirements.

.4 Section 31 23 10 – Site Excavation, Filling and Grading.

.5 Section 31 23 13 – Sitework Subgrade Preparation.

.6 Section 31 23 13-13 – Proof Rolling.

.7 Section 31 23 38 – Trench Excavation and Backfill.

.8 Section 32 05 23 – Sitework Cement and Concrete.

.9 Section 32 11 23 – Aggregate Base Courses.

.10 Section 32 12 13 – Preparatory Coats.

.11 Section 32 12 16 – Asphalt Paving.

.12 Section 32 12 16-13 – Asphalt Paving Materials.

.13 Section 33 05 16-13 – Concrete for Utility Structures.

.14 Section 33 11 00 – Water Utility Distribution Piping.

.15 Section 33 31 00 – Sanitary and Storm Utility Piping.

1.2 REFERENCE DOCUMENTS

.1 Applicable test methods for earthwork testing specified in this Section:

.1 Particle Size Analysis of Fill Materials: Testing for conformance with specified gradation limits will utilize testing sieves complying with CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.2 Compaction Testing: to ASTM D698-91, Laboratory Compaction Characteristics Of Soil Using Standard Effort.

1.3 GEOTECHNICAL SITEWORK TESTING AGENCY SERVICES

.1 The Contractor will appoint and pay for services of a Geotechnical Engineer to perform quality control testing associated with the site grading, underground services and roadway construction, as specified in section 01 21 00 Allowances.

.2 As required by the Contractor and upon the request of the Engineer, the Contractor shall coordinate the Geotechnical Engineer to provide detailed recommendations to site specific requirements, such as a proof roll, or for unforeseen conditions. All recommendations are to be provided to the Consultant of Record and reviewed for contract changes, prior to implementation.

.3 Under no conditions shall the Contractor expect acceptance of sitework without the necessary test results submitted and accepted by the Engineer. The Contractor shall inform the Client and the Engineer if the testing agency is returning test results in excess of 4 weeks. All test results shall be directed to the Engineer, Client and Contractor.

.4 The cost of retests for concrete and asphalt testing, due to original test failures, shall be the responsibility of the Contractor.

.5 Cooperate with testing agency in site sampling for testing.

1.4 FILL MATERIAL TESTING

.1 Provide onsite, for testing purposes, 1 m3 of each type of imported fill material.

.2 Imported fill materials will be tested by the Geotechnical Engineer, before placement, for conformance with requirements and to confirm suitability for intended uses.

.3 Native excavated material to be used as fill material will, before placement, be inspected for compliance with requirements and tested to confirm suitability for intended uses.

1.5 COMPACTION TESTING

.1 Fills for embankments, berms and beneath landscaped areas shall be compacted to 95% of Standard Proctor Density (ASTM D698 Method A) within 2% of optimum moisture content.

.2 Where concrete or pavement structures are to be placed next upon completion of filling, fill shall be compacted to 98% of a Standard Proctor Density (ASTM D698 Method A) within 2% of optimum moisture content.

1.6 OTHER TESTING

.1 Testing associated with subgrade, aggregates, concrete, trench backfill, concrete thrust blocks, asphalt and other Sitework components shall be undertaken as described in the Related Sections which specify field quality control.

Part 2 Products

.1 NOT USED

Part 3 Execution

.2 NOT USED

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Designated classes, gradation and physical requirements of aggregate.

.2 Production and supply of aggregate and quality assurance.

1.2 QUALITY ASSURANCE

.1 The Geotechnical Engineer will conduct sieve analyses to ASTM C136 and other tests to ensure that aggregate being produced and supplied meets the requirements of Tables 2.1, 2.2 and 2.3. The contractor shall provide a daily estimate of production tonnage to the Geotechnical Engineer.

.2 A minimum of one sieve analysis per 500 tonnes of aggregate supplied to a jobsite is required. The aggregate may be sampled from a stockpile at the jobsite or at the gravel pit / crusher site.

.3 If the aggregate fails to meet the specified gradation, the contractor shall suspend gravel placement until proof of compliance with the specification is provided to the Geotechnical Engineer. Alternatively, the contractor may elect to remove the suspect gravel from the jobsite and provide aggregate from a different source.

1.3 STORAGE AND PROTECTION

.1 Place aggregate into stockpile in horizontal lifts of 750 mm maximum thickness. Avoid segregation of particle sizes. Do not dump aggregate over the edges or down the faces of the stockpile. On completion, peak the stockpile at a minimum 3% grade.

Part 2 Products

2.1 MATERIALS

.1 Aggregates shall conform to the requirements in Tables 2.1, 2.2 and 2.3.

.1 Table 2.1: Aggregate Gradation Specifications for Designations 1 – 3

Designation	**1**				**2**	**3**				
Class	**10**	**10**	**16.0**	**20.0**	**20**	**20**	**25**	**40**	**63**	**80**
Application	**10mm-HT**	**10mm-LT**	**SMA**	**20mm-B**	**Soil Cement**	**Granular Base**	**Granular Base**	**Granular Base**	**Granular Base**	**Granular Sub-Base**
80,000										100
63,000								100	100	
25,000				100			100	70-94	55-75	46-85
20,000			100	97-100	100	100	82-97	60-90	50-70	40-81
16,000			97-100	83-97		-	70-93	55-85	44-65	32-76
12,500	100	100	88-100	70-92	60-96	60-96	60-86	50-80	38-60	30-70
10,000	97-100	97-100	30-80	61-84	-	-	52-79	44-74	-	-
8,000	70-94	80-94	-	52-77	-	-	-	-	-	-
6,300	45-85	65-85	22-45	44-70	-	-	-	-	23-47	-
5,000	32-75	50-75	20-35	38-65	36-75	36-75	35-64	32-62	20-45	25-50
2,500	23-55	35-55	16-26	26-52	-	-	-	-	-	-
2,000	-	-	-	-	24-54	24-54	24-50	20-50	14-38	19-42
1,250	16-45	25-45	14-22	18-41	20-43	20-43	19-43	17-43	12-34	15-38
630	11-36	20-36	13-20	13-31	14-34	14-34	14-34	12-34	10-28	10-32
400	-	-	-	-	11-29	11-29	10-27	10-28	8-24	7-27
315	8-26	14-26	12-18	9-22	9-26	9-26	9-24	8-25	7-22	6-24
160	5-15	7-15	10-16	6-14	6-20	6-20	6-18	5-18	4-17	3-18
80	3-8	4-8	10-14	3-7	2-10	2-10	2-10	0-10	0-10	0-10

.2 Table 2.2: Aggregate Gradation Specifications for Designations 4 – 8

Designation	**4**		**5**		**6**		**7**		**8**
Class	**2.5**	**10**	**5**	**80**	**20**	**25**	**10**	**80**	**25**
Application	**Unit Pavers Joint Sand**	**Unit Pavers Bedding**	**Grout Sand**	**Culvert Bedding**	**Sub-Drain Rock**	**Sewer Rock**	**Sewer Backfill**	**Culvert Backfill**	**Radon Rock**
80,000				100				100	
25,000						100			100
20,000				85-100	100				85-100
14,000					90-100				50-90
10,000		100			45-75		100		25-60
5,000		75-95	100	70-90	0-15	10 max	70-100	30-60	0-10
2,500	100	35-70			0-5				0-5
1,250	85-100	20-50							
800				40-80					
630	50-90	10-40							
315	25-60	5-20	50-95						
160	12-30	2-8					5-20		
80	10-15	0-5	25 max	0-15		2 max	0-12	0-15	

.3 Table 2.3: Aggregate Properties

Designation	**1**		**2**	**3**			
Class	**10**	**20**	**20**	**20 & 25**	**40**	**63**	**80**
Application	**10mm-HT & LT**	**20mm-B**	**Soil Cement**	**Granular Base**	**Granular Base**	**Granular Base**	**Granular Sub-Base**
+5000 µm With ≥2 Fractured Faces (% Mass)	*	*	60 min	60 min	75 min	75 min	
Plasticity Index <400 µm	*	*	6 max	6 max	6 max	6 max	
Liquid Limit	*	*	25 max	25 max	25 max	25 max	
LA Abrasion Wear (% Mass)	*	*					
Soundness Loss (% Mass)	*	*					
Lightweight Pieces (% Mass)	*	*	2 max	2 max	2 max	2 max	2 max

* Note: See Section 32 12 16-13 Asphalt Paving Materials for requirements

2.2 EQUIPMENT

.1 Crushers: capable of producing aggregate as specified.

.2 Scale Tickets: Supply truckers with scale ticket forms approved by the local municipality.

.3 Metric Sieves: CAN/CGSB-8.2-M sieve sizes shall replace ASTM E11 sieves as follows:

CAN/CGSB-8.2-M Sieves (µM)	ASTM E11 Sieves (mm)
125 000	125.0
80 000	75.0
63 000	63.0
50 000	50.0
40 000	37.5
25 000	25.0
20 000	19.0
16 000	16.0
12 500	12.5
10 000	9.5
5 000	4.75
2 500	2.36
2 000	2.00
1 600	1.70
1 250	1.18
800	0.850
630	0.600
400	0.425
315	0.300
160	0.150
80	0.075
45	0.045

Part 3 Execution

3.1 EXAMINATION

.1 Crushed aggregate shall consist of sound, hard and durable particles of sand, gravel and rock, free of elongated particles, injurious amounts of flaky particles, soft shale, coal, ironstone, clay lumps and organic and other deleterious material.

3.2 PREPARATION

.1 Adjust and modify aggregate as required to meet gradation requirements by aggregate splitting, elimination of fines, or blending with sand.

END OF SECTION

Part 1 General

1.1 INTENT

.1 This Section specifies general requirements common to all earthwork. Read this Section in conjunction with related Sections which specify requirements for specific types of earthwork.

1.2 RELATED SECTIONS

.1 General Conditions of Contract – Changes in Sub-Surface Conditions.

.2 Section 31 00 10 – Geotechnical Sitework Testing.

1.3 DEFINITIONS

.1 Earthwork: Earthwork means excavating of all types, backfilling, filling, compacting, grading and related work.

1.4 BASIS OF EXCAVATION

.1 For bidding purposes, assume that all excavation work will be "Earth Excavation".

.2 Rock encountered within areas requiring excavation and classified by Engineer as "Rock Excavation in Trenches or Pits" or "Rock Excavation in Open Excavations", will be considered a change in the Work and valued in accordance with the General Conditions of Contract.

.3 Classifications of excavation encountered which are contrary to the foregoing, and are classified as such by Engineer, will be considered a change in the Work and valued in accordance with the General Conditions of Contract.

1.5 UNAUTHORIZED EXCAVATION

.1 Unauthorized excavation shall be any excavation beyond elevations and dimensions indicated, without specific direction by Engineer.

.2 Fill unauthorized excavation to elevations and dimensions indicated.

.3 Unauthorized excavation and remedial work shall be at Contractor's expense.

1.6 EXCAVATION LEVELS

.1 For bidding purposes, assume that the excavation levels will be as indicated on the Drawings.

.2 Notify Engineer if unsuitable subgrade materials are encountered at the design subgrade elevations. Upon approval by the Engineer, carry excavation deeper and replace excavated material with suitable materials.

.3 Adjustments in levels, if approved by the Engineer, will be considered a change in the Work and will be valued in accordance with the General Conditions of Contract.

.4 Contractor is responsible to undertake an earthworks analysis as part of the tender process, using the Grading & Drainage Plan and the Geotechnical Report, to determine the extent of earthworks required on the site. The Contractor shall be responsible for the import of suitable fill materials and the disposal of excess materials off-site, where necessary.

Part 2 Products

2.1 FILL MATERIALS

.1 Imported fill materials will be tested by the Geotechnical Engineer, before placement, for conformance with requirements and to confirm suitability for intended uses.

Part 3 Execution

3.1 PREPARATION

.1 Notify Engineer minimum 2 days prior to beginning excavating operations.

.2 Prior to commencing excavation:

.1 Contact all affected utility companies regarding exact location and current status of all utilities, voltage of underground and overhead power lines and pressure of natural gas lines.

.1 Notify Engineer if any utility lines have been omitted from or incorrectly indicated on Drawings.

.2 Identify known underground utilities. Stake and flag locations. Identify and flag surface and aerial utilities.

.3 Removal and/or relocation of existing utility lines will be coordinated with the Engineer, affected utility company, Contractor and Client to minimize disruption to the construction schedule.

.3 Hydrovac and/or hand excavate building connections, service connections, utilities at sufficient intervals to confirm horizontal and vertical alignment of existing utilities within the proposed work area.

.4 Maintain and protect existing above and below grade utilities which pass through work area. Protect active utility lines exposed by excavation, from damage.

.5 Where existing pipes, ducts or other underground services intersect a trench, support trench in a manner approved by Utility.

.6 Where existing overhead line poles are adjacent to excavations, temporarily support poles in a manner approved by Utility.

3.2 SHORING AND BRACING

.1 If required to provide safe working conditions and to prevent cave-ins and loose soil from falling into excavations, protect excavations by shoring, bracing, sheet piling, underpinning, or other suitable methods.

.2 Underpin adjacent structures which may be damaged by excavation work, including service utilities and pipe chases or cuts.

3.3 DEWATERING

.1 Maintain excavations free of water. Provide pumps, piping, temporary drains, trenches, sumps, and related equipment to remove water.

.2 Do not use sanitary sewers or private property for discharge of water.

.3 The Contractor is responsible for all dewatering costs and should reference the Geotechnical Report for further details on existing groundwater conditions.

3.4 EXCAVATING

.1 Verify topsoil and unsuitable materials have been removed to the satisfaction of the Geotechnical Engineer prior to beginning of excavation, embankment/engineered fill and subgrade preparation. Dispose any remaining topsoil and unsuitable materials off-site.

.2 Do not excavate under wet conditions or when such conditions are anticipated.

.3 When excavating is necessary through roots of plant materials, which are to remain, follow procedures approved by the Landscape Architect or local municipality.

3.5 MATERIAL STORAGE

.1 Native excavated material, other than topsoil, acceptable and required for use as fill material under this Contract: Stockpile on site until required.

.2 Stockpile locations shall be subject to Engineer and Client's approval.

3.6 DISPOSAL OF EXCESS AND WASTE MATERIAL

.1 Native excavated material, other than topsoil, acceptable but in excess of that required for use as fill material under this Contract: Remove from site.

.2 Unacceptable excavated topsoil, unacceptable native excavated material, waste material, trash and debris: Remove from site and ensure proper disposal.

.3 Contractor shall be responsible for all permits and fees associated with all disposal required by this section.

3.7 BACKFILLING

.1 Ensure areas to be backfilled are free of debris, snow, ice, water and that surfaces are not frozen. Do not backfill over porous, wet, or spongy subgrade surfaces.

3.8 COMPACTION

.1 Compact fill materials using only mechanical methods. Do not use hydraulic methods.

.2 Do not perform compaction using vehicles and other equipment not designed for compacting.

.3 Maintain optimum moisture content of materials being compacted, as required to attain specified compaction density.

END OF SECTION

Part 1 General

1.1 INTENT

.1 This section describes the minimum requirements for the supply and installation of a radon mitigation rough-in system.

.2 If, after the building is completed and occupied, long term radon testing results indicate the rough-in system needs to be activated, the installed components provide radon gas extraction points from within the building. Follow Health Canada guidelines for long term radon testing. The Building Owner would then need to mechanically vent the radon to the outside, so that radon levels are controlled within the building.

1.2 REFERENCES STANDARDS

.1 Alberta Building Code 2014.

.2 EPA/625/R-92/016 - 1994 Radon Prevention in the Design and Construction of Schools and Other Large Buildings.

.3 ASTM applicable standards.

.4 Health Canada – Guide for Radon Measurements in Public Buildings – 2016.

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meeting:

.1 Contractor to arrange for a site meeting with the Consultant to review existing conditions and all requirements related to materials, material handling and storage, installation, scheduling, testing, and quality assurance and control, to confirm compliance with manufacturer and installation requirements.

.2 Submittals:

.1 Submit component product information related to the system design drawings and specifications. This includes the geotextile fabric, gas permeable venting layer, membrane barrier system, suction pit and pipe, collection/extension/riser piping, and sealing methods for the slab perimeters and penetrations.

.2 Provide final as-built drawings that indicate the final locations of the collection/ extension/riser pipes and the suction pits and cages.

.3 Quality Control:

.1 Component installation for the radon mitigation rough-in system is to be done by competent and skilled workers having a minimum of two (2) years experience installing vapour barriers, sealants and waterproofing membranes.

1.4 DELIVERY, HANDLING AND STORAGE

.1 Ensure all products delivered to the site meet manufacturer’s quality requirements. Remove and do not use any defective products. Store and handle materials as per manufacturer’s requirements,

recommendations and safety data sheets. Protect materials from construction- and weather-related damage using appropriate coverings and adequate ventilation.

1.5 ENVIRONMENTAL / SITE CONDITIONS

.1 All products and materials are to be stored at temperatures and environmental conditions that conform to manufacturer guidelines.

.2 Perform installation work only when the weather conditions are within installation guidelines established by manufacturer.

.3 Do not proceed with membrane barrier system installation until the substrate preparation and condition is reviewed by the Consultant.

.4 Do not proceed with the concrete slab pour until the membrane barrier system preparation and condition is reviewed by the Consultant.

1.6 WARRANTY

.1 Provide a two (2) year warranty against slab perimeter and penetration sealing defects and/or deficiencies, and confirm that the materials meet performance specifications and installation requirements.

.2 Review all manufacturer's requirements for warranty period before the commencement of work. Ensure that all materials and installations are in conformance with manufacturer and warranty requirements, system design, and requirements of this specification.

1.7 PERFORMANCE REQUIREMENTS

.1 Installation of the geotextile fabric, gas permeable layer, suction pits, collection pipes, membrane barrier system, and sealing methods for the slab perimeters and penetrations for the building concrete in contact with the soil, is to comply with manufacturers requirements, system design, and the requirements of this specification.

.2 All system components are to be chemically compatible with the soil environment (ASTM E154-88).

.3 The radon rock (gas permeable venting layer) is to be a minimum 150 mm layer of clean, coarse, aggregate meeting Section 31 05 16 Aggregate Materials, Designation 8.

.4 The radon membrane barrier system (also the vapour barrier) is to be a minimum, 15 mil polyolefin based resin sheet membrane, meeting the requirements of ASTM E 1745-11.

.5 Radon membrane barrier system is to be overlapped and sealed at all perimeters and floor slab penetrations to provide a continuous seal of the building area in contact with the soil, as per manufacturer requirements, and the requirements of this specification.

.6 Install and seal floor drains, suction pits and collection pipes with polyurethane elastomeric joint compound.

Part 2 Products

2.1 MANUFACTURER

.1 No specific product manufacturers for the radon mitigation rough-in system are identified. All products shall conform to the applicable ASTM standards and the EPA/625/R-92/016 - 1994 technical design document, and as indicated in the design drawings and specifications. Materials and components included for use are to be reviewed by the Consultant.

2.2 GEOTEXTILE FABRIC

.1 The geotextile fabric is to be installed on the subsoil below the radon rock gas permeable venting layer. The geotextile fabric protects the gas venting layer from being contaminated with fines from the subsoil. Other geotextile fabric layers can be proposed.

.2 The geotextile fabric is to have the following physical characteristics:

.1 Non-woven fiber construction with an apparent opening size of 0.15mm.
.2 Unit weight of 340g/m^2 (ASTM D5261)
.3 Grab tensile strength of 1100 N (ASTM D4632).
.4 Elongation of from 45 to 105% (ASTM D4632).
.5 Trapezoid tear resistance of 450N (ASTM D4533).
.6 Puncture resistance of 700N (ASTM D4833).
.7 Mullen Burst of 3600Pa (ASTM D3786).

2.3 GAS PERMEABLE VENTING LAYER

.1 The gas permeable venting layer (radon rock) is to be a minimum 150 mm layer of clean, coarse, aggregate meeting Section 31 05 16 Aggregate Materials, Designation 8.

2.4 MEMBRANE BARRIER SYSTEM

.1 The radon membrane barrier system (also the vapour barrier) is to be a minimum, 15 mil polyolefin based resin sheet membrane, meeting the requirements of ASTM E 1745-11.

.2 All membrane seams are to be prepared, overlapped and sealed as per the manufacturer's recommendations.

.3 Supply and install Blueskin WP 200, or an accepted substitution as a transition between the radon membrane and upturn onto grade beams, foundation walls, footings or any item that penetrates the finished floor slab, mechanically fasten on 300mm centers. Joints are to be designed to accommodate anticipated movement.

.4 Gas tight seals are to be provided around the surfaces of all vertical penetrations. Such surfaces are to be prepared as per manufacturer's requirements to facilitate membrane adherence. Use Blueskin WP 200, sealants and construction tape as required to provide a continuous seal between radon membrane and any pipe, conduit or other item that penetrates the floor slab.

2.5 SUCTION PIT

.1 The suction pits and pipes are to be as shown on drawings.

.2 Ensure that a vertical collection riser pipe extends a minimum 300 mm above the finished floor slab before a piping connection.

2.6 COLLECTION, EXTENSION AND RISER PIPES

.1 The collection, extension and riser pipe locations are to be as shown on 4 System Details.

.2 The collection, extension and riser pipes are to consist of non-perforated smooth walled 150mm diameter rigid pipe of XFR, or High-Density PE construction, with joints fully sealed.

.3 A vertical riser pipe is to be installed at each suction pit location and extend from the suction pit to a minimum of 600mm above the finished roof membrane.

Part 3 Execution

3.1 INSTALLATION

.1 Contractor to review footing, wall and grade beam building construction drawings, and review radon mitigation rough-in system design drawings and specifications to ensure proper understanding before installation.

.2 All installation work is to be reviewed by the Consultant.

.3 Each individual sub-slab area isolated by building footings, foundation walls or grade beams is to be connected to an installed radon roughed-in mitigation system. The system design may use collection piping to draw radon gas from multiple sub-slab areas to a single suction pit, to minimize the number of suction pits.

.4 Prepare sub-grade surface prior to installation of the geotextile fabric, suction pits, and collection, extension and riser piping, as per the elevations specified in the building construction drawings and specifications.

.5 Place geotextile fabric layer over the entire sub-grade surface, with sufficient overlaps as per the manufacturer's requirements.

.6 Construct and install the suction pits in locations as shown on drawings.

.7 Install collection/extension/riser pipes in sub-grade beams between all interior grade beams. Exterior grade beams are not required to have pipes. Refer to Typical Radon Gas Sleeve Penetration on Drawing S0.4.

.8 All pipe joints are to be solvent welded and fully inserted into coupling or fitting to ensure joint integrity as per manufacturer's instructions.

.9 The gas permeable venting layer (radon rock) is to be a minimum 150 mm layer of clean, coarse, aggregate meeting Section 31 05 16 Aggregate Materials, Designation 8.

.10 The gas permeable venting layer (radon rock) is to be constructed by placing, grading and compacting it over the entire sub-grade surface, and geotextile layer. Ensure the suction pit remains clear of the gas permeable venting layer (radon rock).

.11 At completion of the substrate, component and gas permeable venting layer, the Contractor is to contact the Consultant to review the installation of this portion of the system.

.12 After review of the substrate, component and gas permeable venting layer installation, the membrane barrier system construction can commence.

.13 Membrane barrier system is to be placed over the gas permeable venting layer (radon rock). All membrane overlaps and sealing is to be done as per the manufacturer's requirements and specifications.

.14 Membrane barrier system installation is to be performed by trained qualified installers using manufacturer's recommended techniques and equipment.

.15 Membrane barrier system is to be a minimum, 15 mil polyolefin based resin sheet membrane, meeting the requirements of ASTM E 1745-11.

.16 Membrane barrier system is to be installed and sealed around all vertical penetrations with sufficient overlap and using Blueskin, sealant and construction tape or chemical welded seams as per manufacturer's requirements and specifications.

.17 At completion of the membrane barrier system, Contractor is to contact the Consultant to review the membrane barrier system.

.18 After review of the radon mitigation rough-in system installation, the floor slab construction can commence.

.19 Care must be taken not to puncture the membrane during floor slab construction. To limit membrane puncture during floor slab construction, items such as rebar chair supports designed with a wide base (instead of legs) are recommended to better spread the rebar load.

.20 Once concrete floor slab has cured sufficiently to allow work to proceed on it, clean joint surfaces in accordance with manufacturer's instructions and seal all finished floor slab perimeter cold joints and any other floor slab penetration junctions between dissimilar materials using high quality sealants suitable for use on each subject material surface. Test sealant to confirm adhesion with all surfaces prior to use.

.21 The above slab exposed joints in the riser pipes must be 100% solvent welded to provide a complete seal.

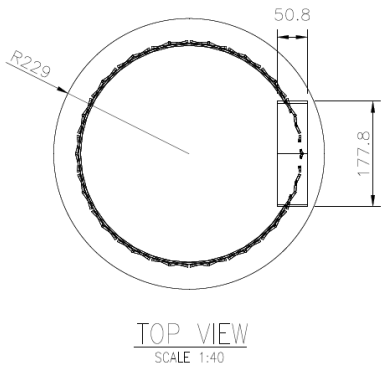
.22 The above slab exposed riser pipe to be labeled to identify as part of the Radon Mitigation Rough-in System.

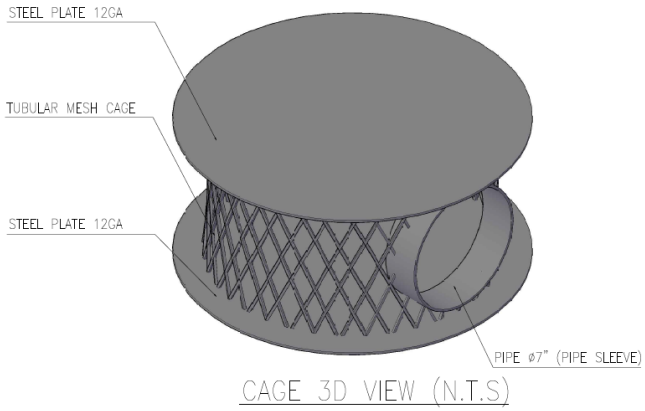
.23 At completion of the slab perimeter and penetration sealing and capping and labeling of the exposed riser pipes, Contractor is to contact the Consultant for a final review of the installation.

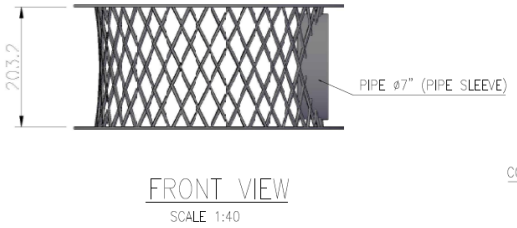
.24 When final review of the installation of the slab perimeter and penetration sealing and labeling of the exposed riser pipes has been completed by the Consultant, the passive radon mitigation rough-in system is considered complete.

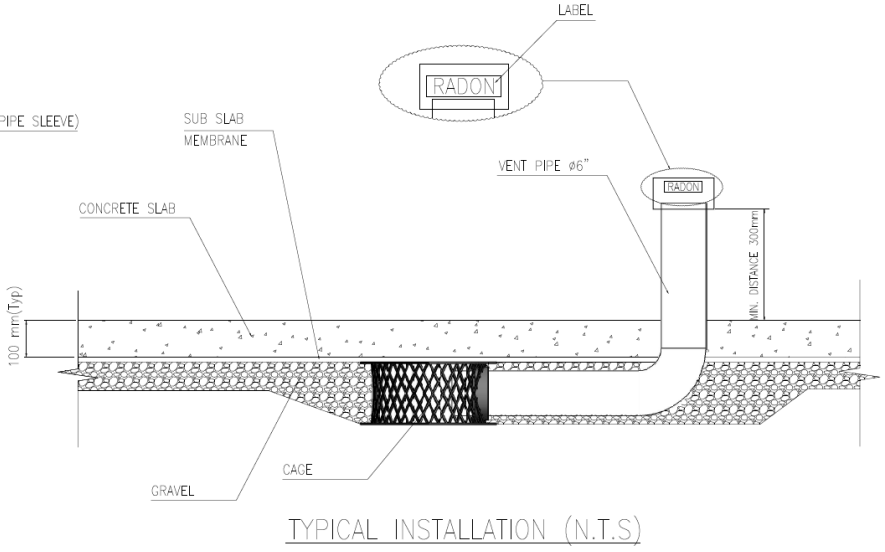
.25 Deficiencies in the radon mitigation rough-in system are to be corrected in accordance with this specification and as per instructions from the Consultant.

3.2 System Detail









END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 00 10 – Geotechnical Sitework Testing.

.2 Section 31 20 10 – Earthwork General Requirements.

.3 Section 31 23 13 – Sitework Subgrade Preparation.

1.2 SECTION INCLUDES

.1 Excavation of soil for construction of roadway and associated structures.

.2 Construction of fill.

.3 Disposal of surplus and unsuitable materials.

1.3 DEFINITIONS

.1 Common Excavation: includes topsoil, clay, silt, sand, gravel and peat within a jobsite.

.2 Borrow Excavation: includes select topsoil, clay, sand and gravel from off the jobsite for use as fill within a jobsite.

.3 Garbage Excavation: includes household, commercial and industrial refuse or any other deleterious material.

.4 Fill: any earth structure built up by successive lifts of a specified material compacted to specified densities.

.5 Berm: a type of fill for a specific purpose, such as for noise attenuation or landscaping, as indicated on the drawings.

1.4 AS-BUILT DRAWINGS

.1 Provide as-built drawings on completion of contract. Contractor to supply as-built grading plan prepared by a surveyor in ACAD and pdf format that captures the as-built, geodetic elevation of all design elevations shown on the Grading & Drainage Plan.

Part 2 Products

2.1 MATERIALS

.1 Suitable Materials: The Geotechnical Engineer will determine the suitability of excavated materials for use in embankments, subgrade, backfill, berms and any other purpose.

.2 Salvageable Materials: When directed by the Geotechnical Engineer, reserve and stockpile at designated locations topsoil, sand, gravel, surplus fill and other materials deemed salvageable by the Geotechnical Engineer.

.3 Unsuitable Materials: Remove and dispose off-site of peat, roots, stumps, topsoil, frozen soil, garbage and any other material deemed unsuitable by the Geotechnical Engineer.

2.2 EQUIPMENT

.1 Only vehicles licensed for highway use shall be used for hauling on developed roadways.

.2 Off-highway earthmoving equipment shall not travel along or across developed roadways, unless authorized in writing by the local municipality before work starts.

.3 Equipment shall be adequately muffled to conform to local noise abatement bylaws.

Part 3 Execution

3.1 EXCAVATION

.1 Excavate to designated cross-sections. Complete initial excavation and exercise caution to preserve bank stability where necessary. Stage excavation to allow related work. The Engineer will provide an electronic base plan for use during the grading operation.

.2 Use of Excavated Soil: Use Geotechnical Engineer-approved excavated soil to construct embankments, subgrade, berms, boulevard fill, trench backfill and for other purposes as directed.

.3 Borrow Excavation: The Contractor is responsible to determine whether there is sufficient on-site suitable material for jobsite use. If not, the Contractor is responsible for costs associated with acquisition of additional suitable material from a borrow site. Excavate, load, haul, place and compact, as required.

.4 Undercut: When excavation exposes unsuitable materials below the subgrade elevation and the Geotechnical Engineer directs removal, excavate such materials using transition slopes no steeper than 10%. Make the bottom of the cut level, with no loose material.

.5 Over-Excavation: Where over-excavation occurs, restore grades by backfilling, compacting and re-grading as directed by the Geotechnical Engineer. If over-excavation is the result of the Contractor's error, no claim shall be made for the excess excavation and grade restoration.

.6 Excess Topsoil and Suitable Fill Soils: The Contractor shall dispose of all excess soils off-site at the Contractor’s cost and at a location to be chosen by the Contractor.

3.2 FILL

.1 Preparation: Where necessary, clear and grub the base of fill, remove topsoil, other unsuitable materials and granular base and scarify the base to ensure bond with fill material.

.2 Soil Moisture Alteration: The required compaction can best be achieved if the soil is dried or moistened to within ±2% of optimum moisture content. The Contractor is responsible to condition the soils, as necessary, to achieve the required compaction.

.3 Fill Placement and Compaction: Place and spread fill material in successive horizontal lifts, each lift not exceeding 150 mm thickness when compacted. Compact each lift to the required density using suitable equipment.

.4 Berm: Unless indicated otherwise on drawings or directed by the Geotechnical Engineer, build up the berm by spreading layers of approved material not more than 300 mm thick. Grade each layer using at least three passes of the spreading equipment.

3.3 SIDE SLOPES

.1 Trim slopes of cuts, fills and berms from top to bottom. Leave the base of the slope neatly trimmed by removing lumps or loose material, or by blending loose material into the base. Finish slopes true to designated alignment, grade and shape.

3.4 FIELD QUALITY CONTROL

.1 Grade Tolerances: Check graded surfaces to ensure they meet a grade tolerance of ±25 mm maximum variation from designated grade elevations and that crossfall and bottoms of ditches are graded to create positive flow:

.1 When tolerance is exceeded: Trim high areas to within tolerance and scarify low areas, backfill with approved material, compact to required density and regrade to within tolerance.

.2 Density Requirements:

.1 Maximum density: as used in this section, is the dry unit mass of sample at optimum moisture content as determined in the laboratory according to ASTM D698 Method A.

.2 The required densities for fill are:

.1 Fills for embankments, berms and beneath landscaped areas shall be compacted to 95% of Standard Proctor Density (ASTM D698 Method A) within 2% of optimum moisture content.

.2 Where concrete slabs or pavement structures are to be placed next upon completion of filling, fill shall be compacted to 98% of a Standard Proctor Density (ASTM D698 Method A) within 2% of optimum moisture content.

.3 Testing Frequency: The quality assurance laboratory will take a minimum of one field density test for each 2 000 m2 of compacted lift, or approved alternate frequency, according to ASTM D1556, ASTM D2167, or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method A.

.4 Noncompliance: If a density test result is less than the required density, that test result is to be recorded as "failed" and a retest shall be performed on the area represented by the failed test. If the retest is less than the required density, the area shall be reworked to the full depth of the lift, the soil moisture altered as necessary and re-compacted to the required density.

.5 If the lift is covered before the Geotechnical Engineer has accepted the test results then the Contractor assumes the risk of uncovering and reworking the compacted lift.

3.5 PROTECTION

.1 Drainage: If the work area floods, drain immediately by natural flow or by pumping into catch basins, manholes or ditches. The Contractor is responsible to maintain positive drainage and mitigate rutting caused by construction equipment at all times during construction to prevent damage to the subgrade materials due excessive moisture.

.2 Protect subgrade materials and finished grades from damage. The Contractor is responsible to repair and retest damaged areas, as required by the Geotechnical Engineer.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 23 10 – Site Excavation, Filling and Grading.

.2 Section 31 23 13-13 – Proof Rolling.

1.2 SECTION INCLUDES

.1 Working and compacting sitework subgrade soil.

1.3 DEFINITION

.1 Prepared subgrade: soil immediately below a pavement structure or slab, compacted to a depth of 150 mm, or as specified on the Drawings, and to extend horizontally to 300mm past the back of curb or edge of asphalt.

1.4 QUALITY ASSURANCE

.1 Maximum Density: the dry unit mass of a soil sample at optimum moisture content as determined in the laboratory according to ASTM D698 Method A.

.2 Required Density: a minimum of 100.0% of the maximum density for each 150 mm lift of subgrade under pavement structures, concrete curb, concrete gutter, commercial and alley crossings, garbage pads and asphalt walks/bikeways and a minimum of 97.0% of the maximum density for each 150 mm lift of subgrade under concrete walks, curb ramps, slabs, private crossings and walk made of concrete pavers, brick pavers, or granular materials.

.3 Testing Frequency: the quality assurance laboratory will take a minimum of one field density test for each 1 000 m2 of compacted subgrade lift according to ASTM D1556, ASTM D2167, or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method A or as directed by the Engineer.

.4 Proof Rolling: a proof roll of the finished subgrade will be required to confirm adequate bearing capacity of the subgrade soils. The proof roll shall be supervised by the Engineer, and must be performed in accordance with the Geotechnical Engineer’s recommendations

Part 2 Products

2.1 MATERIALS

.1 Use only compacted clay subgrade soil with no deleterious material approved by the Engineer.

2.2 EQUIPMENT

.1 Equipment: various pieces of equipment designed for and capable of disking, scarifying, spreading, spraying water, compacting and trimming soil to specified depth.

Part 3 Execution

3.1 EXCAVATION

.1 Loosen soil to required depth. Work soil with cultivating and mixing equipment until soil is pulverized into pieces no larger than 25 mm maximum dimension, exclusive of stones.

.2 The required compaction can generally best be achieved if the soil is dried or moistened to within ±2% of the optimum moisture content before compacting.

.3 If the Engineer and Geotechnical Engineer determine that the soil stability is insufficient following the proof roll, they may order alternate treatments.

.4 Leave the surface of the compacted subgrade slightly higher than required elevation; then trim to design crown and grade. Leave finished surface even and free of depressions, humps and loose material.

3.2 FIELD QUALITY CONTROL

.1 Check finished surface of subgrade to ensure it meets the following tolerances:

.1 Grade: 6 mm maximum variation above designated elevation. 25 mm maximum variation below designated elevation.

.2 When Tolerance Exceeded

.1 Trim high spots and refinish surface to within tolerance.

.2 Add approved material to low areas, scarify and blend to full subgrade depth, recompact to required density and refinish surface at the contractor's expense. Alternatively, fill low areas with extra thickness of subsequent granular sub-base or base course at the contractor's expense.

.3 If a density test result is less than the required density, that test result is discarded and a retest shall be performed on the area represented by the failed test. If the retest is less than the required density, the area shall be reworked to the full depth of the lift, the soil moisture altered as necessary and recompacted to the required density.

.4 The Contractor shall assume the risk of uncovering and reworking the subgrade if it is covered before the Engineer has accepted test results thereof.

3.3 PROTECTION OF FINISHED WORK

.1 Do not permit vehicular traffic over the prepared subgrade.

.2 If folding of the subgrade occurs, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches. This shall be done at the expense of the Contractor.

.3 Maintain protection of prepared subgrade until subsequent granular sub-base or base course is placed. Repair and retest as required by the Engineer if damaged.

.4 Install wick drain and connect to catchbasins, as per Drawings and manufacturer's specifications.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 00 10 – Geotechnical Sitework Testing.

.2 Section 31 23 10 – Site Excavation, Filling and Grading.

.3 Section 31 23 13 – Sitework Subgrade Preparation.

.4 Section 32 11 23 – Aggregate Base Courses.

1.2 SECTION INCLUDES

.1 Verifying the stability and uniformity of the subgrade and aggregate base course compaction. This procedure shall be performed in the presence of the Engineer, or its designate, and the Geotechnical Engineer. Actual requirements for representation on the project site for the proof rolling operation will be site dependent.

1.3 EXECUTION

.1 Equipment

.1 The vehicle used to perform the Proof rolling shall conform to the following**:**

.1 Tandem axle, dual wheel dump truck, fully loaded water truck or grader.

.2 Tire pressure shall be no less than 90 percent of the manufacturer's recommended maximum inflation.

.3 The minimum gross weight of the loaded vehicle shall be 24,800 kg.

1.4 PROCEDURE

.1 The proof rolling vehicle shall be operated at a rate not to exceed 3.0 to 6.0 km/hr. or a comfortable walking pace. Adjust the speed to allow the Inspector/Engineer to measure any deflections and/or areas of rutting.

.2 Operate the proof roll in a pattern so that all areas are loaded with at least one pass of the proof rolling vehicle**.**

.3 After proof rolling, check the subgrade or granular base course for conformance to the plans, and correct all surface irregularities. Re-shape the subgrade or granular base course to specified tolerances.

1.5 EVALUATION

.1 There shall not be any discernable rutting during the proof roll. Visible rutting greater than 100 mm, shall be considered a failure and will require the subgrade or granular base course to be reworked and compacted.

.2 There shall not be any discernable deflection (pumping) during the proof roll. Visible deflections of greater than 100 mm, shall be considered a failure, and will require the subgrade or granular base course be reworked and compacted.

.3 Rutting and/or deflections in excess of 100 mm must be reviewed by a Geotechnical Engineer, who is to provide recommendations as to how to meet density and performance requirements.

.4 When remedial work is performed under Item 1.5.3, a final proof roll must be performed upon completion of the work. If remedial work is performed as directed under 1.5.1 or 1.5.2, a second proof roll may be required at the discretion of the Engineer, or its designate.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 05 16, Aggregate Materials

1.2 REFERENCE STANDARDS

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

- .1 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 ASTM D1557-12e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2,700 kN-m/m3).
- .3 ASTM D4318-17e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

.2 Canadian Standards Association (CSA International)

- .1 CAN/CSA A3000-13, Cementitious Materials Compendium.
- .2 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

1.3 DEFINITIONS

.1 Fill classes:

- .1 General Engineered Fill: comprised of clean, inorganic granular or clay soils, used in areas where a moderate potential for subgrade movement is tolerable.
- .2 Select Engineered Fill: comprised of clean, well graded granular soils or inorganic low to medium plastic clay soils, used below slabs on grade and within the building footprint.
- .3 Structural Engineered Fill: comprised of clean, well-graded inorganic granular soils, used below slabs on grade.

.2 Waste material: excavated material unsuitable for use in Work or surplus to requirements.

.3 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.

.4 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.

.5 Unsuitable materials:

- .1 Weak, chemically unstable, and compressible materials.
- .2 Frost susceptible materials.

.6 Unshrinkable fill: very weak mixture of Portland cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.4 SUBMITTALS

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

.2 Inform Consultant at least 4 weeks prior to beginning Work, of proposed source of fill materials.

1.5 TESTING

.1 Comply with requirements of Division 1.

.2 Pay for costs of tests as specified in Section 01 29 83 – Payment Procedures for Testing Laboratory Services.

.3 Cooperate with testing agency in site sampling for testing, and in compaction testing.

1.6 FILL MATERIAL TESTING

.1 Provide on site, for testing purposes, 1 m3 of each type of imported fill material.

.2 Imported fill materials shall be tested, before placement, for conformance with specified requirements and to confirm suitability for intended uses.

.3 Native excavated material to be used as fill material shall, before placement, be inspected for compliance with specified requirements and tested to confirm suitability for intended uses.

1.7 COMPACTION TESTING

.1 Compaction testing shall be performed during fill material placement operations to ensure that specified minimum compaction requirements are met.

.2 Frequency of compaction testing shall be as specified in Section 31 23 10 – Site Excavation, Filling and Grading.

1.8 QUALITY ASSURANCE

.1 Do not use soil material until written report of soil test results are reviewed by Consultant.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Storage and Protection:

.1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.

.2 Existing buried utilities and structures:

.1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

.2 Contact all affected utility companies regarding exact location and current status of all buried utility lines. Identify all known underground utility lines and stake and flag locations. Identify and flag surface and aerial utility lines.

.3 Notify the Consultant if any utility lines have been omitted from or incorrectly indicated on the drawings.

.4 Expose existing utility lines by hand excavation to confirm location.

.5 Maintain and protect from damage water, sewer, gas, electric, telephone and other utilities and structures encountered. Support utility lines in trenches in a manner approved by the Utility.

.6 Where utility lines or structures exist in area of excavation, obtain direction of Consultant before removing or re-routing.

.7 Record location of maintained, re-routed and abandoned underground lines.

.8 Confirm locations of recent excavations adjacent to area of excavation.

.3 Existing buildings and surface features:

.1 Conduct, with Consultant, 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 Consultant.

.3 Where required for excavation, cut roots or branches as directed by Consultant.

.2 Construction/Demolition Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Collect and separate for disposal all packaging for recycling in accordance with Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Handle and dispose of hazardous materials in accordance with all federal and provincial laws, regulations, codes, and guidelines.

.5 Ensure emptied containers are sealed and stored safely.

.6 Divert excess aggregate materials from landfill to local recycling facility for reuse as directed by Consultant.

1.10 UNAUTHORIZED EXCAVATION

.1 Unauthorized excavation shall be any excavation beyond the elevations and dimensions indicated, without specific direction from the Consultant.

.2 Unauthorized excavation and remedial work shall be at the Contractor’s expense.

Part 2 Products

2.1 MATERIALS

.1 General Engineered Fill: properties to Section 00 31 00 – Available Information Document and the following requirements:

- .1 Low to high plastic clay, inorganic, free of deleterious materials
- .2 Materials meeting Select Engineered Fill or Structural Engineered Fill

.2 Select Engineered Fill: properties to Section 00 31 00 – Available Information Document and the following requirements:

- .1 Low to medium plastic clay:
  - .1 Liquid limit: 20 to 40%
  - .2 Plastic limit: 10 to 20%
  - .3 Plasticity Index: 10 to 30%
- .2 Pit run gravel or fill sand:
  - .1 Pit run gravel: properties to Section 31 05 16 – Aggregate Materials, Designation 3, Class 80 (Granular Sub-base).
  - .2 Fill sand: properties to Section 31 05 16 – Aggregate Materials, Designation 7, Class 10 (Sewer Backfill).

.3 Structural Engineered Fill (Main building): properties to Section 31 05 16 – Aggregate Materials, Designation 8 (Radon Rock).

.4 Structural Engineered Fill (Outbuildings): properties to Section 31 05 16 – Aggregate Materials, Designation 3, Class 25 (Granular Base).

.5 Native Excavated Material: clean, native excavated soil, low to medium plastic, free from organic matter, frozen materials, stones larger than 75 mm, building debris and other foreign substances.

.6 Geotextile Fabric: refer to Section 31 21 13 – Radon Mitigation Rough-in System.

Part 3 Execution

3.1 SITE PREPARATION

.1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.2 Identify all known underground utilities with stakes and flags. Identify and flag all surface and above ground utility lines.

.3 Expose existing utility lines by hand excavation to confirm location before machine digging within 600 mm of lines.

3.2 STOCKPILING

.1 Stockpile fill materials in areas designated by Consultant. 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.

3.3 SHORING AND BRACING

.1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Occupational Health and Safety Act for the Province of Alberta.

3.4 DEWATERING AND HEAVE PREVENTION

.1 Keep excavations free of water while Work is in progress.

.2 Submit for Consultant's review details of proposed dewatering or heave prevention methods.

.3 Protect open excavations against flooding and damage due to surface run-off.

.4 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures 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.

.5 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.

3.5 EXCAVATION

.1 Advise Consultant at least 7 days in advance of excavation operations.

.2 Excavate to lines, grades, elevations and dimensions as directed by Consultant.

.3 Remove paving, sidewalks, and other obstructions encountered during excavation.

.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 Keep excavated and stockpiled materials safe distance away from edge of trenches as directed by Consultant.

.7 Restrict vehicle operations directly adjacent to open trenches.

.8 Dispose of surplus and unsuitable excavated material off site.

.9 Do not obstruct flow of surface drainage or natural watercourses.

.10 Excavate to elevations and dimensions indicated on drawings within a tolerance of plus or minus 50 mm, and extending a sufficient distance from grade beams and walls to permit placing and removal of concrete formwork, installation of services, other required construction, and for inspection.

.11 Remove unsuitable materials from trench bottom including those that extend below required elevations to extent and depth as directed by Consultant.

.12 Correct unauthorized over-excavation as follows:

.1 Fill under bearing surfaces with structural engineered fill compacted to not less than 100% of corrected Standard Proctor maximum dry density.

.2 Fill under other areas with general engineered fill compacted to not less than 95% of corrected Standard Proctor maximum dry density.

.13 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.

3.6 SUBGRADE PREPARATION

.1 Outbuildings: Subgrade to be constructed in accordance with recommendations for subgrade preparation- Partial Replacement Option- in soils report (see Section 00 31 00 – Available Information Document).

.2 Main building: Subgrade to be constructed in accordance with recommendations for subgrade preparation- Structurally Supported Floor Slab.

3.7 FILL TYPES AND COMPACTION

.1 Use types of fill as indicated or specified below, unless noted otherwise. Compaction densities are percentages of maximum densities obtained from ASTM D698.

.1 Exterior side of perimeter walls and grade beams, excluding where sitework concrete or pavement structures are to be placed: use General Engineered Fill to subgrade level. Compact to 95% of Standard Proctor Density.

.2 Within outbuilding area, under slabs on grade: use Select Engineered Fill to underside of base course for floor slabs. Compact to 98% of Standard Proctor Density for clay and 100% for granular fill. Place clay between optimum and 2% above optimum moisture content. Base course: 300 mm of Structural Engineered Fill, compacted to 98% of Standard Proctor Density.

.3 Under structural slabs on grade: use Select Engineered Fill, compacted sufficiently to support slab until concrete has reached its 28 day strength.

.4 Within main building area, under concrete slabs: provide 150 mm compacted thickness base course of 20 mm crush Structural Engineered

Fill (Radon Rock), vibrated with a light plate tamper, over geotextile fabric.

3.8 BEDDING AND SURROUND OF UNDERGROUND SERVICES

.1 Place and compact granular material for bedding and surround of underground services as indicated.

.2 Place bedding and surround material in unfrozen condition.

3.9 BACKFILLING

.1 Use compaction equipment as indicated in Section 00 31 00 – Available Information Document.

.2 Do not proceed with backfilling operations until completion of following:

- .1 Consultant has inspected and approved installations.
- .2 Consultant 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.

.3 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.

.4 Do not use backfill material which is frozen or contains ice, snow or debris.

.5 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer to the minimum percentages of Standard Proctor Density before placing succeeding layer.

.6 Backfilling around installations.

- .1 Place bedding and surround material as specified elsewhere.
- .2 Do not backfill around or over cast-in-place concrete within 14 days after placing of concrete.
- .3 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 0.6 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 is obtained from Consultant.

    or:
  - .2 If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.
- .5 Prevent damage to or displacement of waterproofing, insulation, conduit, and other work.

3.10 RESTORATION

.1 Upon completion of Work, remove waste materials and debris in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal. Trim slopes and correct defects as directed by Consultant.

.2 Clean and reinstate areas affected by Work as directed by Consultant.

.3 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 00 10 – Geotechnical Sitework Testing

.2 Section 31 05 16 – Aggregate Materials.

.3 Section 31 23 10 – Site Excavation, Filling and Grading.

.4 Section 33 31 00 – Sanitary and Storm Utility Piping.

.5 Section 33 05 13 – Manholes and Structures.

1.2 SECTION INCLUDES

.1 Excavating and backfilling trenches and cuts for sewer and watermains, manholes, valve chambers, catch basins, area drains, subdrains, culverts and other underground utilities and structures.

1.3 REGULATORY REQUIREMENTS

.1 The following legislation and related regulations shall be observed at all times:

.1 Alberta Occupational Health and Safety Act

.2 Local municipality bylaws

.3 Explosives Act Canada

1.4 QUALITY ASSURANCE

.1 Testing Standards: The quality assurance laboratory will take density and other tests on compacted soil to the following standards as directed by the Geotechnical Engineer: ASTM D698 Method A., ASTM D1556, ASTM D2167, ASTM D2922 and ASTM D3017.

Part 2 Products

2.1 MATERIALS

.1 Native Fill Material: Material excavated from trench or from grading and approved by the Geotechnical Engineer.

.2 Section 31 23 10 – Site Excavation, Filling and Grading: Fill material shall be free of stones larger than 200 mm, organic matter and other deleterious material.

.3 Imported Fill Material: Geotechnical Engineer approved material from off-site to supplement or replace insufficient or unacceptable material on-site. Fill material shall be free of stones larger than 50 mm, organic matter and other deleterious material.

.4 Granular Fill: to Section 31 05 16 - Aggregate Materials as specified.

.5 Pipe Bedding Material: Consult individual pipe installation sections for material specifications.

Part 3 Execution

3.1 TRENCHING

.1 Trench Excavation:

.1 Excavate trench to indicated alignment and to width and depth required to achieve indicated elevations and to accommodate required bedding. Hand trim bottom of trench where required.

.2 The Engineer or the utility Client may require that a professional engineer design the method of support to existing or proposed utilities within the trench limits. Submit any required design drawings for the Engineer's or utility Client's review before beginning trench excavation.

.3 The Engineer may limit the amount of trench to be opened or left open at any one time.

.4 Stockpile excavated material or imported fill at a safe distance from edge of trench.

.5 Dispose of surplus or otherwise non-useable excavated material offsite or as directed by the Engineer.

.2 Trench Dimensions:

.1 The depth of trench shall be as shown on the drawings.

.2 Cut back the walls of trench in strict compliance with the Occupational Health and Safety Regulations.

.3 For a vertical cut trench with sheeting, the width of trench shall be:

.1 At the pipe springline: a minimum width equal to the outside diameter of pipe plus 450 mm and a maximum width equal to the outside diameter of pipe plus 600 mm.

.2 At ground level: a maximum width of outside diameter of pipe plus 600 mm.

.4 Do not over-excavate beyond the specified limits. If the trench must be excavated deeper or wider than specified, obtain approval from the Engineer. No additional payment for over-excavation will be made unless authorized by the Engineer.

.3 Trench Shoring:

.1 Where the sides of the trench or excavation need to be sheathed, shored or braced to protect life, property, the work, structures adjacent to the work or for maintaining trench widths, the Contractor shall supply and place all material required at no additional cost. Strictly follow Occupational Health and Safety regulations or a professional geotechnical engineer's recommendations.

.2 If required, the Contractor shall engage the services of a qualified professional engineer (the design engineer) who is registered in Alberta to design and regularly inspect cofferdams, shoring, bracing and underpinning required for the work.

.3 Design and supporting data are to bear the stamp and signature of the design engineer. They shall be submitted to the Engineer at least two weeks prior to start of work. Reports of the design engineer’s inspections shall be displayed in the engineer’s site office.

.4 The design engineer responsible for the design of the temporary structures shall submit to the local municipality proof of insurance coverage for professional liability, except where the engineer is an employee of the Contractor, in which case the Contractor shall submit proof that the work by the design engineer is included in the Contractor’s insurance coverage.

.5 Construct temporary works to depths, heights and locations as required to prevent failure.

.6 During backfill operations:

.7 Unless otherwise indicated or directed by the Engineer, remove sheeting and shoring from the excavations. Do not remove bracing until backfilling has reached the level of

such bracing. Pull sheeting in increments that will ensure compacted backfill is maintained at an elevation at least 500 mm above the toe of sheeting.

.8 When sheeting is required to remain in place, cut off tops at elevations indicated or as directed by the Engineer.

.9 Upon completion of the substructure construction, remove shoring and bracing and remove excess materials from site.

.10 Obtain any required permits from the authority having jurisdiction for the diversion of watercourses.

.11 Protect excavations and adjacent properties against cave-ins, shear failure, slides, undermining, erosion and settlement. Erect shoring, cribbing, bracing, sheet piling or planking as necessary to provide such protection. Place such work so as not to interfere with operations and independent of any footing.

.12 The contractor shall assume full responsibility for any failure, collapse or movement of shoring or bracing method, collapse of earth banks, trenches, manholes or other excavations.

.4 Trenching in Poor Ground:

.1 If the bottom of the trench is in soil which, in an undisturbed state, has adequate bearing capacity, but becomes "quick" due to soil water pressure or becomes unstable due to the construction activity in the trench, the contractor shall over-excavate to a depth specified by the Engineer, place geotextile fabric and cover with foundation granular material, all as specified by the Engineer.

.2 If the bottom of the trench is in peat or other unsuitable foundation material, apply one of the following corrective measures as appropriate:

.1 Over-excavate to suitable material and backfill with compacted gravel or washed rock to the underside of bedding if the amount of over-excavation is less than 0.5 m.

.2 Backfill with fillcrete if the amount of over-excavation is 0.5 m to 1.0 m.

.3 Do not over-excavate, but provide structural support for the pipe as specified by the engineer, if the depth to suitable foundation soil from the bottom of the pipe bedding is greater than 1.0 m.

3.2 EXCAVATION FOR UNDERGROUND STRUCTURES

.1 Excavations for structures shall conform to the Occupational Health and Safety Act.

.2 Do not over-excavate beyond the specified limits. If the excavation is larger in length or width than specified, advise the Engineer and obtain instructions.

.3 Advise the Engineer If the excavation is deeper than the specified limits. Fill the over-excavation with 30 MPa (28-day strength) concrete or proceed as directed by the Engineer.

.4 If, at the specified depth, unsuitable foundation material is encountered, advise the Engineer and obtain instructions. Over-excavation and replacement with competent backfill or a structural foundation may be required.

.5 Minimize disturbance of the native soil at foundation level. Do not use heavy equipment at the bottom of the excavation. If necessary, provide pads for the equipment. If soil that has adequate strength in an undisturbed condition is disturbed, advise the Engineer and obtain instructions.

.6 Where, at the specified depth, the soil has adequate bearing capacity in an undisturbed state, but becomes unstable due to ground water pressure, advise the Engineer. Over-excavate, place a

geotextile fabric, fill to the specified depth with competent backfill material and compact, as instructed by the Engineer.

.7 Haul all unsuitable or surplus excavated material to an approved site for disposal.

3.3 DEWATERING

.1 Keep the excavation free of water.

.2 Protect open excavations against flooding and damage due to surface runoff.

.3 Do not allow ground water to drain into water pipes.

.4 Water from the excavation shall be disposed of in accordance with the General Requirements or in a manner approved by the Engineer. Do not pump muddy water into local sewers. Obtain written approval for disposal of clean water into local sewers.

.5 Dispose of water in a manner not detrimental to public and/or private property or any portion of the work completed or under construction.

3.4 BEDDING

.1 Place and compact pipe bedding for sewers in accordance with the individual pipe installation sections.

3.5 BACKFILLING AND COMPACTION

.1 Backfill the trench with approved fill material from the top of bedding to the designated subgrade elevation or existing ground level, whichever is lower.

.2 Place backfill in uniform horizontal lifts and compact each lift according to trench and backfill types in 3.6 below.

.3 Remove any free water from a lift before placing the next lift of backfill.

.4 Backfilling Alternatives: The Engineer may consider alternative proposals from the Geotechnical Engineer to use special materials or methods that will achieve long term stability of trench backfill. Use only alternatives accepted by the Engineer.

.5 Backfilling in Cold Weather:

.1 The reference for shutdown temperatures shall be the temperature reported by Environment Canada.

.2 Do not start daily excavation, backfilling or compaction for open cut trenches under pavement when the average air temperature is expected to be -10°C or lower or when the minimum air temperature is expected to be -20°C or lower.

.3 For open cut trenches the shutdown temperature is -15°C. If an approved trench covering system is used the shutdown temperature is -25°C.

.4 Frozen ground shall be thawed by an approved ground burning method before commencing excavation. Remove all frozen materials from the trench including snow and ice.

.5 Do not backfill with frozen soil or with material containing ice, snow, straw, organic or other deleterious material.

.6 Limit the length of open trench ahead of the backfilled portion to 10 m.

3.6 TRENCH AND BACKFILL TYPES

.1 Backfill with native or imported fill material over bedding up to the designated subgrade or existing ground elevation, whichever is lower, in lifts not exceeding 200 mm when compacted.

3.7 DENSITY REQUIREMENTS

.1 Reference Density:

.1 Standard Proctor: the maximum dry density obtained from a plot of the dry densities of multiple specimens at various moisture contents, moulded and compacted in the laboratory according to ASTM D698 Method A.

.2 Required Compaction:

.1 Compact sand bedding to 95% Standard Proctor Density.
Compact each lift to 98% Standard Proctor Density.

.3 Testing Frequency:

.1 Sand bedding: A minimum of 1 density test per 100m of trench length.

.2 Trench greater than 15 m in length: A minimum of 2 density tests per 600 mm of trench depth per 100 m of trench length. The tests shall be representative of the entire length, width and depth of trench backfill, including areas around catchbasins, manholes, valves and service connections. The Engineer or a qualified geotechnical representative, may require additional testing as deemed necessary.

.3 Trench 15 m or less in length: A minimum of 3 density tests evenly spaced through the depth and length of the trench or as directed by the Engineer.

.4 Non-compliance: If a density test result is less than the required density, that test result is discarded and a retest shall be performed on the area represented by the failed test. If the retest is less than the required density, the area shall be reworked to the full depth of the lift, the soil moisture altered as necessary and recompacted to the required density.

3.8 RESTORATION AND CLEANUP

.1 Restore or replace all pavement structures, sidewalk and curb and gutter damaged or removed during trenching and backfilling, unless directed otherwise by the Engineer.

.2 Restore or replace in an approved manner all fences, poles, shrubs, grass and other structures damaged or removed during trenching and backfilling, unless directed otherwise by the Engineer.

.3 Remove and dispose of all debris, surplus fill and unused material excavated from the trench.

.4 Leave work site clean and as nearly as possible in original condition.

END OF SECTION

Part 1 General

1.1 MEASUREMENT PROCEDURES

.1 Measure bored piles in units incorporated into work.

.2 Amount of bored pile shaft added or deducted in event actual bearings are below or above elevations indicated will be measured in metres.

.3 Base bid on number and lengths of piles as indicated.

.4 Actual lengths of piles installed: established by Consultant from piling records.

.5 Measure piles in metres measured from base elevation to cut-off elevation.

1.2 REFERENCE STANDARDS

.1 Canadian Standards Association (CSA International)

.1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/ Test Methods and Standard Practices for Concrete.

.2 CSA G30.18-09(R2014), Carbon Steel Bars for Concrete Reinforcement.

.3 CSA G40.20-13/G40.21-13 (R2018), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.4 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.

.5 CSA W186-M1990 (R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Indicate reinforcing, pile lengths, shaft diameters, and bell diameters.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

.2 Divert unused metal materials from landfill to metal recycling facility as approved by Consultant.

.3 Divert unused concrete materials from landfill to local facility as approved by Consultant.

Part 2 Products

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.2 Reinforcing steel: to CSA G30.18 and in accordance with Section 03 20 00 - Concrete Reinforcing, grade 400.

.3 Welding materials: to CSA W48.

Part 3 Execution

3.1 INSTALLATION

.1 Bore holes to diameters as indicated until required bearing stratum as determined by Consultant is reached.

.2 Belled piles:

.1 Upon confirmation of factored load bearing value by Consultant excavate bell to details as indicated.

.3 Protective steel casing:

.1 Where required, use steel protective casing approved by Consultant.

.1 Ensure penetration of casing to required depths either by self mass or driving.

.2 Have casing on site at time of drilling.

.3 Casing will be paid for at the unit price in the bid form.

.4 Dispose of excavated materials off site.

.5 Consultant to inspect pile excavation prior to placing of concrete.

.1 Remove loose material, foreign matter and water as directed by Consultant.

.6 Install steel reinforcement in accordance with Section 03 20 00 - Concrete Reinforcing and as indicated.

.7 Welding of reinforcement shall conform to CSA W186.

.8 Fill pile excavations with concrete to elevations as indicated.

.1 Place concrete in one continuous pour in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.9 Steel protective casing may be removed at option of Contractor, unless otherwise specified.

.10 Where steel protective casing is to be removed, provide concrete with minimum slump of 125 mm and with retarder to prevent arching or setting of concrete.

.1 Withdraw casing in conjunction with concrete placing, keeping bottom of casing 600 mm below level of concrete.

3.2 DEFECTIVE PILES

.1 Cased concrete shaft piles rejected where:

.1 Soil has entered casing.

.2 Water has entered casing.

.3 Casing is damaged, out of tolerance or alignment.

.2 Defective pile, as directed by Consultant, to be cut off at elevation specified by Consultant.

3.3 TOLERANCES

.1 Locate centreline of piles within the following tolerances:

.1 Maximum Variation of Location:

.1 For pile diameters of 600 mm or less: 25 mm.

.2 For pile diameters over 600 mm: 1/24 of shaft diameter.

.2 Shafts Out of Plumb: maximum 1.5% of length or 12.5% of shaft diameter, whichever is less.

.2 Concrete Cut-off Elevation: plus 25 mm to minus 75 mm.

.3 If tolerances are exceeded and result in excessive eccentricity, propose corrective construction to compensate. Submit proposal for review and approval by Consultant prior to proceeding.

3.4 FIELD QUALITY CONTROL

.1 Field Records: maintain installation records for each pile, including depth of pile and cut-off elevation.

.2 Piling will be monitored by a geotechnical firm retained by the Contractor in accordance with Section 01 29 83 – Payment Procedures for Testing Laboratory Services. Cooperate with the monitoring firm.

3.5 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 RELATED SECTIONS

.1 32 01 90 – Topsoil and Fine Grading

.2 32 91 13.16 – Mulches

.3 32 92 93 – Sod

.4 32 93 00 – Trees, Shrubs and Groundcovers

1.2 MAINTENANCE PERIOD

.1 The Contractor shall provide maintenance for all sod, plants and other related work for a minimum of two years that shall include two full and complete growing seasons (May 1st to October 31st) commencing from the Date of Substantial Completion of the Work. All maintenance requirements will be extended to October 31st of the second year of the warranty period, which may extend beyond the Final Acceptance date of the warranty period and work. Note: The Owner has the option to waive the Contractors warranty and maintenance period and turn this work over to a Landscape Maintenance Contractor. If this option is applied, a formal Construction Completion Review of all work will be completed by all parties prior to and acceptance agreement by the Owner, Contractor and Landscape Maintenance Contractor. Once accepted, all further Contractor warranty is waived by the Owner.

1.3 QUALITY ASSURANCE

.1 Site Supervisor: perform all landscape maintenance services at all times under the on-site direction and supervision of a competent, knowledgeable and certified Landscape Journeyman Gardener with a minimum of five years of progressive supervisory experience.

.2 Staffing: provide experienced, competent and trained grounds maintenance personnel to perform all tasks and services in a knowledgeable and professional manner. Workers shall act appropriately and professionally at all times while working on site. Contractor shall not assign any worker that the PM or Departmental Representative deems incompetent, careless, insubordinate, or otherwise objectionable to work on site grounds.

.3 Site Security: Contractor's personnel shall carry personal identification at all times while working on site. Identification shall be presented when requested by the PM or Departmental Representative or other site security staff. All employees must check in with site security upon entering and leaving the premises.

.4 Employee Attire/Safety Vests: Contractor's employees shall be properly attired at all times. Each employee working on site shall wear a reflective coloured safety vest at all times for safety and visibility.

.5 Submit the following for PM or Departmental Representatives review and approval:

.1 Pesticide Applicator's certificate of qualification, Landscape Class: submit at commencement or maintenance each season.

.2 Landscape Journeyman Gardener's certificate of qualification and credentials regarding site supervisor's maintenance experience and horticulture knowledge.

.3 Pruning credentials of each Certified Arborist and other landscape personnel who may perform pruning services.

.4 Grounds maintenance log: submit to the PM or Departmental Representative each week.

.5 Other required submittals as noted and specified in contract.

.6 During the Warranty and Maintenance Period it is the responsibility of the Contractor to monitor plant health and replace (without PM or Departmental Representative notice) immediately if dead or in poor condition.

1.4 MAINTENANCE COORDINATION:

.1 The Contractor is responsible for reviewing all snow clearing and storage considerations with the Owner and Snow Removal Maintenance Company to mitigate plant damage during the two (2) year warranty and maintenance period. Considerations should include: snow removal (equipment use), snow storage (assigned locations, drainage and erosion/sediment mitigation), and snow/ice control material use (sand, salt, gravel). Any plant material damaged by snow removal, storage, or material uses shall be considered Third Party damage and replaced or rehabilitated at the Owners cost.

.2 All seasonal (spring, summer and fall) landscape maintenance is to be provided by the Contractor. Any plant material damage caused by the maintenance (spraying, fertilizing, pruning, watering/irrigating, etc) of the Property Management company (or their Maintenance company) will be considered Third Party damage and replaced or rehabilitated at the Owners cost.

.3 Pedestrian Desire Lines: The Contractor is responsible for coordinating the installation of Temporary Controls to prevent shrub bed damage caused by pedestrian desire line traffic during the two (2) year warranty and maintenance period. Any identified desire lines shall be reviewed and assessed by the PM or Departmental Representative and Owner for potential hard surface restoration. Note: Desire line development will typically occur during the first winter of the warranty and maintenance period. The Contractor should visit the site during the winter months to assess and contact the PM or Departmental Representative to discuss Temporary Control requirements.

1.5 SITE REVIEWS / MEETINGS

.1 During initial maintenance establishment period, site meetings and inspections may be conducted minimum every two weeks between Contractor and the PM or Departmental Representative. Contractor's workmanship and performance will be reviewed and other landscape concerns or issues will be addressed and evaluated.

.2 Subsequent site meetings and inspections may be held minimum once a month after landscape has adequately established as determined by the PM or Departmental Representative.

.3 The PM or Departmental Representative shall, at his direction, conduct random site inspections throughout the maintenance period to evaluate the quality and completion of work performed. Deficient work, noted by the PM or Departmental Representative, shall be promptly corrected by Contractor.

1.6 MAINTENANCE LOG & PAYMENT

.1 Complete a daily maintenance log during each day of maintenance activity throughout contract.

.2 Submit log to the PM or Departmental Representative at end of each week.

.3 Contractor's site supervisor shall complete and sign maintenance log at completion of work each day. Contractor shall ensure all maintenance log data is true and accurate.

.4 Record and update all maintenance activities including date/time of activities, materials and quantity used on site, location where activities were carried out, number of employees and name of supervisor on site.

.5 Detail applications of all chemical pesticides including target weed, insect or other pest, mode, type, and rates of application and results. Include date, time, weather conditions and name of licensed applicator. Keep and maintain pesticide applicator's log.

1.7 SOIL TESTING

.1 Provide minimum five soil tests each spring from locations randomly selected by the PM or Departmental Representative on site. Contractor shall arrange and pay for services of accredited testing laboratory, approved by the PM or Departmental Representative.

.2 Test soil for: existing soil nutrients; soil pH value; total soluble salts (electrical conductivity); percentage of organic matter; soil texture and percentage of sand, silt and clay; fertilizer recommendations; and recommendations for soil amendments.

.3 Submit original copy of each soil test to the PM or Departmental Representative. Review results with the PM or Departmental Representative.

.4 Correct and amend soil as recommended. Perform additional tests to verify results of work completed to amend and correct soil deficiencies.

.5 Regularly use a moisture sensor device to test and measure availability of moisture in native turf and plant soil areas. Record data in maintenance log.

1.8 DELIVERY, STORAGE AND HANDLING

.1 No equipment of materials shall be stored on-site. Remove all equipment and materials off site each day to Contractor's own storage space.

.2 Leave tools, equipment and materials in a secure storage area when not in use during period of operation and at completion of each scheduled task.

.3 Contractor shall be present to accept delivery of all equipment and/ or material shipments.

1.9 MAINTENANCE SCHEDULE

.1 Schedule: submit a neat, legible and detailed maintenance schedule at commencement of maintenance each spring. List all daily, weekly and monthly maintenance services and tasks with approximate dates for completion. Review schedule with PM or Departmental Representative for approval.

1.10 TRAINING

.1 Contractor shall thoroughly train and instruct the Owner's ground maintenance personnel regarding plant care for each plant installed on site, care of all native grassed areas and maintenance for other site features. Training shall be provided prior to termination of maintenance period in contract.

.2 Provide adequate training sessions both on site and in an office setting to review required landscape maintenance services and discuss all maintenance issues and concerns regarding the installed landscape.

1.11 GENERAL

.1 Landscape maintenance services and tasks in contract include for all equipment, labour, materials and incidentals necessary to complete all maintenance requirements in contract.

Part 2 Products

2.1 WATER

.1 Contractor shall supply clean fresh water, water tanker, equipment, sprinklers, and labour necessary for use in sodding operations and to adequately and efficiently apply water to all sodded areas during maintenance period.

.2 Water shall be clean fresh and free of substances or matter that would inhibit vigorous and healthy plant growth.

.3 Record quantity of water supplied and applied on site in maintenance log.

.4 The Owner will supply Contractor with a limited supply and access to water on site using building source but only if available.

.5 Irrigation system control (if applicable) is to be supervised by the Contractor during the two (2) year warranty and maintenance period. Refer to Section 1.4.6 for coordination requirements.

2.2 FERTILIZER

.1 Organic Turf Fertilizer: Contractor shall submit a proposal to use organic fertilizers instead of synthetic fertilizers in maintenance of all sodded turf areas prior to commencement of work in spring. The Owner will review proposal for acceptance.

.2 Turf Fertilizer: apply a high quality granular synthetic fertilizer containing minimum 40% of nitrogen in a slow or controlled release form to maintain turf in a healthy and vigorous condition as directed by the PM or Departmental Representative or in accordance with soil tests.

.3 Plant Fertilizer: as directed by the PM or Departmental Representative or in accordance with soil tests. Use only controlled or slow release plant fertilizers.

.4 Do not use "weed and feed" type fertilizer.

2.3 TOPSOIL AND PEATMOSS

.1 Imported Topsoil: natural, fertile, friable, shredded, screened agricultural soil containing no less than 6% organic matter, pH value ranging from 5.9 to 7.0, E.C. – salinity reading

not exceeding 1.5, loam soil texture, and reasonably free from subsoil, slag, clay, stone, lumps, live plants, roots, sticks, quack grass, noxious weeds and foreign matter.

.2 Peatmoss: decomposed plant material, fairly elastic and homogeneous, free of decomposed colloidal residue, wood, sulphur and iron. Minimum 80% organic matter by mass, pH value between 4.0 and 5.0.

2.4 PEST CONTROLS

.1 Chemical pest control: supply and install all required chemical pesticides including herbicide, insecticides and fungicides, when Integrated Pest Management Principals (IPM) are considered ineffective in controlling or suppressing pest populations on-site.

.2 Pesticide Application Records: pesticide application records shall be kept by licensed applicator. Submit written records at completion of each pesticide application on-site. Provide information regarding target weed, insect or other pest, mode, type and rates of application and results. Include date, time, weather conditions and name of licensed applicator.

2.5 PROTECTIVE MATERIALS

.1 Rodent Protection: chemical repellent, liquid soap, and galvanized woven wire mesh (or equivalent product) complete with fasteners. Contractor to wrap and tie all deciduous tree trunks with 2 full wraps of chicken wire, 1.0m minimum height to protect against rabbit damage. Any plant material damaged by animals or rodents shall be replaced at the Contractors cost.

.2 Burlap Wrap: natural untreated products.

.3 Perforated plastic spiraled strip for horticultural use.

.4 Winter snow traction and de-icing products protection: 1.2m snow fence lined with 6mm clear poly liner where heavily sanded and/or salted roads and walks interface with planted beds.

2.6 SNOW FENCING

.1 Snow fencing (Temporary Controls): Standard type, 1.2m height and posts supplied by Contractor.

Part 3 Execution

3.1 GENERAL WORKMANSHIP

.1 The PM or Departmental Representative will be the “Sole Judge” for assessing Contractor’s maintenance performance and workmanship.

.2 Schedule timing of operations to growth, weather conditions and use of site. Do each operation continuously and complete within reasonable time period.

.3 Do not perform work in any location or manner that may endanger the health and safety of the public.

.4 Coordinate maintenance practices with the PM or Departmental Representative. Alter maintenance schedules, when necessary, to accommodate site activities.

.5 Collect and dispose of excess material and debris to municipal disposal site weekly. Separate and recycle materials suitable for composting.

.6 Contractor shall promptly correct all maintenance deficiencies noted by PM or Departmental Representative during site meetings or following notification of site inspection results completed by the PM or Departmental Representative.

3.2 SPRING CLEAN-UP

.1 Complete spring clean-up by May 15th or as soon as working conditions are favourable.

.2 Remove and dispose of protective coverings and mulch used in winter protection.

.3 Thoroughly, clean, collect and remove all sand, rock chips, salt and other debris accumulated during winter months from all maintained turf and hard surface areas. (Refer to Section 1.4.6) Dispose in approved municipal disposal site.

.4 Remove and store on site: snow fence and stakes, burlap and other protective materials. Reinstall all loose edging material or replace if necessary

.5 Completely clean planting beds, tree wells, and planters of all debris, leaves, litter, unsuitable plant growth and other foreign matter. Loosen and lightly cultivate soil without disturbing roots of permanent plantings.

.6 Place specified soil in all plant beds where settlement has occurred. Topdress and reseed turf deficiencies. Match seed and submit seed labels to confirm.

.7 Sweep and clean all hard surfaces to maintain a clean and tidy appearance.

3.3 TURF MAINTENANCE

.1 Provide adequate maintenance services to ensure the proper establishment and maintenance of all turf areas and to provide healthy vigorous growing conditions. Maintenance shall include but are not limited to:

.1 Provide adequate watering, as necessary, to ensure proper seed germination and turf development and to prevent grass and underlying soil from drying out. Contractor shall provide and operate a portable irrigation system to water seeded turf areas as necessary until well established.

.2 Top-dress and reseed all deficient and unhealthy turf areas that show root growth failure, deterioration, bare, burnt or thin spots, ruts, wash outs and erosion or which have been damaged by any means or cause including replacement operations.

.3 Provide weed control methods that shall include cultivation, physical removal, use of approved chemicals during active seed growth and establishment, and nitrogen reduction methods (if dictated by soils tests) using sawdust or oat seeding. (Sow oats at 20 kg/ha. Cut the oats as the head forms and dispose off-site).

.4 Removal of weeds shall be ongoing. Ensure weed seed heads are removed before maturity. All weeds shall be removed from site.

.5 Provide initial cut when native grass is approximately 100 mm high over 75% of the seeded area. Mow to height of 70 mm.

.6 Mowing of native seed areas shall occur during the last two weeks of June and August. Mow tall native grass at height of 150 mm and short native grass at

height of 90 mm. Mowing native turf lower than specified will not be acceptable. Provide an additional cut when necessary due to accelerated growth but only if directed by the PM or Departmental Representative.

.7 Remove all papers, litter, rocks and other foreign material prior to cutting.

.8 Mulch clippings in seeded areas if feasible. Contractor shall remove clippings if volume of clippings will result in grass being smothered or in unsightly appearances.

.9 During each cutting operation, temporarily relocate movable site furnishings and replace to approximate original location

.10 All seeded areas shall be adequately protected by Contractor until established unless directed otherwise by the PM or Departmental Representative.

.11 Turf Fertilizer: apply 20-10-15 slow release granular fertilizer to all seeded areas by May 25th and by July 15th. Spread fertilizer evenly at rate of 3kg/100 m2. Record quantity of fertilizer applied in maintenance log.

.12 Apply water immediately after fertilizing turf areas to obtain moisture penetration of minimum 50 mm. Apply moisture in accordance with fertilizer manufacturer's recommendations or time fertilizer applications with rainfall.

3.4 TREE AND SHRUB MAINTENANCE

.1 Monitoring:

.1 Contractor shall regularly monitor and visually inspect the health and care of all plants on site to ensure adequate plant care is provided in accordance with specifications that will enable plants to grow in a vigorous, healthy and non-stressed condition.

.2 Contractor shall indicate results of each plant monitoring inspection in maintenance log.

.2 Trees and Plant Beds:

.1 Maintain all plants during the maintenance period as necessary each week to maintain healthy and vigorous growing conditions. As native plants become established the need for regular maintenance measures will gradually decrease. Consult with the PM or Departmental Representative of the need to reduce various maintenance activities.

.2 Cultivate tree pits, planting beds and planters as necessary to maintain a loose friable soil free from perennial weeds and grass including their roots. If necessary, pull weeds and their roots by hands or spot spray with approved herbicide without damaging other plants.

.3 Remove and dispose of all debris, rubbish, and animal waste each week. Provide a clean and well-maintained appearance within all planting beds and tree wells.

.4 Edge all plant beds evenly to depth of 100 mm as necessary to maintain original line and shape. Remove all cut edges from site.

.5 Edge and maintain neat, clean and circular tree wells. Do not damage roots of plants when re-edging. Keep well area free of weeds and litter.

.6 Record and remove dead and unhealthy plants including roots from site and install replacement plants when necessary.

.7 Straighten all plants that lean or sag. Replant any plant that settles or which is planted too low as necessary.

.8 Rake, level and re-spread mulch within plant beds and tree wells to achieve a fresh appearance and to correct any disturbances as necessary.

.9 Keep mulched areas clean and free of all debris, litter and weed growth. Place additional mulch to match existing, when necessary, to maintain original depth.

.10 Place planting soil in plant beds to correct any low and-uneven areas.

.11 Maintain correct soil conditions in plant beds to promote optimum growth and health for each plant. Add soil amendments and organic matter according to soil analysis

.3 Staking and Tree Protection:

.1 Keep required stakes and guy wires taut and plants plumb during maintenance period. Repair guy wires as required. (if applicable).

.2 Remove support stakes and staking accessories on self-supporting trees as required. At completion of maintenance all stakes and guying materials shall be removed from site. (if applicable).

.3 Install and keep plant protection materials in proper repair and adjustment when required or when directed by the PM or Departmental Representative. (if applicable)

3.5 FERTILIZATION

.1 Organic Fertilizer: Contractor shall submit a proposal to use organic fertilizers instead of synthetic fertilizers in maintenance of all plant material prior to commencement of work in spring. The PM or Departmental Representative will review proposal for acceptance.

.2 Synthetic Fertilizer:

.1 Apply plant fertilizer as directed by the PM or Departmental Representative or in accordance with soil test analysis. Use only controlled or slow release plant fertilizers. Record all plant fertilizations in maintenance log.

.2 Plant fertilizer shall generally be applied during second year and subsequent years of maintenance unless directed otherwise based on soil analysis.

.3 Apply 30-10-7 or 10-6-4 plant fertilizer or similar to all trees by June 1st at rate of 18 g/25mm of caliper per tree from trunk to drip line. Apply fertilizer using a pressurized injection method of injecting fertilizer into the soil.

.4 Plant Beds/Specimen Plants: apply liquid 20-20-20 fertilizer at 1 kg to 250 litres of water. Alternatively, apply Ozmocote 14-14-14 slow release granular fertilizer in accordance with manufacturer's specifications by June 1st each spring.

.5 Apply water after applying granular fertilizer to ensure penetration of fertilizer into soil and roots

3.6 WATERING

.1 Monitor: regularly test and monitor soil moisture conditions and a plant's need for water to ensure adequate health and survival. Natural rainfall shall be considered in determining the amount and frequency of watering.

.2 All plants shall generally be watered on a regular basis to ensure healthy and vigorous growing conditions and to ensure survival. During periods of dry soil conditions and warm weather provide additional deep root watering to maintain health.

.3 Gradually, as native plants become established the need for water shall be reduced. Consult with the PM or Departmental Representative regarding the need to reduce watering.

.4 Apply sufficient water per application to obtain moisture saturation of the plant root ball.

.5 Any additional plant watering that may be required during the early spring or late fall due to dry weather conditions shall be the Contractor's responsibility to ensure plant warranty is maintained. Contractor shall monitor weather conditions and apply water as necessary to protect and provide healthy growing conditions.

3.7 PRUNING

.1 Prune all plants in accordance with proper practices and standards of the International Society of Arboriculture (ANSI A-300 Pruning Standards).

.2 Use only qualified and experienced Certified Arborists and other personnel in performance of all tree pruning services. Shrubs and perennials plants may be pruned by contractor's trained and experienced landscape journeymen gardeners if approved by the PM or Departmental Representative.

.3 Do not shear or top any plant, strip lower branches or raise crown.

.4 Use sharp pruning tools at all times to prune plants without tearing and ripping plant tissue.

.5 Limit pruning to removal of dead, diseased or injured branches, stray branches, double leaders, water sprouts, suckers and to compensate for loss of roots as a result of transplanting. Remove undesirable, rubbing and crowded limbs and maintain an adequate clearance where necessary.

.6 Prune to take advantage of the plant's growth habit, accentuating its natural tendencies, seldom modifying them.

.7 Prune to ensure that there is a central leader on coniferous trees.

.8 Improperly pruned plants shall be replaced by Contractor.

3.8 PLANT REMOVAL AND REPLACEMENT

.1 Contractor shall immediately remove from site all dead, unhealthy and unappealing plants during the maintenance/warranty period or when directed by the PM or Departmental Representative. Healthy new replacement plants shall be promptly supplied and installed by Contractor subject to availability to ensure site landscaping is maintained as originally designed. Replacement plants shall meet specifications and be approved by the PM or Departmental Representative.

.2 Trees flagged for replacement shall be marked with orange florescent paint sprayed directly on tree trunk.

.3 Replacement plantings shall be performed in a timely manner and as soon as conditions permit. Contractor shall advise Minister when availability of any replacement plant will be delayed.

.4 All replacement plants must be fully established by termination of maintenance period. Contractor shall continue to provide specified maintenance for replacement plants not fully established until deemed acceptable by the PM or Departmental Representative.

.5 The PM or Departmental Representative reserves the right to extend warranty on all plants not fully established or where replacement plantings have been delayed by Contractor.

.6 Required replacement plantings during the maintenance period resulting from theft and vandalism shall be the Owner's responsibility. All reported theft or vandalism will be reviewed and confirmed by the PM or Departmental Representative.

3.9 WEED, INSECT AND DISEASE CONTROL

.1 Contractor shall manage and control pests using Integrated Pest Management (IPM) principals that utilizes regular monitoring to identify pests, considers various control options (biological, physical, cultural, mechanical and chemical) before implementing an effective, economical and environmentally acceptable solution to prevent and suppress pests.

.2 Contractor to advise the PM or Departmental Representative of all identified pests on-site, controls implemented to manage pests and the outcome of each treatment action. Record all information in maintenance log.

.3 Submit a detailed Integrated Pest Management program that will be implemented on site prior to commencement of maintenance each spring.

.4 Other general considerations include:

.1 Pest Monitoring: monitor and visually inspect all landscape areas each week to identify potential pest problems. Pest problems include insect, disease and weed infestations. Contractor shall ensure that all pest infestations are properly and positively identified by using the services of a specialist. Submit report to the PM or Departmental Representative.

.2 Determine susceptibility of plant species to pesticide damage before recommending or applying chemical pesticides. Submit specified pest control information and obtain the PM or Departmental Representative approval prior to any pesticide application. Submit information on using IPM principles to control pests.

.3 Pesticide Applicator: when pesticides are deemed necessary to control pests, the application of each pesticide on site shall be performed by a licensed pesticide applicator. Submit a pesticide applicator's log to the PM or Departmental Representative at completion of each pesticide application

.4 Perform pest control applications in accordance with Provincial codes and regulations regarding use and application of pesticides. Provide the PM or Departmental Representative with three day advance notification of intent to apply chemical pesticides.

.5 Prepare and apply pesticide according to manufacturer's specifications. Minimize drift at all times. Erect signs to notify building occupants and the public regarding pesticide use on site.

.6 Timing: pesticides shall be applied at times, which limit any possibility of contamination from climatic and other factors. Monitor weather conditions to

avoid making application prior to inclement weather to eliminate potential runoff from treated areas. Confine all applications to outside of regular site operation hours to avoid contamination from drift and its effect on surroundings, occupants of nearby buildings and site users.

.7 Ineffective and improper application of pesticide shall be immediately corrected by Contractor. Additional applications of pesticides shall be completed approximately two weeks after any initial application is noted as visibly inadequate or deemed deficient by the PM or Departmental Representative.

.8 Apply pre-emergent in spring or fall to control weeds in plant beds and tree wells.

.9 Shallow cultivate and weed plant pits and beds when required.

.10 Weeds: apply pesticide to eradicate weeds and foreign perennial grass within turf areas on site only when necessary and approved by the PM or Departmental Representative.

.11 Insects: apply pesticide based on development stage of insects' life cycles to prevent loss or damage to plant material. Turf areas shall be treated when necessary to control turf diseases and insects.

.12 Repair and pay for damage caused by application of pesticides.

.13 Do not use soil sterility products.

3.10 AUTUMN PREPARATION

.1 Leaf Removal: rake and vacuum leaves as they shed each week and remove from site. Continue to perform this service until leaves cease to fall.

.2 Remove all leaves and other foreign debris from all plant beds, walkways and other hard surface areas, catch basins and from along all service roads and parking curbs each week. Clean all road and parking curbs free of leaves and other debris. Remove all collected leaves and other debris from site to approved waste recycling depot.

.3 Cut back damaged foliage of perennials within one week after killing frost. Stake location of perennials, if necessary, and thoroughly water.

.4 Deep root water all plant material between October 1st and 15th. Supply clean water, water tanker, equipment, hoses and labour necessary to apply water.

.5 Protect plants from rodent, animal, sun and all other damage by supplying and installing appropriate plant protection materials.

.6 Sweep and clean all hard surfaces. Remove all debris and litter from site.

.7 Flag utility services for winter identification as necessary.

.8 Erect stakes and snow fences as required or as directed by the PM or Departmental Representative and/or Owner.

3.11 CLEANLINESS OF GROUNDS

.1 Keep grounds in clean and tidy condition on a regular basis each week. Maintain clean site appearances free of all debris, litter and pests.

.2 Provide prompt service (within two hours) when directed by the PM or Departmental Representative and/or Owner to correct any inadequate or deficient clean up services.

.3 Collect and dispose of excess material, litter and other debris to municipal disposal site following each clean-up. Contractor to pay all disposal costs.

.4 Sweep and clean hard surfaces including curbs adjacent to areas of native turf and plant maintenance. Keep catch basins clean and clear of all debris resulting from site maintenance.

.5 Keep all rocks, boulders and gravel surfaces clean and free of weeds and other pests. Ensure all other site features are kept clean and pressure washed when necessary to remove foreign matter.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 32 10 00 – Sitework Concrete Forms and Accessories.

.2 Section 32 20 00 – Sitework Reinforcing Steel.

.3 Section 33 05 16.13 – Concrete for Utility Structures

1.2 SECTION INCLUDES

.1 This section applies only to sitework concrete, including curbs and gutters, sidewalks, curb ramps, garbage and shed pads, driveways and patios, but excludes exterior structural stoops, structural slabs and exterior structural piles.

.2 Production of Portland cement concrete.

.3 Requirements for concrete mix design, quality control, quality assurance and placement.

1.3 QUALITY ASSURANCE

.1 Approval of a mix design, or inspection and testing by the Engineer shall not relieve the Contractor of responsibility for the quality of concrete used in the Work.

.2 The Geotechnical Engineer will perform concrete quality assurance sampling and testing for slump, air content, air voids and compressive strength.

.3 Quality assurance testing shall be performed by a technician certified by CSA or ACI.

.4 Slump Tests:

.1 Methods: to CAN/CSA-A23.2-1C and CAN/CSA-A23.2-5C.

.2 Test Frequency: Slump tests will be taken between the 10% and 90% points of discharge of a concrete load with every strength test and as required by the Engineer.

.5 Air Content Tests:

.1 Methods: to CAN/CSA-A23.2-1C and CAN/CSA-A23.2-4C or CANCSA-A23.2-6C.

.2 Test Frequency: Air content tests will be taken between the 10% and 90% points of discharge of a concrete load with every strength test and as required by the Engineer.

.6 Air-Void Examination:

.1 Method: to ASTM C457, modified point-count traverse method at 100X magnification.

.2 Sample: a 100 mm diameter core drilled from hardened concrete.

.3 Cross-Section Preparation: The top of the core shall be ground to 2 mm ±0.5 mm below and parallel to the finished concrete surface to produce a surface suitable for microscopic examination.

.4 Maximum Allowable Spacing Factor: If the spacing factor obtained by a full traverse of the cross-section of the single core is greater than 0.23 mm, the concrete represented by the core shall be removed and replaced.

.7 Strength Tests:

.1 Methods: Compressive strength test specimens shall be cast and cured in accordance with CAN/CSA A23.2-3C. Initial curing Temperatures must be reported. Test specimens cast from concrete mixes with slump levels equal to or less than 40mm shall be consolidated

by rodding. The testing agency shall ensure complete densification of the test cylinders and will confirm that corresponding unit weights are characteristic of the mix design unit weights. Test cylinders exhibiting a lack of consolidation will be weighed and the unit weight and accompanying remarks recorded on the concrete test report. Compressive strength determination shall be in accordance with CAN/CSA A23.2-9C.

.2 Test Frequency: Standard tests for strength will be conducted at a frequency of not less than one strength test for each 60m3 of concrete or fraction thereof, for each class of concrete produced in any one day.

.3 Definition of a Strength Test: to CAN/CSA A23.1 clauses 4.4.6.4.1 and 4.4.6.4.2.

.4 For standard strength tests, either 150mm x 300mm cylinders or 125mm x 250mm cylinders may be used.

.5 Required Strength: The result of each compressive strength test shall equal or exceed the specified minimum compressive strength.

Part 2 Products

2.1 MATERIALS

.1 Portland Cement**:** to CAN/CSA-A3000, A3001-03 of the following types.

.1 Type GU – General use hydraulic cement

.2 Type HE - High early-strength hydraulic cement

.3 Type HS – High sulphate-resistant hydraulic cement

.2 Aggregate: to clause 4.2.3, CAN/CSA-A23.1, testing shall include but not be limited to: unconfined Freeze-thaw in course aggregate, MgSO4 soundness loss, petrographic examination, alkali-aggregate reactivity, and ironstone content, and as supplemented below:

.1 Petrographic Analysis: To be performed by a qualified laboratory to CAN/CSA-A23.2-15A.

.2 Ironstone Content: To be performed by an approved facility to the Method for Ironstone Content Determination in Fine and Coarse Concrete Aggregates. Do not use aggregate until the corresponding results have been reviewed by the Engineer. Ironstone content in coarse aggregate shall not exceed 1.0% by mass of the total coarse sample (retained on the 5 mm sieve and larger), and in fine aggregate shall not exceed 1.5% by mass of the total dry, unwashed fine aggregate sample (passing the 5 mm sieve to that retained on the 2.5 mm sieve). Any concrete supplied with aggregate exceeding the specified ironstone content will be rejected, and shall be removed by the Contractor as directed by the Engineer.

.3 Water: to clause 4.2.2, CAN/CSA-A23.1, clear, free from injurious amounts of oil, acid, alkali, organic matter, sediment, or other substance harmful to the mixing and curing of concrete.

.4 Air-Entraining Admixture: to ASTM C260.

.5 Chemical Admixtures: to ASTM C494, including water-reducing agents, retarders and accelerators. Chemical admixtures shall not be used unless permitted in writing by the Engineer.

.6 Fly Ash: to CAN/CSA-A3000, A3001-03 pozzolan type F or Cl. For Class A,B, and C concrete no replacement of the specified minimum cement content with fly ash from the commencement of the construction season to May 15 and after September 30 unless permitted by the Engineer.

.7 Sulfate Resistant Concrete: Concrete using Type HS (High sulfate-resistant hydraulic cement) cement shall not be placed after September 30, for Class A, B, and C concrete.

.8 Curing compound: to ASTM C309, type 2, class B, white pigmented, resin based, liquid membrane-forming compound.

.9 Preformed Joint Filler: to ASTM D1751.

.10 Joint Sealant: to ASTM D1190, Sika 2c or approved equivalent.

.11 Forms: To Section 32 10 00 Sitework Concrete Forms and Accessories.

.12 Reinforcement: To Section 32 20 00 Sitework Reinforcing Steel.

2.2 MIX DESIGN

.1 Mix design criteria for each class of concrete:

.1 Spring and Fall Mixes

Class	Minimum 28 Day Compressive Strength (MPa)	Slump (mm)	Entrained Air Limits (% by volume)	Maximum Aggregate Size (mm)	Maximum Water to Cementing Materials Ratio (by mass)	Minimum Portland Cement Content (kg/m3)	Cement Type
A	30	60 ± 20	5.0 - 8.0	20	0.45	335	GU*
B	30	60 ± 20	5.0 - 8.0	20	0.45	335	GU*
C	30	60 ± 20	> 5.0	20	0.45	335	GU*
D	30	100 ± 30	5.0 - 8.0	20	0.45	335	HS*
E	30	80 ± 20	5.0 - 8.0	20	0.45	300	HS*

* Note: GUb and HSb cements can be used only upon approval of the Engineer

.2 Summer Mixes

Class	Minimum 28 Day Compressive Strength (MPa)	Slump (mm)	Entrained Air Limits (% by volume)	Maximum Aggregate Size (mm)	Maximum Water to Cementing Materials Ratio (by mass)	Minimum Portland Cement Content (kg/m3)	Cement Type
A	30	60 ± 20	5.0 - 8.0	20	0.45	302	GU*
B	30	60 ± 20	5.0 - 8.0	20	0.45	302	GU*
C	30	60 ± 20	> 5.0	20	0.45	302	GU*
D	30	80 ± 20	5.0 - 8.0	20	0.45	335	HS*
E	30	80 ± 20	5.0 - 8.0	20	0.45	300	HS*

* Note: GUb and HSb cements can be used only upon approval of the Engineer

.3 Class C concrete: shall attain the minimum compressive strength corresponding to the percentage of entrained air in the plastic concrete as follows.

Air Content (%)	Minimum 28 Day Compressive Strength (MPa)
5.0 to 5.9	32.0
6.0 to 8.0	44 - (2 * Air Content)
greater than 8.0	28.0

.4 High Early Strength Concrete: For special situations or conditions the Engineer may require that the specified 28 day compressive strength be met in 7 days.

.5 If any class of concrete is to be placed by pumping, the specified slump and air content shall be met at the point of pump discharge. Samples for testing will be obtained at the point of pump discharge.

.6 For class C extruded parapet retaining walls and New Jersey Barriers the mix shall contain 0.6kg of synthetic micro fibres or approved equivalent per m3 of concrete.

.7 For class E concrete the following mix conditions shall apply: A minimum ratio of supplementary cementitious materials to total mass of cementitious materials of 0.15, and A minimum sand content of 45% by total weight of aggregate.

.2 Application of concrete classes:

.1 Class A: One course exposed pavements, commercial and residential alley crossings.

.2 Class B: Unexposed pavement base.

.3 Class C: All exposed road associated works including curb and gutter, sidewalks, walkways, crossings, swales, medians, New Jersey barriers and parapet walls.

.4 Class D: Structural pile foundations.

.5 Class E: Exposed retaining walls.

.3 Seasonal concrete mix requirements:

.1 Spring Mixes

.1 From the commencement of the construction season to May 15, or as directed by the Engineer: no replacement of the minimum cement content with fly ash (Clause 2.1.6) is permitted.

.2 Summer Mixes

.1 From May 16 to September 30: no more than 10% of the specified minimum cement content may be replaced with fly ash.

.3 Fall Mixes

.1 From October 1 to October 15: no replacement of the minimum cement content with fly ash is permitted (clause 2.1.4) and type HS cement may not be used (clause 2.1.5).

.4 Cold Weather Mixes

.1 From October 16 to the end of the construction season, or as defined by the Engineer: meet the requirements for cold weather concrete in clause 2.2.4.

.4 Cold weather concrete: All classes of concrete placed after October 15 shall attain a minimum compressive strength of 27.0 MPa in 7 days and shall be provided with cold-weather protection to clause 7.4.2.5.3, CAN/CSA A23.1. High early strength concrete (as defined in clause 2.2.1.2) shall attain a minimum compressive strength of 32.0 MPa in 7 days and shall be provided with

cold weather protection to clause 7.4.2.5.3, CAN/CSA A23.1 (type 2 curing). This cold weather protection must be adequate to maintain concrete surface temperatures at a minimum of 10º C for a period of 7 days following placement.

.5 For slipformed (machine placed) concrete, limit slump as follows:

.1 20 ± 10 mm for curb, curb and gutter and New Jersey barrier, and 30 ± 10 mm for walk, monolithic walk and pavement.

.6 Type HE or Type HS cement may be substituted for Type GU cement, except as limited in clause 2.1.5.

.7 Class A, C and E concrete may be subjected to air-void examination.

.8 Concrete mix designs shall be prepared by a CSA approved laboratory, or by a concrete supplier with the capability and a facility approved by the Engineer.

.9 If requested, the supplier shall provide evidence that proportions in the mix design will produce concrete of the quality specified. Include strength tests on trial mixes made under plant conditions.

.10 Concrete production may not proceed until the Engineer has approved the applicable mix design.

Part 3 Execution

3.1 INSPECTION OF FORMWORK AND REINFORCEMENT

.1 Carefully inspect the installed work of all other trades prior to all of the Work of this section, and verify that all such work is complete to the point where this Work may properly commence.

.2 Provide 48 hours notice and obtain the Engineer's approval before placing concrete.

.3 Ensure that reinforcement, formwork, inserts or accessories are securely fastened and will not be disturbed during concrete placement.

.4 Verify that all items to be embedded in concrete are in place.

.5 Verify that concrete may be placed to the lines and elevations indicated on the Drawings with all required clearance for reinforcement. In the event of any discrepancy, immediately notify the Engineer. Do not proceed with installation until all such discrepancies have been fully resolved.

3.2 DELIVERY OF CONCRETE

.1 Deliver concrete to the job site to clause 5.2.4, CAN/CSA-A23.1, as supplemented or modified below.

.2 Rotating Drum Trucks: Transport concrete using only equipment with mixing or agitating capability.

.3 Rotate the drum on the job site at mixing speed for 3 minutes immediately before discharge.

.4 The minimum load size to be delivered to site is 3 cubic meters.

.5 Retempering with Water: Do not add water after the initial introduction of mixing water at the plant except as follows:

.1 When the slump at the point of initial discharge is less than specified

.2 Introduce additional water into the drum mixer in an amount not exceeding 12 litres/m^3, to bring the slump to within specified limits.

.3 Rotate the drum a minimum of 30 revolutions at mixing speed until the required uniformity of concrete is attained.

.4 Do not subsequently add any further water to the load.

.5 If a load of concrete is retempered with water and the resulting slump exceeds the specified maximum slump, that load of concrete will be rejected.

.6 If the need for retempering with water becomes persistent or continuous, the Engineer or his representative may refuse to accept concrete loads that have been retempered with water.

.6 Slow rotation of the drum for extended periods of time for the purpose of slump reduction in loads of concrete delivered with a slump exceeding the specified maximum slump will only be permitted for concrete placed by extrusion.

.7 Retempering with Air-Entraining Admixtures is only permitted under the following conditions

.1 Retempering on site with an approved air-entraining admixture shall only be performed by a quality control technician working for the concrete supplier or the Contractor. Dry, powdered, bagged or premeasured liquid air-entraining admixtures may be added by the concrete truck operator under the direction of the supplier's quality control technician. For retempering purposes the concrete supplier shall use a comparable air-entraining admixture to what was originally approved for use in the mix design. Rotate the drum for 3 to 5 minutes or until the mix is uniform, after the addition of the air entraining admixture.

.2 The Geotechnical Engineer technician shall perform an air content test on each load of concrete retempered with air-entraining admixtures and shall immediately provide the test results to the Engineer.

.3 Guidelines for retempering with air-entraining admixtures:

Measured Air Content (%)	**Action**
4.0 – 4.9	Air-entraining admixtures or air-entraining admixtures and water must be added as deemed necessary by the supplier to meet specifications
< 3.9	No re-tempering with air-entraining admixtures or water is permitted; load will be rejected

.4 When retempering with air-entraining admixtures, the supplier will be given one opportunity to meet the specified air content.

.5 If the need for retempering with air-entraining admixtures becomes persistent or continuous, the Engineer or his representative may refuse to accept concrete loads that have been retempered with air-entraining admixtures.

.6 The use of de-airentraining admixtures is not permitted.

.7 A load of concrete will be rejected if it is retempered with air-entraining admixtures and the resulting air content exceeds the specified maximum air content.

.8 A load of concrete that is rejected at the jobsite may not be retempered at the concrete plant with cement, aggregate, sand or admixtures and subsequently returned to the jobsite.

.9 On site mix adjustments with cementitious materials, sand aggregate or any chemical admixtures other than air-entraining admixtures and superplasticizers will not be permitted.

.8 When the ambient air temperature in the shade is 23º C or higher, concrete at time of placement shall not have a temperature exceeding 30º C.

.9 When the ambient air temperature is lower than 5º C, the concrete delivered to the site shall have a temperature between 15º C and 30º C.

.10 Discharge Time: Complete the discharge of concrete within 90 minutes of the initial introduction of mixing water to the cement and aggregate at the plant. The discharge time may be extended to 120 minutes by incorporating hydration control admixtures. The supplier must submit mix designs for approval and provide evidence that the plastic concrete properties (slump, air content and temperature) can be maintained through the extended discharge time period.

.11 Delivery Record: Provide the Engineer with a delivery ticket showing the batch plant location, the supplier's name, ticket and truck numbers, mechanically punched date and time of initial plant mixing, class and mix design designation, cement type and aggregate sizes, type and amount of admixtures, water added, volume of concrete, site arrival time, start and end of discharge time and other information requested by the Engineer.

3.3 PLACING CONCRETE

.1 Handle, deposit and consolidate fresh concrete to CAN/CSA-A23.1 and as supplemented below.

.2 Moisten the surface of the subgrade or subbase before placing concrete to minimize absorption of water from the deposited concrete. Do not create mud, nor let water pond.

.3 Ensure that reinforcement and formwork are thoroughly clean and wetted before placing concrete.

.4 Do not place concrete during rain or when there is imminent danger of rain or if the weather, in the opinion of the Engineer, is not suitable**.**

.5 Place hot and cold weather concrete to CAN/CSA-A23.1. Ensure that the procedures used are approved by the Engineer.

.6 Pour concrete continuously and as rapidly as possible between predetermined construction joints to the approval of the Engineer.

.7 Locate construction joints to Section 32 10 00 Sitework Concrete Forms and Accessories.

.8 Consolidate concrete in accordance with CAN/CSA-A23.1.

.9 Concrete cover over reinforcing steel shall be to CAN/CSA-A23.1.

3.4 FINISHING

.1 Perform the initial and final finishing of the plastic concrete surfaces to CAN/CSA-A23.1, as described on the Engineering and Landscape drawings and as supplemented below.

.2 Do not apply water to the concrete surface to facilitate finishing under any circumstances. To retain surface moisture and facilitate concrete finishing, the contractor may elect to fog the surface with Master Builders Confilm or an approved equivalent.

.3 Protect the Work from rain to avoid excessive moisture on the unfinished surface and to prevent pitting to the finished surface if still plastic.

.4 Concrete finishing shall be performed by or under the direction of certified Journeyman concrete finishers.

.5 Brush or Broom Finish: Use a brush or a broom with nylon bristles that can form surface grooves no deeper than 3 mm. Remove excess water from the bristles before brushing. Brush in the designated direction.

.6 Burlap Finish: Drag multiple ply burlap equal in length to the width of the slab and having at least a 1 m strip in contact with the plastic concrete surface. Drag carefully in the direction of concrete placement to produce a finished surface simulating a sandy texture with no disfiguring marks.

3.5 JOINTS

.1 Construct joints as required in each type of construction to the following standards as applicable. The Architectural, Civil and Landscape drawings shall be referenced for the type, size and frequency of joints.

.2 Crack-Control Joints: intended to control the location of shrinkage cracks in hardening concrete. Construct joints to the indicated dimensions, spacing, and pattern by any of the following methods:

.1 Formed Joint: Form the groove by inserting a metal or fibre strip, or polyethylene film into the plastic concrete. Finish the edges to a 6 mm radius. Remove the insert immediately after the initial set of the concrete. Seal the joint with a specified sealant.

.2 Tooled Joint: Hand form the groove using a jointing tool with a thin metal blade to impress a plane of weakness into the plastic concrete. Finish the edges to a 6 mm radius. Seal the joint with a specified sealant.

.3 Sawed Joint: Cut the groove with a concrete saw as soon as the concrete surface has hardened sufficiently to resist raveling as the cut is made, but before shrinkage cracks form in the concrete. The Contractor is responsible for the proper timing of the saw cut. Immediately flush the saw cut clean with water. Once the joint surfaces are dry, seal the joint with a specified sealant.

.3 Isolation Joint: required where concrete is placed adjacent to an immovable structure or where indicated on the Drawings. Construct the joint by sawing or forming to create a clean break through the full cross-section of the concrete member. Make the joint wide enough to permit a snug fit for the pre-formed joint filler. Alternatively, place the pre-formed joint filler against the structure and pour the concrete against the pre-formed joint filler.

.4 Construction Joint: required between concrete pours or for joining new concrete to existing work. Construct the joint with a keyway, dowels or tie bars as detailed on the drawings or as directed by the Engineer. Finish edges to a 6 mm radius. Vertically trim the existing concrete by sawing at least 50 mm deep and breaking. Leave the joint form in place until the concrete has set, then remove the joint form without damaging the concrete.

3.6 PROTECTION AND CURING

.1 Protect freshly placed concrete from freezing, premature drying, temperature extremes, adverse weather conditions, and physical disturbance to clause 7.4, CAN/CSA-A23.1, and as supplemented below.

.2 Cold Weather Protection: Concrete shall be protected from freezing for a minimum of 4 days after placement or for the time necessary to achieve 75% of the specified 28-day compressive strength.

.3 Membrane Curing: Cure exposed concrete surfaces using a specified curing compound applied with a pressurized spray nozzle. Curing compound shall be applied immediately after final finishing and cover the entire exposed surface with an unbroken and uniform film at a rate depending on surface roughness but not less than 1 litre per 4 m2 of surface. Membrane curing will not be required when the maximum daily air temperature for the 72 hours following placement of the concrete is not expected to be greater than 5º C.

.4 Moist Curing: Use where specified or directed by the Engineer. After the concrete has set, maintain exposed surfaces continuously moist using wet burlap or polyethylene film in contact with the concrete for a minimum of 7 consecutive days after placement when Type GU or Type HS cement is used, or a minimum of 3 consecutive days when Type HE cement is used.

3.7 FIELD QUALITY ASSURANCE

.1 The contractor and the concrete supplier shall assist the field technician in obtaining samples for quality assurance testing**.**

.2 The contractor shall suspend pouring operations after sampling until the results of the field quality tests are known.

.3 Inadequate Protection and Curing:

.1 For concrete where the surface temperature is measured to be below 0º C the concrete may be accepted subject to inspection by the Engineer.

.4 Deficient Slump:

.1 For any load of concrete, if the measured slump is outside the specified limits, a check test is taken on another portion of the load, or a retest is done if retempering with water is permitted by the Engineer. If the second test fails, the Engineer may reject that load of concrete including removal of the portion already poured.

.5 Deficient Air Content:

.1 For any load of concrete, if the tested air content is outside the specified limits, the Engineer will require one of the following:

.2 Air content below 5.0%: Concrete poured from the load shall be removed and the rest of the load shall be discarded.

.3 Air content above 8.0%: Except for class C concrete, concrete poured from the load shall be removed and the rest of the load discarded. For class C concrete where high early strength is not specified, the concrete will be accepted if the specified 28 day strength is met.

.4 If the measured air content is below the specified minimum air content, then the contractor may elect to retemper with air entraining admixtures to Clause 3.2.6.

.5 When Air Void Examination Is Required The quality assurance laboratory will drill cores from the hardened concrete for air void examination to Clause 1.3.6, at a frequency of at least one core for each 2 000 m of local and collector sidewalk, curb and gutter or monolithic walk, curb and gutter, or as requested by the Engineer.

.6 Where concrete has been rejected and is to be removed for not meeting the spacing factor requirement in Clause 1.3.6, the Contractor at the Contractor’s expense shall prove that the concrete left in place at both ends of the removal meets the specified spacing factor by air void examination to be performed by a qualified laboratory. The test results shall be submitted to the Engineer.

.6 Deficient Strength:

.1 Concrete work for roadways represented by a strength test result which is less than specified may be accepted subject to approval of the Engineer. If the strength is unacceptable, the Engineer may reject the concrete and require removal and replacement or direct the Contractor to undertake additional coring as outlined below.

.2 Optional core strength test:

.3 The Contractor, at their expense, may be required to provide evidence of strength by coring and testing to CAN/CSA-A23.2-14C moisture conditioned, by a qualified laboratory within 7 days of a failed 28-day cylinder test or within 3 days of a failed 7-day cylinder test. Three cores shall be drilled from the hardened concrete represented by the failed cylinder strength tests at locations approved by the Engineer.

.4 Test results shall be submitted to the Engineer.

.5 The average strength of the 3 cores shall equal 100% of the specified cylinder strength; otherwise, the concrete will be rejected and removal and replacement will be required.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Supply of all labour, materials and equipment to complete the concrete formwork, including slipforming required for Sitework Concrete external to the building, excluding structural stoops and aprons, as indicated on the drawings or specified herein.

1.2 RELATED SECTIONS

.1 Section 32 16 13 – Concrete Curb, Gutters and Walks.

.2 Section 32 20 00 – Sitework Concrete Reinforcing Steel.

.3 Section 33 05 16-13 – Concrete for Water and Drainage Structures.

1.3 QUALITY ASSURANCE

.1 At least one person thoroughly familiar with the type of material being installed, the referenced standards and the requirements of this section shall direct this portion of the Work.

.2 Supply, erect and dismantle concrete formwork in accordance with CSA-A23.1-04 except where specified elsewhere.

.3 The design of all formwork shall be the responsibility of the Contractor.

Part 2 Products

2.1 MATERIALS

.1 Formwork Materials: comply with CAN/CSA-S269.3, plain reusable pre-coated plywood sheets or formed steel panels.

.2 Form Ties: use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in the concrete surface.

.3 Form Release Agent: chemically active release agents containing compounds that react with free lime in concrete resulting in water insoluble soaps.

.4 Form Stripping Agent: colourless mineral oil, free of kerosene, with viscosity between 15 to 24 mm2/s at 40°C, flashpoint minimum 150°C, open cup.

.5 All other materials, not specifically described but required for proper completion of concrete formwork, shall be as selected by the Contractor, subject to the advance approval of the Engineer.

.6 Slipform Equipment: of a design suitable to the type of work being constructed, for use with vibrators, and capable of uniformly extruding, spreading, shaping, and consolidating fresh concrete to produce a dense homogeneous mass with surfaces requiring a minimum of hand finishing; self-

propelled and capable of automatically controlling alignment and grade from taut wires or string lines.

Part 3 Execution

3.1 FABRICATION AND ERECTION

.1 Verify lines, levels and centres before proceeding with formwork, and ensure dimensions agree with drawings.

.2 Use of earth forms is prohibited.

.3 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1-04

.4 Align form joints and make watertight. Keep form joints to a minimum.

.5 Use 50 mm chamfer strips on external corners and 25 mm fillets at interior corners of concrete members, unless specified otherwise.

.6 Form chases, slots, openings, drips, recesses and expansion and control joints as indicated.

.7 Build in anchors, sleeves, and other inserts required to accommodate work specified in other sections. Assure that all anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.

3.2 SLIPFORMING

.1 Set and maintain grade line by establishing taut string line or wire, based on survey control datum.

.2 Provide stable support for travelling slipform machine. Protect adjacent work and repair if damaged.

.3 Coordinate concrete delivery and placing to ensure uniform progress of slipform machine without stoppage. If machine is stopped for any cause, immediately stop vibrating and tamping elements.

.4 Maintain proper slump to ensure slipformed concrete does not sag.

.5 Slipformed surfaces shall be smooth, dense, and free of pockets and honeycomb. Apply a minimum of hand finishing to correct minor irregularities.

3.3 FORM REMOVAL

.1 Review the proper timing of form removal with the Engineer in all cases.

.2 Loosen all forms within the first 24 hours after placing, and strip forms within 48 hours to facilitate finishing.

3.4 CONSTRUCTION JOINTS

.1 Construct joints in accordance with the details shown on the Architectural, Civil and Landscape drawings and/or local municipal standards.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 05 16 – Aggregate Materials.

.2 Section 31 23 10 – Site Excavation, Filling and Grading.

.3 Section 31 23 13 – Sitework Subgrade Preparation.

.4 Section 31 23 13-13 – Proof Rolling.

1.2 SECTION INCLUDES

.1 Spreading and compacting imported aggregate into a base or sub-base.

.2 Scarifying, shaping and compacting existing granular base or sub-base.

.3 Windrowing existing gravel, preparing the subgrade and spreading and compacting granular base or sub-base.

1.3 DEFINITION

.1 Maximum Density: The dry unit mass of a sample at optimum moisture content as determined in the laboratory to ASTM D698 Method A.

1.4 QUALITY ASSURANCE

.1 Testing Frequency:

.1 The quality assurance laboratory will take a minimum of one field density test on a compacted granular lift for each 1 500 m^2 of road or parking and 500 m^2 of walk, monolithic walk, curb ramp, alley crossing, commercial crossing, private crossing, or median or island strip, according to ASTM D1556, ASTM D2167, or ASTM D2922 for comparison with a maximum density determined according to ASTM D698 Method A.

.2 Required Density:

.1 The compacted lift thickness of a granular course shall not exceed 150 mm, or as directed by the Engineer. The required density of granular base courses is shown in the following table.

Compacted Granular Base Course	Required Percentage of Maximum Density
under roads, curb and gutter, including the curb portion of monowalk with curb.	100%
under commercial or alley crossings, or garbage pads, or shed pads	100%
under asphalt or concrete walk, transit pads	97%
under walk portion of monolithic walk	97%
under curb ramps	97%
under private crossings	97%
under median or island strips	97%
under granular walkways	95%

.3 Proof Rolling:

.1 A proof roll of the finished granular base course will be required to confirm adequate bearing capacity of the aggregate layer. The proof roll shall be supervised by the Engineer, and must be performed in accordance with the Geotechnical Engineer's recommendations.

Part 2 Products

2.1 MATERIALS

.1 Granular Materials: to Section 31 05 16 Aggregate Materials, Designation 3, classes as indicated on the Drawings.

2.2 EQUIPMENT

.1 Equipment: Graders, rollers and other equipment of adequate design and capacity to produce a granular base or subbase as specified.

Part 3 Execution

3.1 PREPARATION

.1 The prepared subgrade shall be inspected by the Engineer before placing the granular course.

3.2 NEW GRANULAR BASE OR SUBBASE COURSE

.1 Deposit aggregate and spread uniformly in lifts not exceeding 150 mm thickness when compacted.

.2 Segregation: If segregation occurs:

.1 In Class 20 aggregate: blade the lift and mix thoroughly before final spreading and shaping to crown and grade.

.2 In Class 63 or Class 80 aggregate: remove and replace the segregated material.

3.3 COMPACTION

.1 Bring the moisture content of the aggregate to near optimum.

.2 Non-compliance: If a density test result is less than the required density, that test result is discarded and a retest shall be performed on the area represented by the failed test. If the retest is less than the required density, the area shall be reworked to the full depth of the lift, the soil moisture altered as necessary and recompacted to the required density.

.3 The Contractor shall assume the risk of uncovering and reworking the granular base if it is covered before the Engineer has accepted test results thereof.

3.4 FIELD QUALITY CONTROL

.1 Check finished surface of granular base to ensure that it meets the following tolerances:

.1 Surface Tolerance: 15 mm maximum variation under 3 m straightedge.

.2 Grade Tolerance: 6 mm maximum variation above designated elevation and 15 mm maximum variation below designated elevation.

.2 When Tolerance Exceeded

.1 Trim high spots and refinish surface to within tolerance.

.2 Add approved aggregate to low areas, scarify, blend, re-spread and recompact to required density and refinish surface. Alternatively, compensate low areas with extra thickness of subsequent granular base course.

3.5 SUBSEQUENT PAVING COURSE

.1 Do not permit vehicular traffic on the compacted granular base before paving.

.2 If the granular base floods, drain immediately by natural flow or by pumping to catch basins, manholes, or ditches.

.3 Repair any damage, including freezing, to the granular base course and retest for density before paving.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 32 12 13 – Preparatory Coats.

.2 Section 32 12 16-13 – Asphalt Paving Materials.

1.2 DESCRIPTION:

.1 This section specifies requirements for asphalt tack coat.

.2 The work includes supply of asphalt tack material, equipment and placing of tack coat.

1.3 SAMPLES

.1 The quality assurance laboratory may take and test samples of liquid asphalt used weekly from each source. Material not meeting specifications shall be replaced.

Part 2 Products

2.1 MATERIALS

.1 Asphalt Track: Anionic emulsified asphalt, slow setting (SS-1h) to the following requirements:

Requirement Tests on Emulsion	ASTM Test Method	Min.	Max.
Saybolt Viscosity, Flurol Seconds at 25° C.	D244	20	60
Residue By Distillation, % By Mass	D244	55	-
Settlement In 5 Days, % By Mass	D244	5.0	5.0
Storage Stability Test, 24 hr., % By Mass	D244	1.0	1.0
Sieve Test, % Retained On a No. 1 000 Sieve, % By Mass	D244	0.10	0.10
Cement Mixing Testing, % By Mass	D244	2.0	2.0

Tests on Residue	ASTM Test Method	Min.	Max.
Penetration At 25° C 100 G, 5 sec, dmm	D5	40	100
Ductility at 25° C, cm	D113	60	-
Solubility in Trichlorethylene, % By Mass	D2042	97.5	-

Part 3 Execution

3.1 EQUIPMENT

.1 Pressure Distributor: Designed, equipped, maintained and operated so that asphalt at uniform temperature may be applied uniformly on variable widths of surface up to five (5) metres at readily determined and controlled rates from 0.2 to 5.4 L/m² with uniform pressure, and with an allowable variation from any specified rate no exceeding 0.1 L/m².

.2 Capable of distributing asphalt material in uniform spray without atomization at temperature required. The spray patterns made by alternate nozzles shall meet with no overlap, to avoid streaking. Nozzles shall be of the same manufacturer, size and type, and shall be set in the spray bar so that all nozzle slots make the same angle with the longitudinal axis of the spray bar.

.3 Equipped with the metre registering lineal metres per minute, visibly located to enable the operator to maintain constant speed required for application at specified rates.

.4 Pump equipped with flow meter registering litres per minute passing through the nozzles and visible to the operator of the distributor. The pump shall operate by a separate power unit independent of the truck power unit.

.5 Equipped with an easily read, accurate and sensitive device which registers the temperature of the liquid in the reservoir.

.6 Equipped with the accurate volume measuring device or calibrated tank.

.7 Equipped with heating attachments and circulation or agitation capability.

3.2 APPLICATION

.1 Obtain Engineer's approval of existing surface before apply tack oil.

.2 Temperature condition emulsified asphalt to between 20° C and 50° C.

.3 Apply undiluted emulsified asphalt tack coat material to existing pavement surface at a rate not greater than 0.5 L/m².

.4 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt material.

.5 Do not apply tack coat when air temperature is less than 5° C or when rain is forecast within two (2) hours.

.6 Avoid applying tack coat to surfaces that will be visible when paving completed

.7 Evenly distribute excessive deposits of tack coat by brooming.

.8 Keep traffic off tacked areas until tack coat has cured.

.9 Permit tack coat to cure before placing asphalt paving mixtures.

END OF SECTION

Part 1 General

1.1 DESCRIPTION:

.1 This section specifies the requirements for the supply of hot mix asphalt concrete paving.

.2 The work includes supply of aggregates and asphalt cement, and reclaimed asphalt pavement and liquid anti-strip where applicable; asphalt plant mixing, transporting, placement finishing, and compaction to all requirements of this specification.

.3 The work includes all materials certification, quality control, verification and mix design testing, analysis and reporting to be completed as required in this specification.

1.2 RELATED WORK

.1 31 00 10 Geotechnical Sitework Testing.

.2 Section 32 12 13 – Preparatory Coats.

.3 Section 32 12 16-13 – Asphalt Paving Materials.

1.3 DEFINITIONS

.1 End Product Specification (EPS) – A specification whereby the methods of construction are not defined. Under EPS the Engineer will monitor the Contractor's control of the process that produces the items of construction and will accept or reject the end product according to a specified acceptance plan. The Contractor is responsible for quality control. End product acceptance, including quality assurance is the responsibility of the Engineer.

.2 Engineer – As referenced to in this specification, applies to the Civil Engineer of Record or the designated project representative.

.3 Hot Mix Asphalt (HMA) – Generally refers to the mixture of aggregates and asphalt cement and other additives where applicable.

.4 Asphalt Concrete – Generally refers to the final HMA product in place.

.5 Pre-Production Quality Control – Materials and process quality control conducted in accordance with this specification prior to plant mixing.

.6 Post-Production Quality Control – Materials and construction quality control conducted in accordance with this specification during and after plant mixing.

.7 Quality Assurance – Acceptance testing and the monitoring undertaken on behalf of the Owner

.8 Job Mix Formula – The Job Mix Formula (JMF) establishes the proportioning of aggregate, asphalt cement and Reclaimed Asphalt Pavement (RAP) and/or liquid anti-strip where applicable, to be used for the production of hot mix asphalt (HMA).

1.4 QUALITY ASSURANCE

.1 Thickness Cores – The Geotechnical Consult will:

.1 Take a minimum of one core per 1,000 m2 of FMA hot-mix asphalt pavement and determine the thickness of the mat, for each stage of paving.

.2 A thickness deficiency at the completion of the first stage of paving may be accepted by the Engineer provided the deficiency is less than 12 mm and the deficient thickness can be included in the subsequent stage of paving.

.3 If the initial core thickness is deficient at the completion of the final lift of paving, that initial thickness is discarded, and 3 new cores will be taken within 10 m of the original core location at a minimum spacing of 2.5 m between cores. The average thickness of the 3 new cores represents that area.

.2 Asphalt Cement Content and Density Specimen Sampling and Testing – The Geotechnical Consult will:

.1 Determine the Lot Mean Relative Density (MRD) and asphalt cement content of the FMA at a minimum frequency of one test for every 250 tonnes of FMA produced, or a day's production, whichever is less.

.2 Obtain one core from compacted mat placed from same load of FMA from which FMA specimens were obtained, or from suspect compacted mat, and test for density. Where specified in the special provisions of the contract obtain a second core from the compacted mat for rut testing in the Asphalt Pavement Analyzer (APA).

.3 Obtain one core from compacted mat representing 1,000m² and test for density.

.4 Basis of Acceptance: FMA pavement compaction will be accepted based on the ration (in percent) of the core density to the Lot Mean Relative Density (MRD). If cores were taken from a mat where no MRD are available, acceptance will be based on the ratio of core density to the average MRD for that day's production.

.5 Representative Cores: A single core is initially taken representing the quantity of HMA in not more than 1,000m² of mat, with a minimum of one core taken from a day's production. If the initial core density is below specified, that initial density is discarded, and 3 new cores will be taken within 10m of the original core location at a minimum spacing of 2.5m between cores. The average density of the new cores represents that area.

1.5 WARRANTY

.1 All asphalt paving constructed within the municipal rights-of- municipal rights-of-way (19A Avenue and 8 Street) shall be subject to a two (2) year warranty from the date of Construction Completion approval from the Town of Coaldale. A Final Acceptance inspection will be conducted with the Town of Coaldale to identify deficiencies at the end of the warranty period. The Contractor shall be responsible to undertake any identified repairs. The Consultant shall assign responsibility for payment of these repairs.

Part 2 Products

2.1 MATERIALS

.1 Asphalt Cement – to Section 32 12 16-13 – Asphalt Paving Materials.

.2 Aggregates:

.1 Coarse aggregate is aggregate retained on the 5,000 µm sieve. Fine aggregate is aggregate passing the 5,000 µm sieve.

.2 Aggregate material shall be crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps cementation, organic material, frozen material and any other deleterious materials.

.3 Gradations to be within limits specified, when tested to ASTM C-136 and ASTM C-117 with sieve sizes to CAN/CGSB 8-GP-2M rather than ASTM E11.

.4 Aggregate shall be processed to meet the following requirements:

.1 Natural fines shall be pre-screened and stockpiled with not more than 10% of material retained on the 5,000 µm and 100% passing the 10,000 µm sieve.

.2 Aggregate delivered to the crushing plant shall be pre-screened and shall contain no more than 5% passing the 5,000 µm sieve.

.3 Crushed aggregates shall be separated and stockpiled in accordance with the following:

.1 Coarse fraction to contain no more than 10% of material passing the 5,000 µm sieve.

.2 Fine fraction or manufactured sand to contain no more than 20 % of material retained on the 5,000 µm sieve.

.5 Physical properties of aggregates to meet the requirements in Table 2.1.2.5.

Table 2.1.2.5
Aggregate Physical Property Requirements

Requirement	Test Standard	Mix Types I, II and III
Los Angeles Abrasion, Grading B (% Loss)	C131	32.0 max
Magnesium Sulphate Soundness (% Loss) Coarse Aggregate: Fine Aggregate:	C88 - -	- 12.0 max 12.0 max
Lightweight Particles (%)	C123	1.5 max

.6 Blend Sand:

.1 To consist of natural or manufactured sand passing the 5,000 µm sieve.

.2 Stockpile volumes shall be maintained to ensure a minimum of 5,000 tonne of plant mix production at all times.

.7 Blended Aggregate Requirements:

.1 Aggregate Gradation Requirements, including RAP, to meet the requirements of Table 2.1.2.7.1.

Table 2.1.2.7.1
Blended Aggregate Gradation Requirements

Sieve Size (µm)	Percent (%) Passing					
	Type I		Type II		Type III	
	Max	Min	Max	Min	Max	Min
25,000	-	-	100	100	-	-
20,000	-	100	95	85	-	-
16,000	100	97	88	77	-	100
12,500	95	85	80	65	100	90
10,000	85	70	72	57	90	75
5,000	65	50	55	40	75	60
2,500	50	40	42	30	60	45
1,250	40	30	33	23	45	30
630	30	20	27	17	36	22
315	23	15	22	12	27	15
160	16	6	15	6	18	6
80	8.0	4.0	8.0	4.0	10.0	4.0

.2 . Coarse Aggregate Fracture: Of coarse fraction (retained on 5,000 µm sieve size) the percentage of particles with two (2) or more fractured faces shall be by mass:

.1 Mix Type I – 80% minimum

.2 Mix Type II – 60% minimum

.3 Mix Type III – 80% minimum

.3 Flat and Elongated Particles: Of coarse fraction (retained on 5,000 µm sieve size) the percentage of flat and elongated particles greater than a 5:1 ratio shall be by mass less than 10%.

.4 Manufactured Sand: Of total fine fraction (passing 5,000 µm sieve size), manufactured sand shall be by mass:

.1 Mix Type I – 70% minimum

.2 Mix Type II – 50% minimum

.3 Mix Type III – 50% minimum

.5 For mixes incorporating RAP, 50% of the RAP sand portion shall be considered manufactured sand.

.6 The sand equivalent value (ASTM D2419, mechanical method) determined for the fine aggregate portion shall be.

.1 Mix Type I and III – 45% minimum

.2 Mix Type II – 40% minimum

.7 Of total aggregate, the maximum RAP portion shall be by mass:

.1 Mix Type I – 15% maximum

.2 Mix Type II – 15% maximum

.3 Mix Type III – 20% maximum

2.2 MIX DESIGN

.1 An asphalt mix design must be prepared and submitted to the Engineer for review and approval at least one (1) week prior to the Work. The Contractor shall use qualified engineering and testing services licensed to practice in the Province of Alberta.

.2 The mix design shall follow the Marshall Method of mix design as outlined in the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2), and shall include five (5) separate trial values of asphalt content.

.3 Design of Mix:

.1 Mix Types I and Type II – 75 Blows on each face of test specimens.

.2 Mix Type III – Blows on each face of test specimens.

.4 Include the following data with mix design submission:

.1 Aggregate specific gravity and asphalt absorption.

.2 Sand equivalent, coarse aggregate fracture, flat and elongated particles, and percent manufactured sand values.

.3 Asphalt cement supplier / refinery, specific gravity and mixing and compaction temperatures, based on temperature – viscosity properties of asphalt cement.

.4 Job Mix Formula (JMF) including aggregate gradation and blending proportions, and design asphalt content.

.5 Maximum relative density at each trial asphalt content.

.6 Where Reclaimed Asphalt Pavement (RAP) is to be incorporated into the mix supply, RAP gradation, RAP asphalt cement content and design recycle percentage.

.7 Data to satisfy the requirements of the following:

Table 2.2.3.7
Mixture Physical Property Requirements

Property	Requirements		
	Mix Type		
	I	II	III
Marshall Stability (kN)	10.0 min.	10.0 min.	5.4 min.
Marshall Flow (0.25mm Units)	8 - 14	8 - 15	8 – 14
Air Voids (%)	3.8 – 4.2	4.3 – 4.7	2.8 – 3.2
Voids in Mineral Aggregate (VMA) (%)	13.5 – 15.0	12.5 – 14.0	14.0 – 16.0
Voids Filled With Asphalt (VFA) (%)	65 - 75	60 - 70	70 - 80
Film Thickness (µm)	7.0 – 8.5	6.0 – 8.0	7.0 min

2.3 JOB MIX FORMULA

.1 Subject to approval by the Engineer, the aggregate proportioning (including RAP), target gradation, asphalt content and air void content from the Mix Design will become the Job Mix Formula (JMF) for the supply of hot mix asphalt.

.2 Once established, no alterations to the Job Mix Formula will be permitted unless the Contractor submits a new JMF and is approved by the Engineer.

.3 If the sum of any alterations to the JMF is in excess of any one of the following limits, a new Mix Design is required:

.1 ± 5% passing the 5,000 µm sieve size

.2 ± 1% passing the 80 µm sieve size

.3 ± 0.30% asphalt content

.4 Any alteration to the JMF shall not result in properties which do not meet the requirements of this specification.

Part 3 Execution

3.1 PREPARATION FOR PAVING

.1 The Contractor shall provide the Engineer a minimum of six (6) hours' notice of the intention to commence paving over any previously approved primed or tacked surface.

.2 The hot asphalt mixture shall be laid upon a dry firm surface, true to grade and cross-section and free from all loose or foreign material. No hot mix shall be placed when the surface is wet or when other conditions prevent from proper spreading, finishing or compaction.

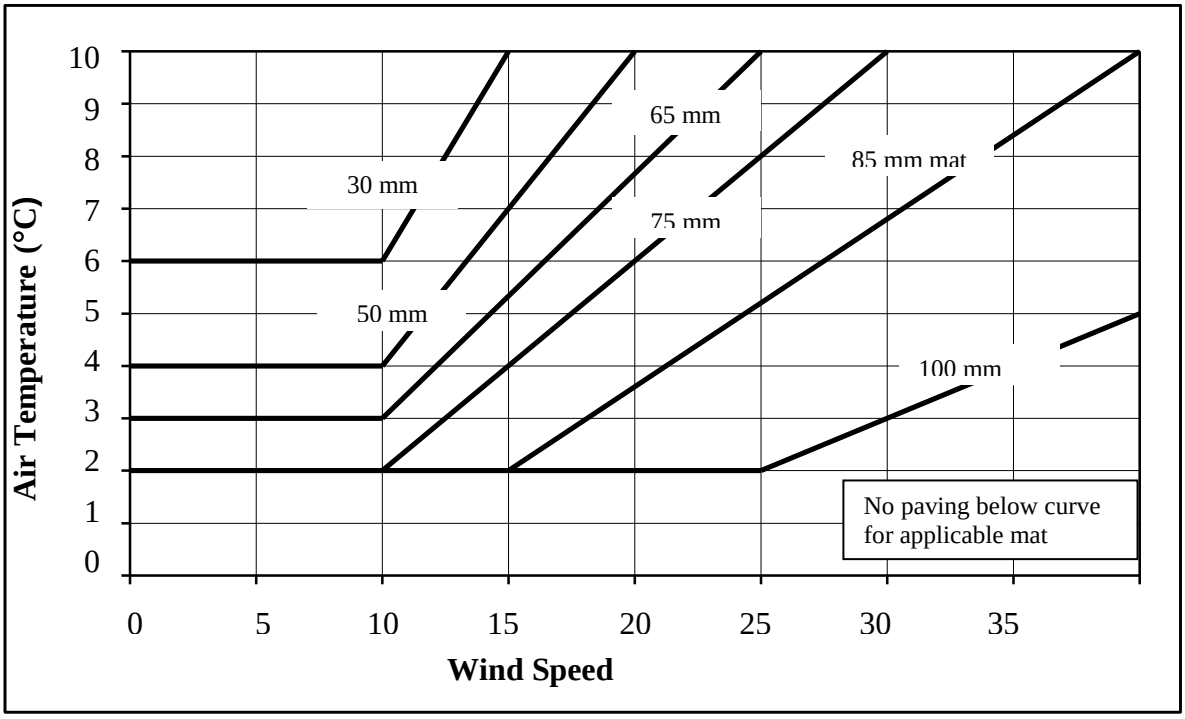
.3 If undercutting, and subsequent backfill with asphalt concrete is done, the backfill operation shall be performed sufficiently far ahead of the paving operation to allow the asphalt concrete time to cool down enough to support equipment.

3.2 HOT MIX ASPHALT PLACING TEMPERATURE

.1 No paving is permitted when rain or snow is imminent, or when the surface or base to be paved is wet, icy, snow-covered, or frozen, unless waived by the Engineer.

.2 No paving is permitted when air temperature and wind speed conditions are below the applicable mat curve in Chart3.3.2, unless waived by the Engineer.

.3 Chart 3.3.2: Air Temperature and Wind Limitations on Paving:



3.3 **TRANSPORT OF HOT MIX ASPHALT**

.1 Trucks shall be equipped with tarpaulins of sufficient weights and size to cover the entire open area of the truck box. Regardless of weather conditions, tarpaulins shall be used.

.2 Vehicles used for the transportation of hot mix asphalt from the plant to the site of work shall have tight metal boxes previously cleaned of all foreign matter. The inside surface may be lightly lubricated with a soap solution just before loading. Excess lubrication will not be permitted.

.3 For purposes of checking asphalt mixture temperatures, trucks shall have an accessible 13 mm diameter hole drilled into the into the box and 150 mm clear of the reinforcing ribs.

.4 The speed and weight of hauling trucks shall be regulated so that, in the opinion of the Engineer, no damage will occur to any portion of the work to the tack coat, prime coat or the existing surface caused by the Contractor's equipment.

3.4 **HOT MIX ASPHALT SPREADERS**

.1 The spreading machine shall be self-propelled and capable of placing a uniform layer of asphalt mix to the depth and grades as shown on plans or as indicated by the Engineer.

.2 The screed shall include a tamping bar or vibratory strike-off device for use when required. The screed shall strike-off the mix to the depth and cross-section specified and produces a finished surface of uniform texture.

.3 Control of the screed shall be by automatic sensing devices. Longitudinal control shall be accomplished by a sensor, which follows a string line, ski, or other reference. The

grade sensor shall be movable and mounts provided so that grade control can be established on either side of the paver. A slope control sensor shall also be provided to maintain the proper transverse slope of the screed. Use automatic grade control for paving operations.

3.5 HAND TOOLS

.1 Only lutes shall be used during the spreading operation and when the asphalt is worked by hand in areas in which the paver cannot reach.

.2 Tamping irons may be used to consolidate the material along structures inaccessible to the rollers. Mechanical compaction equipment, satisfactory to the Engineer, may be used instead of tamping irons.

.3 For purposes of checking the finished surface, Contractors must provide and carry on each paving machine a 3 metre straight edge and slope measuring level.

3.6 PRE-LEVELING FOR ASPHALT CONCRETE

.1 Pre-levelling of uneven surfaces over which asphalt concrete is to be placed shall be accomplished by the use of asphalt concrete placed with a grader, paver, hand or by a combination of these methods as directed by the Engineer.

.2 After placement, the asphalt concrete used for pre-levelling shall be compacted thoroughly with pneumatic-tired rollers.

3.7 PAVING OPERATIONS

.1 The asphalt concrete shall be placed to the design thickness as shown on the contract drawings. On new construction where an established reference is lacking, a string-line reference will be required. Adjacent mats on the same lift are to be controlled by use of the grade sensor. No relaxation of the above procedure will be permitted without written approval of the Engineer.

.2 The spreader shall be operated in such a manner as to distribute the asphalt concrete mix to proper cross-section, width and thickness without causing segregation of the mix. Segregated areas, which may occur, shall be corrected immediately. The forward motion of the spreader shall be controlled so that no irregularities in the pavement surface are caused by excessive speed. The rate of placement of the mixture shall be uniform and shall be coordinated with the production rate of the asphalt plant without intermittent operation of the spreader.

.3 Any failure of the machine or operation to produce a smooth, uniformly dense mat, free from irregularities, shall be corrected immediately to satisfaction of the Engineer.

3.8 AREAS INACCESSIBLE TO THE PAVING MACHINE

.1 Areas that are inaccessible to the paving machine may be paved by other methods, as approved by Engineer.

.2 In small areas of where the use of mechanical equipment is not practical, the mix may be spread and finished by hand. The asphalt mixture shall be dumped on the area and immediately thereafter distributed into place by shovels and spread with lutes in a loose uniform layer of uniform density and correct depth. Material must be handled so as to avoid segregation.

3.9 COMPACTION

.1 The Contractor shall supply sufficient compaction equipment:

.1 Provide a compaction rate that will equal or exceed the placing rate of the spreader.

.2 Ensure the specified compaction is attached before the temperature of the mat falls below 80 °C.

3.10 LONGITUDINAL AND TRANSVERSE JOINTS

.1 Longitudinal and transverse joints shall be made in a manner consistent with industry standards. Coarse aggregate removed from the hot mix during joint preparation shall not be broadcast on to the mat.

.2 Paving joints shall not be placed in the same vertical plane. Longitudinal joints shall be offset at least 150 mm and transverse joints shall be offset at least 2 m.

.3 Longitudinal joints shall not be located within travel lanes, unless approved by the Engineer.

.4 Edges where additional pavement is to be placed shall be vertically formed to true line. A lute shall be used immediately behind the paver when required to obtain a true line and vertical edge.

.5 The exposed edged of all cold asphalt joints and the face of concrete curb and gutter shall be cleaned and painted with a thin coat of asphalt tack.

.6 At the end of each day's paving of the surface course and upper lift of the base course mix, the uncompleted paving mats shall be provided with vertically cut transverse joints. Joints between old and new pavements or between successive days' work shall be carefully made in such a manner as to endure a thorough and continuous bond between the old and new surfaces.

3.11 OPENING TO TRAFFIC

.1 Prior to any application of traffic, paving mats shall be sufficiently cool to resist any deformation or surface scuffing.

.2 The Engineer may, at their discretion, require means of cooling (eg. application of water), completed pavements prior to opening to traffic.

.3 At their discretion, the Engineer may prohibit traffic from traveling on newly paved surfaces for any length of time deemed necessary.

Part 4 End Product Acceptance or Rejection

4.1 PRODUCTION AND PAVING TOLERANCES AND PAVING

.1 All mixtures shall be supplied to the Job Mix Formula (JMF), within the range of tolerances specified.

.2 Asphalt cement content: ± 0.30% of JMF value.

.3 Temperature: Mix temperature at the point of plant discharge, shall not vary from that specified in the JMF, by more than ± 10 °C.

.4 Aggregate Gradation:

Aggregate Passing Sieve Size (µm)	Tolerance (% By Mass)
Max. Size to 5,000	± 5.0
2,500 & 1,250	± 4.0
630 & 315	± 3.0
160	± 2.0
80	± 1.5

.5 Air Voids: ± 1.0% of the JMF value.

.6 Mixture Properties: Marshall Stability, Marshall Flow, Voids Filled with Asphalt, Voids in Mineral Aggregate and Film Thickness as per requirements identified in Table 2.2.3.7.

.7 Moisture in Mix: Maximum permissible moisture, at point plant discharge, is 0.2% by mass of mix.

.8 Asphalt cement recovered from freshly produced Hot Mix by the Abson Method, ASTM D1856 and subsequently tested in accordance with ASTM D5, shall retain a minimum value of 50% of its original penetration value.

4.2 THICKNESS TOLERANCE

.1 Deficient Thickness: If the average core thickness is deficient, after re-cores are taken, the following shall occur:

.1 If the thickness deficiency is less than 10.0% of the design thickness, the asphalt pavement shall be accepted.

.2 If the thickness deficiency is between 10.0% and 15.0% of the design thickness, the Contractor may be requested to remedy the thickness deficiency or be assigned a payment penalty, subject to agreement among the Client, Engineer and Contractor.

.3 If the thickness deficiency is greater than 15.0% of the design thickness, the Contractor shall grind and resurface the asphalt pavement in the area defined by the Engineer.

.2 Excess Thickness: Asphalt pavement with excess thickness may be accepted with no extra payment, if surface and grade tolerances and texture are met.

4.3 DENSITY TOLERANCE

.1 Required Density: Each mat of hot-mix placed shall be compared to the required minimum density (Percent of Maximum Relative Density (MRD)) for the type of paving as indicated on the engineering drawings.

.2 Deficient Density: If the average core density, after re-cores are taken, is below the required minimum density, the following shall occur:

.1 If the average density is 1.0% nor less than the required minimum density, the asphalt pavement shall be accepted.

.2 If the average density is between 1.0% and 2.0% less than the required minimum density, the Contractor may be requested to remedy the density deficiency through grinding and/or additional asphalt pavement or to be assigned a payment penalty, subject to agreement among the Client, Engineer and Contractor.

.3 If the average density is greater than 2.0% below the required minimum density, the Contractor shall remove and resurface the asphalt pavement in the area defined by the Engineer.

4.4 SMOOTHNESS

.1 The completed asphalt concrete surface shall be true to the dimensional and tolerance requirements of the specifications and drawing. Unless detailed otherwise in the contract documents, the tolerances in both profile and crown are:

.1 Base Course – 10 mm in 3 m

.2 Surface Course – 5 mm in 3 m

.2 When deviations in excess of the above tolerances are found, the pavement surface shall be corrected by methods of satisfactory to the Engineer. Correction of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances.

4.5 SEGREGATION

.1 The finished surface shall have a uniform texture and be free of segregated areas. A segregated area is defined as an area of the pavement where the texture differs visually from the texture of surrounding pavement.

.2 All segregation will be evaluated by the Engineer to determine repair requirements.

.3 The severity of segregation will be rated as follows:

.1 Slight – The matrix of asphalt cement and fine aggregate is in place between the coarse aggregate particles, however there is more stone in comparison to the surrounding acceptable mix.

.2 Moderate – Significantly more stone than the surrounding mix, and exhibit a lack of surrounding matrix.

.3 Severe – Appears as an area of very stony mix, stone against stone, with very little or no matrix.

.4 Segregated areas shall be repaired by the Contractor as directed by the Engineer. The following methods of repair are identified.

.1 Slight – Squeegee asphalt to completely fill the surface voids.

.2 Moderate – Slurry seal for full mat width.

.3 Severe – Removal and replacement or overlay.

.5 All repairs shall be regular in shape and finished using good workmanship practices to provide an appearance suitable to the Engineer.

.6 Any other methods of repair proposed by the Contractor will be subject to the approval of the Engineer.

.7 Repairs will be carried out by the Contractor at their expense.

END OF SECTION

Part 1 GENERAL

1.1 DESCRIPTION:

.1 This section specifies requirements for asphalt tack coat

.2 The work includes supply of asphalt tack material, equipment and placing of tack coat.

1.2 RELATED WORK

.1 Section 31 05 16 – Aggregate Materials.

.2 Section 32 12 16 – Asphalt Paving.

.3 32 12 13 Preparatory Coats

1.3 SAMPLES

.1 Asphalt Cement Data

.1 Name of the Supplier.
.2 Source(s) of the base asphalt cement(s).
.3 Type and source(s) of admixture(s).
.4 Proportions of materials used in the asphalt cement.
.5 Current laboratory test results of the asphalt cement.

Part 2 PRODUCTS

2.1 MATERIALS

.1 Asphalt Cement shall be prepared by the refining of petroleum and shall not foam when heated to 177 °C.

.2 The tolerance allowed by ASTM for testing precision will be applied from acceptance of asphalt cement.

.3 Asphalt cement shall meet the following requirements:

Requirements	ASTM Test Method	Values
Kinematic Viscosity at 135 °C, mm/sec	D2170	200-300
Absolute Viscosity at 60 °C 300 mm, hg Vacuum, Pa.S	D2171	60-100
Penetration at 0 °C, 200 g, 60 sec; dmm	D5	30 min.
Flash Point (Cleveland Open Cup) , °C	D92	201 min.
This Film Oven Test	D5	50 min.

Penetration after test at 25 °C, 100g, 5 sec.; % of Original		
Ductility at 25 °C and 5 cm/min.; cm	D113	100 min.
Solubility in Trichlorethylene % By Mass	D2042	99.5 min.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 05 16 – Aggregate Materials.

.2 Section 31 23 13 – Sitework Subgrade Preparation.

.3 Section 32 05 23 – Sitework Cement and Concrete.

.4 Section 32 10 00 – Sitework Concrete Forms and Accessories.

.5 Section 32 20 00 – Sitework Concrete Reinforcing Steel.

.6 Section 32 11 23 – Aggregate Base Courses.

1.2 SECTION INCLUDES

.1 Construction of Portland cement sitework concrete, including curb, curb and gutter, gutter, walk, monolithic curb, gutter and walk, median or island slabs, curb ramp and crossings, excluding exterior structural stoops and structural slabs.

1.3 QUALITY ASSURANCE

.1 Slump, Air Content, Nuclear Density Tests, Air-Void Examination, Strength Tests and Acceptance Criteria to Section 32 05 23 – Sitework Cement and Concrete.

1.4 WARRANTY

.1 All concrete curbs, gutters, swales and walks constructed within the municipal rights-of-way (19A Avenue and 8 Street) shall be subject to a two (2) year warranty from the date of Construction Completion approval from the Town of Coaldale. A Final Acceptance inspection will be conducted with the Town of Coaldale to identify deficiencies at the end of the warranty period. The Contractor shall be responsible to undertake any identified repairs. The Consultant shall assign responsibility for payment of these repairs.

Part 2 Products

2.1 MATERIALS

.1 Concrete:

.1 Class C, Type GU, or as specified in the Geotechnical Report. Refer to Section 32 05 23.

.2 Reinforcement Bars, Tie Bars, Dowels, Welded Steel Wire Fabric:

.1 Refer to Section 32 20 00 Sitework Concrete Reinforcing Steel.

Part 3 Execution

3.1 TYPES OF CONSTRUCTION

.1 The Contractor has the option of constructing the following types of work by hand forming or by slipforming methods, or by a combination of both. Construct as detailed on plans and drawings or as directed by the Engineer.

.2 Curb, Curb and Gutter & Barrier Curb:

.1 Construct curb, curb and gutter and gutter on prepared subgrade, cement stabilized subgrade, granular base course, soil cement, or asphalt concrete, as indicated on the drawings.

.3 Walk:

.1 Construct walk on a granular base course.

.4 Monolithic Walk Curb and Gutter:

.1 Construct the walk portion of monolithic walk, curb and gutter on a granular base course. If the walk portion is wider than 2 m, place longitudinal and transverse crack control joints at the proper spacing. Monolithic walk and curb (and gutter) shall be poured monolithically.

.5 Curb Ramps:

.1 Curb ramps are an incline built monolithically into curb cut and walk. Construct curb ramps on a granular base course.

3.2 PREPARATION

.1 Verify that the prepared subgrade or base is ready for concrete placement and repair any deterioration or damage.

.2 Cut behind Curb:

.1 Compact soil to Section 31 23 13 and trim to within 25 mm of the back of curb.

.3 Granular Base Course:

.1 The granular base course under concrete walk, curb ramps and the walk portion of monolithic walk, curb and gutter shall consist of 100 mm compacted thickness of Designation 3, Class 20 aggregate. Compaction and tolerance testing shall be to Section 32 11 23.

3.3 HAND FORMING

.1 Place forms to Section 32 10 00 and as supplemented below.

.2 Use flexible forms to construct curves of less than 40 m radius.

.3 Place a minimum 50 m of forms before a concrete pour to allow checking for true line and grade.

.4 The Engineer will not allow the use of forms that are out of shape, dented, rough, or otherwise unsuitable.

3.4 PLACING REINFORCEMENT

.1 Place reinforcement of the type, size and spacing as detailed on drawings or as required by Engineer, to Section 32 20 00.

3.5 PLACING CONCRETE

.1 Place concrete to Section 32 05 23 and as supplemented below.

.2 Use 50 mm pencil vibrators for curb and gutter and approved vibrating screeds for walk and slabs.

.3 Place concrete continuously until the scheduled pour is complete. Arrange the rate of concrete delivery to ensure that the discharge interval between successive loads does not exceed 30 minutes. If the discharge interval is greater than 30 minutes, place a construction joint.

.4 Where possible curbline walk, curb ramps and curb crossings shall be poured monolithically. Where it is possible to pour the curbline walk, curb ramps and curb crossings monolithically the use of dowels and joint sealant at the back of the curb is not permitted.

3.6 SLIP FORMING

.1 Slipform concrete to Section 32 10 00 and as supplemented below.

.2 Hand form and place concrete at corners, driveways and catch basins concurrent with the slipforming operation. Where concurrent work is not practical, complete this work within 7 days of the slipforming of adjacent work.

3.7 FINISHING

.1 Finish concrete to Section 32 05 23 and as supplemented below.

.2 Tool all edges and joints to a width of 50 mm and round edges to a 6 mm radius unless indicated otherwise.

.3 Apply a brush final finish longitudinally along curb and gutter and transversely on walk and slabs.

.4 Refer to finishing details as specified on the Civil and Landscape drawings.

Name Plate: Stamp the Contractor's name and year of construction in the plastic concrete on:

.1 The top of the curb in each block or at 200 m intervals, whichever is less and

.2 The walk at the end of each block on an extension of a property line.

3.8 CRACK-CONTROL JOINTS

.1 Joint Size:

.1 Refer to the Architectural, Civil and Landscape drawings for the location, size and spacing of joints.

.2 For general broom finish concrete, joints shall be 3 mm to 5 mm wide at the following depths:

.1 For curb and gutter and pin on curb: 50 mm minimum to a maximum of 25% of the gutter depth.

.2 For walk and slabs: 25 mm minimum to a maximum of 25% of the walk or slab thickness.

.3 Joint Spacing: 3 m maximum.

.4 Surface Dummy Joints: tooled 5 mm wide by 10 mm deep, centred between contraction joints across walk and slabs. In monolithic construction, place surface joints across the walk portion and contraction joints on the curb and gutter, both joints being on same line. Where required, place a longitudinal surface joint on walk and slabs continuing on through alley crossings and driveways.

3.9 TRANSVERSE CONSTRUCTION JOINTS

.1 Use 10M deformed tie bars at 300 mm spacing and extending 300 mm minimum into both sides of the joint.

.2 Vary joint spacing near the end of a concrete pour as follows:

.1 If a concrete pour ends within 300 mm of a required joint location, average the spacing of last two joints.

.2 If a concrete pour ends within 800 mm of a required joint location, average the spacing of last 3 joints.

3.10 LONGITUDINAL CONSTRUCTION JOINTS

.1 Use 10M deformed tie bars at 1 m spacing and extending 300 mm minimum into both sides of the joint.

3.11 JOINTS ABUTTING EXISTING CURB

.1 Form a 10 mm wide by 30 mm deep slot between the back of curb and the walk or slab.

.2 Fill the slot with a specified joint sealant.

3.12 BACKFILLING

.1 Backfill Material:

.1 If excavation is part of the work, use approved material from site excavation. If excavation is not part of the work, supply fill material approved by the Engineer.

.2 Behind Curb:

.1 Backfill with suitable clay within 7 days of concrete placement and before placing the initial paving course against the curb and gutter, a minimum of 300 mm width behind the curb in two 150 mm lifts. Tamp each lift with mechanical tampers to a minimum 95% of maximum density. Backfill to the top of curb elevation, unless topsoil placement or walk/slab construction immediately follows, in which case leave backfill low to accommodate subsequent work.

.3 Along Slab Edges:

.1 Backfill along the edge of the walk or slab as soon as practical after the removal of concrete forms, allowing for topsoil depth, unless otherwise directed by the Engineer. Tamp with mechanical tampers a minimum 300 mm width along the slab edge to a minimum 92% of maximum density.

.4 Maximum Density:

.1 As used in this Section, is the dry unit mass of sample at optimum moisture content as determined in the laboratory according to ASTM D698 Method A.

3.13 FIELD QUALITY CONTROL

.1 Walk or Slab Surface Tolerances:

.1 Maximum variation under a 3 m straightedge: 6 mm. Maximum variation from walk crossfall: ±1% provided the finished crossfall is not less than 1% nor more than 4%.

.2 Gutter Surface and Curb Top Tolerances:

.1 Maximum variation under a 3 m straightedge: 6 mm.

.3 Grade of Gutter Lip and Walk/Slab Tolerances:

.1 Maximum variation from designated elevation at any station as established from the survey stake: ±6 mm.

.2 Maximum variation from the difference in designated elevations between 2 consecutive stations as established from survey stakes, provided there is positive drainage in the designated direction: ±12 mm.

.4 Lip of Gutter Alignment Tolerances:

.1 Maximum deviation: ±12 mm in 30 m.

.5 **When Tolerances Exceeded:** If any of the tolerances in 3.13.1 to 3.13.4 are exceeded, remove or correct the concrete work in question as directed by the Engineer.

.6 Walk, Median Strip, Slab-on, Ramps or Crossing Thickness:

.1 At the Engineer's request, the Geotechnical Engineer will take one or more sets of cores from suspect concrete walk or crossing, each set comprising 3 cores whose average thickness represents not more than 500 m2 of concrete walk or crossing. If the average core thickness is deficient, that area shall be removed and replaced, at the discretion of the Engineer.

.2 Concrete walk or crossing with excess thickness may be accepted if surface and grade tolerances are met, but no claim for additional payment will be accepted.

3.14 REJECTED CONCRETE WORK

.1 Remove and replace rejected concrete work by full segments or slabs between crack control or construction joints.

3.15 PROTECTION OF FINISHED WORK

.1 Protect finished work from damage. Repair if damaged.

.2 Do not open walk or crossings to traffic until permitted by the Engineer. When opening to traffic, leave walk or crossings clean and free of debris and remove signs and barricades no longer needed.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 32 12 16 – Asphalt Paving.

1.2 SECTION INCLUDES

.1 Supply and placement of pavement markings on hot-mix asphalt concrete.

1.3 SUBMITTALS

.1 Submit product data for traffic marking paint, including MPI product number.

1.4 QUALITY ASSURANCE

.1 Materials and workmanship for new work shall meet or exceed requirements of the APS Manual.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials in sealed original labeled containers bearing manufacturer's name, type of material, brand name, colour designation.

Part 2 Products

2.1 MATERIALS

.1 Materials are specified by the designated MPI systems, with colours specified herein.

.2 Only products listed in the MPI “Approved Product List” are acceptable for use.

2.2 TRAFFIC MARKING PAINT SYSTEM

.1 Yellow Paint: Federal Standard 595, colour #33538; of CSGB colour 505-308.

.2 Blue Paint: Federal Standard 595, colour #25095.

.3 White Paint: Federal Standard 595 Colour #37925; or CGSB 1-GP-12.1C, White 513-301.

Part 3 Execution

3.1 PROTECTION OF EXISTING WORK

.1 Protect structures, buildings, sidewalks, landscaping and other surface features against spillage and over-spray during painting operation.

3.2 PREPARATION OF SUBSTRATE

.1 Prepare new pavement in accordance with manufacturer’s instructions and in accordance with "Architectural Painting Specification Manual", Chapter 2, Section 3.

3.3 APPLICATION OF PAVEMENT LINE MARKINGS

.1 Clean pavement surface as recommended by paint manufacturer.

.2 Paint lines straight and in uniform width, at locations indicated on drawings.

.3 Apply paint using marking machine or line stencil, and as recommended by manufacturer, to minimum 0.18 mm dry film thickness.

.4 Line Width:

.1 Roadways and Parking Areas: 100 mm, except where otherwise indicated.

3.4 ADDITIONAL PAVEMENT MARKINGS

.1 Apply additional pavement markings as noted on the Architectural or Civil drawings, such as barrier free parking stall symbols and thermoplastic crosswalk markings.

3.5 CLEAN-UP

.1 Remove spillage and over-spray of paint from pavement, sidewalks, building and other site features. Use methods and materials without damaging and leaving visible residue on substrates.

3.6 PROTECTION OF COMPLETED WORK

.1 Keep traffic off pavement markings for a time as recommended by paint manufacturer.

END OF SECTION

Part 1 General

1.1 SCOPE

.1 Supply of all labour, materials and equipment to complete the reinforcing steel required for Sitework Concrete external to the building, excluding structural stoops and aprons, the work, as indicated on the drawings or specified herein.

1.2 RELATED SECTIONS

.1 Section 32 10 00 – Sitework Concrete Forms and Accessories.

.2 Section 32 16 13 – Concrete Curbs, Gutters and Walks.

.3 Section 33 05 16-13 – Concrete for Utility Structures.

1.3 QUALITY ASSURANCE

.1 At least one person thoroughly familiar with the type of material being installed, the referenced standards and the requirements of this section shall direct this portion of the Work.

.2 Install steel reinforcement in accordance with CSA-A23.1 and CSA-W186.

.3 Upon request, provide the Engineer with a certified copy of mill test report of the proposed reinforcing steel, showing physical and chemical analysis, a minimum of 2 weeks prior to ordering of reinforcing steel, or as necessary to facilitate a review.

.4 Upon request, inform the Engineer of proposed source of material to be supplied.

Part 2 Products

2.1 MATERIALS

.1 Reinforcing Steel: billet steel, Grade 400, deformed bars to CAN/CSA-G30.18, unless indicated otherwise. Weldable low alloy steel deformed bars to CAN/CSA-G30.18.

.2 Tie Bars: to CSA-G30.18 grade 300, billet-steel, deformed bars, uncoated; and also to ASTM D3963 for epoxy-coated.

.3 Steel Dowels: to CSA-G30.18, clean, straight, free from flattened or burred ends, uncoated and also to ASTM D3963 for epoxy-coated.

.4 Cold-Drawn Steel Wire: to CSA-G30.3M, uncoated; to ASTM D3963 for epoxy coated.

.5 Welded Steel Wire Fabric: to CSA-G30.5M, uncoated; to ASTM D3963 for epoxy coated.

.6 Chairs, bolsters, bar supports, spacers: adequate for strength and support of reinforcing and live loads during construction conditions.

.7 Tie Wire: Cold-drawn annealed steel to CSA-G30.3.

.8 Epoxy Coating: to ASTM A775/A775M.

.9 Galvanizing: to CAN/CSA-G164.

.10 Plain Round Bars: to CSA-G40.21.

.11 All other materials, not specifically described but required for a complete and proper installation of concrete reinforcement, shall be as selected by the Contractor and be subject to the approval of the Engineer.

.12 Supplementary cementing materials and their use to CAN/CSA-A3000.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA-A23.1, ACI 315, unless otherwise stated.

.2 Protect epoxy and paint coated portions of bars with covering during transportation and handling.

Part 3 Execution

3.1 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by the Engineer.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars that develop cracks or splits.

3.2 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on approved drawings and in accordance with CSA-A23.1.

.2 Place sufficient chairs, and supports to adequately maintain the position of the reinforcing steel during placement of concrete, to within tolerances specified in the referenced CSA/CAN guidelines. Use tie wire to prevent the moving or dislodging of reinforcing steel during placement of the concrete.

.3 Use plain round bars as slip dowels in concrete. Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint. When paint is dry, apply a thick even film of mineral lubricating grease.

.4 Prior to placing concrete, obtain the Engineer’s approval of reinforcing material placement.

.5 Ensure cover to reinforcement is maintained during concrete pour.

.6 Reinforcing steel, anchor bolts, or other required inserts shall not be inserted into concrete during placement.

3.3 FIELD TOUCH-UP

.1 Touch up damaged and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 03 30 00 – Cast In Place Concrete

1.2 REFERENCE STANDARDS

.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 Metallix-Coated Carbon Steel Barbed Wire.

.4 ASTM A123/A123M-15, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.5 A653/A653M-15e1, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.6 ASTM C618-15, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

.7 ASTM F1664-08(2013), Standard Specification for Polyvinyl Chloride (PVC) and Other Conforming Organic Polymer-Coated Steel Tension Wire Used with Chain-Link Fence.

.2 Canadian General Standards Board (CGSB)

.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.

.3 CSA International

.1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CAN/CSA-A3000-13, Cementitious Materials Compendium.

.4 Master Painters Institute (MPI)

.1 Architectural Painting Specification Manual - current edition.

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 include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submittal information indicating locations of fence, post, rails, or other operation, hardware, and accessories. Indicate materials, dimensions, sizes, weights, and finishes of components. Include plans, elevations, sections, and details of post anchorage, attachment and bracing. Installation procedures and instructions by manufacturer describing all details for a typical fence and gates.

.2 Field Measurements: verify layout information for fences and gates shown on drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.4 DELIVERY, STORAGE AND HANDLING

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

.4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 35 43 – Environmental Procedures.

.5 Packaging Waste Management: remove for reuse by manufacturer of padding, crates, packaging materials pallets, as specified in Construction Waste Management Plan in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with CSA A23.1 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 CSA A3000 ASTM C618.

.4 Recycled content: incorporate SCM's in concrete mix.

.2 Chain-link fence: to CAN/CGSB-138.1. Steel Wire Fabric: polymer coated wire, 3.88mm core metal diameter.

.1 Type 1, Class A, heavy style.

.2 Height of fabric: full height of fence.

.3 Mesh Size: 50mm

.4 Height of Fence: 1830 mm typical at perimeter and south side of building. 2440 mm all sides and gates of enclosure on east side of site.

.3 Posts, braces and rails: to CAN/CGSB-138.2, galvanized steel pipe with black vinyl coating.

.4 Bottom and Top tension wire: to CAN/CGSB-138.2, single strand, vinyl coated steel wire, black.

.5 Tie wire fasteners: vinyl coated.

.6 Tension bar: to ASTM A653/A653M, 5 x 20 mm minimum galvanized steel.

.7 Gate frames: to ASTM A53/A53M, galvanized steel pipe, standard weight 45 mm outside diameter pipe for outside frame and interior bracing.

.1 Fabricate gates as indicated with electrically-welded joints and painted with zinc pigmented paint 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.

.5 Provide casters to each gate end.

.8 Fittings and hardware: to CAN/CGSB-138.2, ductile cast iron galvanized steel cast aluminum alloy malleable.

.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 Include projection with clips or recesses to hold 3 strands of barbed wire spaced 100mm apart.

.4 Projection of approximately 300mm long to project from fence at 45 degrees above horizontal.

.5 Turnbuckles to be drop forged.

.9 Organic zinc rich coating: to MPI #18 CAN/CGSB-1.181.

2.2 FINISHES

.1 Vinyl coating: to ASTM F1664.

.1 0.045 mm dry film thickness minimum, colour black.

.2 Vinyl slats: required in fence enclosure located on the east side of site and along south side of building. Colour Black.

Part 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 Consultant.

.2 Inform Consultant 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 Consultant.

3.2 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of Authorities Having Jurisdiction, whichever is more stringent sediment and erosion control drawings requirements of Authorities Having Jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.2 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 30mm to 50mm.

3.3 ERECTION OF FENCE

.1 Erect fence along lines as indicated as directed by Consultant and to CAN/CGSB-138.3.

.2 Excavate post holes to dimensions indicated Space line posts 3m apart, measured parallel to ground surface.

.3 Space straining posts at equal intervals not to exceed 150m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 150m.

.4 Install additional straining posts at sharp changes in grade and where directed by Consultant.

.5 Install corner post where change in alignment exceeds 10 degrees.

.6 Install end posts at end of fence and at buildings.

.7 Place concrete in post holes then embed posts into concrete to depths indicated.

.1 Extend concrete 50mm 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.

.8 Install fence fabric after concrete has cured, minimum of five (5) days.

.9 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.

.10 Install top rail between posts and fasten securely to posts and secure waterproof caps and overhang tops.

.11 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.

.12 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 300mm intervals.

.1 Knuckled selvedge at top and bottom.

.13 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450mm intervals.

.1 Give tie wires minimum two (2)twists.

3.4 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 as indicated in accordance with Section 09 91 13- Exterior Painting.

.1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11- Cleaning.

.1 Leave Work area clean at end of each day.

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

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21- Construction/Demolition Waste Management and Disposal.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 32 01 90 – Landscape Maintenance

.2 32 91 19.13 – Topsoil & Finish Grading

.3 32 92 93 – Sod

.4 32 93 00 – Trees, Shrubs and Groundcovers

1.2 SUBMITTALS

.1 Submit to the PM or Departmental Representative a representative sample of the mulch to be employed.

.2 Label sample to include the following information:

.1 Location to be used and purpose

.2 Name and job number of project.

.3 Supply and store on site one (1) cubic metre of aggregate or bulk mulch to be used.

.4 The PM or Departmental Representative reserves the right to inspect mulches at source or as delivered to site.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Use all means necessary to protect material before, during and after installation. Provide adequate protection to materials, which may deteriorate if exposed to elements.

.2 In the event of damage or rejection make immediate repairs or replace materials at no extra cost to the Owner.

.3 Use (equipment of a design and rating) suited to the site requirements and work specified.

.4 Bulk mulches shall be delivered in closed trucks and covered as necessary to prevent spillage. Store as directed on site.

.5 Mulches packaged in waterproof bags shall be labeled indicating net mass, analysis and manufacturer.

.6 Store on pallets and protect from the elements in locations designated.

.7 Mass of fiber mulch shall be net air dry mass determined in accordance with Canadian Pulp and Paper Section, Standard A2.

1.4 PROTECTION & WORKMANSHIP

.1 Clean up immediately any mulch or debris spilled onto pavement or concrete, lawns, edgers, valve covers or as directed.

Part 2 Products

2.1 MATERIALS

.1 Low Maintenance/Moisture Conservation covers: to be used specifically with tree planting and shrub bed development specifications.

.1 Rock Mulch:

.1 Washed Rock: 28mm round wash rock as indicated on drawing. Mulch shall be approximately 28mm diameter and placed level with adjacent surfaces. Install rock mulch to a depth of 100mm, complete with HD geotextile landscape fabric (overlap of 500mm).

.2 Edgers & Barriers:

.1 Permaloc CleanLine XL (3/16" x 12") Mill Finish edger or approved equivalent. Top of edger shall be embedded flush with adjacent surfaces surface.

.3 Filter Fabrics:

.1 3.5mm "Texel" or approved equal for use under mulched, non-planted areas or over gravel drainage material (500mm overlap).

.4 Equipment:

.1 Fertilizer spreader: gravity feed/drop, surface spreader, width determined by project size.

Part 3 Execution

3.1 MULCH CHOICE

.1 Refer to the landscape plans to identify borders, planting beds and/or tree pits which require mulching to provide for low maintenance & plant protection.

3.2 EROSION CONTROL MULCH INSTALLATION

.1 All grades exceeding 3:1 require either/or a combination of soil engineering and surface mulch covering.

.2 Proceed with installation only after final grade has been approved by the PM or Departmental Representative.

3.3 INSTALLATION OF MULCHES

.1 Proceed with installation only after the final grade has been approved by the PM or Departmental Representative.

.2 Install mulch in planting beds and tree wells as follows:

.1 Level the subsoil providing positive drainage away from building foundations where present or to finish subgrade indicated on site plan.

.2 Remove unwanted vegetation, lumps or debris as indicated.

.3 Place topsoil into beds feathering to existing vegetation and provide a grade specified.

.4 Place specified mulch by hand or mechanically to a minimum depth of 100mm ensuring finished grade is 25mm lower than building finished and flush with top of adjacent surfaces.

.5 Ensure mulch is free of insects and disease, branches, leaves, shavings, sawdust, weeds, and stones. Ensure that mulch is pulled back away from trunk of all trees.

.3 Install aggregate mulch as follows:

.1 Place Filter Fabric, overlapping joint 500mm and stapled as necessary. Plastic mulch is not allowed. Leave 120mm opening around plant bases.

.2 Place specified mulch by hand or mechanically to depth identified in the drawings ensuring finished grade is 25mm lower than building finishes and flush with top of adjacent surfaces.

3.4 CLEAN UP

.1 Broom clean pavement sidewalks, wood edgers exterior finishes and clean slurry spray of specimen plants. Clear soil and rubble from underground or surface storm sewer lids.

.2 Remove packaging and clean up spilled materials.

.3 Leave site tidy and in a condition acceptable to the PM or Departmental Representative daily and at project completion. Remove excess material from site.

.4 Refer to Warranty and Maintenance specifications for mulch/aggregate requirements during the warranty and maintenance period.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 32 01 90 – Landscape Maintenance

.2 32 91 13.16 – Mulches

.3 32 92 93 – Sod

.4 32 93 00 – Trees, Shrubs and Groundcovers

1.2 SUBMITTALS

.1 Submit samples as requested.

.2 Submit 500 g sample of native soil mixed from in-place locations or from stockpiles available on site.

.3 Submit 500 g sample of imported topsoil along with information on source. Test sample if directed by PM or Departmental Representative and/or Owner.

.4 Mix sample soils thoroughly, containerize and label.

.5 Submit to the PM or Departmental Representative a soils analysis of in-place or windrow topsoil representative of topsoil in the contract area. Minimum two separate locations shall be selected.

.1 Soil analysis shall be conducted by a qualified laboratory under the direction of a pedologist.

.2 Soil analysis report shall consist of an analysis of nitrate, phosphate, potassium sulphate, pH, conductivity, organic matter and texture.

.3 Soils analysis shall contain fertilizer recommendations for the establishment of turf and plant material.

1.3 SITE CONDITIONS

.1 Prevent damage to fencing, trees, landscaping, natural features, bench marks, existing buildings, existing pavement, curbs, culverts, and utility lines which are to remain. Make good any damage.

.2 Do not bury foreign material beneath areas to be landscaped.

Part 2 Products

2.1 MATERIALS

.1 Imported Topsoil: fertile natural loam, capable of sustaining healthy growth. Topsoil shall be loose and friable, free of subsoil, clay lumps, stones, live plants, roots or any other deleterious material greater than 20 mm diameter. Topsoil shall be free of litter, foreign matter and toxic materials harmful to plant growth. Topsoil containing construction debris, sod clumps, quackgrass or other noxious weeds is not acceptable. Supply of topsoil shall meet the following requirements:

- .1 Acidity/alkalinity shall range from 6.0 pH to 7.5 pH.
- .2 Electrical Conductivity (E.C.) - level of soluble salts shall not exceed 1.5 dS/m.
- .3 Texture: "Loam Topsoil" in accordance with Canadian System of Soil Classification. Topsoil should fall within the following allowance:
- .4 Sand – 35 % (+/- 5%) by dry mass; Silt – 35% (+/- 5%) by dry mass; and Clay – 30% (+/- 5%) by dry mass. Organic Matter – 5% - 10% by dry mass.
- .5 Sodium Absorption – less than 6.

.2 Stockpiled Topsoil: original (native) topsoil stockpiled on site. Soil stored for longer than two (2) years shall be cleaned of all surface vegetation, shredded, spread and rototilled to a friable consistency amended with soil containers. Sample and test native topsoil to determine soil suitability. Provide recommendations for amendment relative to the soil characteristics defined in 2.1.1. Consult with Minister prior to initializing amendment recommendations. Contractor shall ensure native soil is reasonably free of subsoil, slag, clay, stones, lumps, foreign plants and their roots, sticks and other extraneous matter.

.3 Peatmoss: decomposed plant material, fairly elastic and homogenous, free from decomposed colloidal residue, wood, clay lumps, sulphur and iron. Minimum of sixty (60%) percent organic matter by mass, pH value between 4.0 and 5.0 with a conductivity of less than 0.5mmhos.

.4 Manure: completely decomposed, friable animal litter free from clay, stone, lumps, live plants, roots, sticks, straw, quack-grass, noxious weeds, field crop seed and foreign matter having a pH of 5.8 - 7.3 and conductivity less than 0.5mmhos. Other suitable organic matter includes: hay, bark, sawdust, or bark residue, meeting the organic matter, stability and contaminant requirements.

.5 Fertilizer: industry accepted standard medium containing nitrogen, phosphorus, potassium and other micro-nutrients suitable to specific plant species or application or defined by soil test.

.6 Limestone: Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.

Part 3 Execution

3.1 PREPARATION OF SUBGRADE

.1 Locate runs of utility lines before commencement of work. Protect active lines from damage.

.2 Remove all foreign material, undesirable plants, roots, stones in excess of 20mm, debris and soil contaminated with oil or gasoline from site.

.3 Compact subgrade to eighty-five (85%) percent SPD under all areas to be landscaped.

.4 Grade subgrade to eliminate uneven areas, low spots and ensure positive drainage. Prepare subgrades 150mm below final grade for sodded areas.

.5 Cultivate and or scarify subsoil to depth of 150mm to receive topsoil.

.6 Recultivate subgrade compacted during hauling or spreading.

3.2 PREPARATION OF FINAL GRADE

.1 Subgrade shall be approved by PM or Departmental Representative before commencement of placing topsoil.

.2 Place topsoil delivered by conveyance appropriate to the size of site in dry weather on dry unfrozen grade. Obtain minimum depth after settlement of 150mm depth for sodded areas.

.3 Topsoil should not be worked with heavy equipment while wet.

.4 Feather topsoil over areas requiring regrowth of native plants.

.5 Manually spread topsoil around trees and plants to prevent damage by grading equipment.

.6 Add peatmoss and/or manure as required to bring native soil into organic and chemical ranges specified for imported field topsoil.

.7 Cultivate topsoil to depth of 150mm by rototilling or by hand methods.

.8 Float until surface is smooth. Cut smooth falls to catch basin rim, finish flush.

.9 Topsoil rolled to establish a firm sod bed.

.10 Do not cover catch basins, valve covers or inspection pits.

.11 Fine grade to ensure positive drainage away from building and sidewalks.

.12 Leave surface smooth, uniform and sufficiently firm to prevent sinkage pockets when irrigated.

3.3 FINISH GRADING

.1 Grade to eliminate rough spots and low areas and ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Consolidate topsoil to required bulk density. Leave surfaces smooth, uniform and firm against deep foot-printing.

3.4 ACCEPTANCE

.1 PM or Departmental Representative will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

3.5 SURPLUS MATERIAL

.1 Dispose of materials except topsoil not required.

3.6 CLEAN UP

.1 Clean up immediately to broom clean, any soil or debris spilled onto pavement or concrete, mulched areas or edgers.

.2 Clean up any soil loading of catch basins.

.3 Restore stockpile sites within or adjacent to contract limits to "rake clean" condition acceptable to the PM or Departmental Representative and/or Owner. Seed remaining stockpiles in accordance with specifications.

.4 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 32 01 90 – Landscape Maintenance

.2 32 91 13.16 – Mulches

.3 32 91 19.13 – Topsoil Placement & Grading

.4 32 93 00 – Trees, Shrubs and Groundcovers

1.2 EXAMINATION

.1 Report to the PM or Departmental Representative, in writing, of any conditions or defects encountered on the site during or before construction on which work of this section depends and which may adversely affect its performance.

.2 Do not commence work until such conditions or defects have been investigated and corrected.

1.3 QUALIFICATIONS

.1 All sod work described in this section should be executed by personnel under the constant direction and control of a "Landscape Journeyman Gardener" as defined by Alberta Manpower, and in strict accordance with specifications and best horticultural practice.

1.4 QUALITY ASSURANCE

.1 Supply sod, healthy, vigorous and certified No.1 cultivated turf grass sod, as specified hereinafter.

.2 Supply sod with a strong fibrous root system, free from stones, burned or bare spots, disease, insect infestation and containing not more than one (1%) percent weeds.

1.5 PRODUCT HANDLING

.1 Sod shall be protected during transportation and shall be delivered to the site in a fresh and healthy condition.

.2 Sod shall be stored on site for a maximum twenty-four (24) hours before installation.

.3 Protect sod from drying out or heating up if it cannot be laid immediately upon arrival on the site.

.4 All manufactured materials, such as fertilizers, shall be delivered and stored on site in standard containers clearly indicating contents, weight, analysis and the name of the manufacturer.

.5 Store all materials, which are subject to deterioration, in a dry, weatherproof place on the site.

1.6 SAMPLES & TESTING

.1 The Contractor will supply to the PM or Departmental Representative written documentation from suppliers of fertilizer.

1.7 GUARANTEE

.1 Guarantee all sod areas for a period of two (2) years from date of issue of Certificate of Substantial Performance. All sod maintenance requirements will be extended to October 31st of the second year of the warranty period, which may extend beyond the Final Acceptance date of the warranty period and work. Note: The Owner has the option to waive the Contractors warranty and maintenance period and turn this work over to a Landscape Maintenance Contractor. If this option is applied, a formal Construction Completion Review of all work will be completed by all parties prior to and acceptance agreement by the Owner, Contractor and Landscape Maintenance Contractor. Once accepted, all further Contractor warranty is waived by the Owner.

.2 During the guarantee period make periodic inspection of sod areas and notify Owner and PM or Departmental Representative, in writing, of any corrective or preventive measures necessary to maintain grass areas healthy and vigorous.

Part 2 Products

2.1 MATERIALS

.1 Sod

.1 Kentucky Bluegrass sod: sod grown from certified Canada No. 1 locally grown grass seeds. Seed mixture shall be a 100% mixture of Kentucky Bluegrass including shade and drought tolerant varieties and.

.2 Sod shall be cut by approved methods in accordance with recommendations of the Nursery Sod Growers Association of Alberta. If contractor prefers to use ‘big roll’ sod products, this will need to be approved by the Minister prior to installation. Thickness of the sod soil portion shall be a minimum 25mm and maximum 40mm.

.3 Sod shall be rolled or folded prior to lifting in such a manner as to prevent tearing or breaking.

2.2 SOIL & ACCESSORIES

.1 Topsoil: See Section 32 91 19.13.

.2 All inorganic fertilizers will be complete commercial fertilizers containing sixty (60%) percent or more urea formaldehyde by weight. All fertilizers will be in bags, clearly marked with the name of the manufacturer, contents, weight, and analysis.

2.3 WATER

.1 Contractor shall supply clean fresh water, water tanker, equipment, sprinklers, and labour necessary for use in seeding operations and to adequately and efficiently apply water to all seeded areas during maintenance period.

.2 Water shall be clean fresh and free of substances or matter that would inhibit vigorous and healthy seed growth

.3 Record quantity of water supplied and applied on site in maintenance log.

.4 The Owner will supply Contractor with a limited supply and access to water on site using building source but only if available.

Part 3 Execution

3.1 FERTILIZING

.1 Obtain approval of finished grade prior to fertilizing.

.2 Apply 11-51-0 fertilizer at 2.5kg 100m2 or as indicated in soil fertility report.

.3 Spread evenly with mechanically calibrated distributor. Mix thoroughly into upper 50mm of topsoil.

3.2 SOD APPLICATION

.1 Apply sod during normal growing season. Sod installation at freezing temperatures or over frozen soil is not acceptable.

.2 Lay sod in rows, smooth, even and flush with adjoining areas and with joints staggered. Butt sections closely without overlapping or leaving gaps between sections.

.3 Lay sod flush with adjoining grass areas, paving and top of curbs.

.4 Water immediately in sufficient quantities to obtain moisture penetration through sod into upper 100mm of topsoil.

.5 Roll sod to ensure sod contact with topsoil and to remove minor depressions and irregularities.

.6 All sod areas which show open joints, cuts or are not butted flush with adjoining grass areas, paving, curbs and walks shall be top dressed. Topsoil shall be spread and raked to fill in open joints, gaps and spaces between sod pieces and adjoining grass and paving materials. Top dressing shall be at the Contractor's expense.

3.3 CLEAN UP

.1 Broom clean pavement and sidewalks. Clear soil and rubble from sewer lids and culvert pipes.

.2 Leave site in neat and tidy condition. Remove excess materials from site.

3.4 RESTORATION

.1 Restore pavement, concrete, grassed areas, planted areas, structures, substructures, damaged or disturbed in any way during execution of the project and during maintenance period in manner satisfactory to the PM or Departmental Representative.

3.5 ESTABLISHMENT

.1 All sod areas shall be maintained by the Contractor immediately after sod has been installed and shall continue for a period of two (2) years following acceptance of landscape installation or a Certificate of Substantial Performance, whichever is the later.

.2 Establishment shall include all measures necessary to establish and maintain all sod areas in a healthy, vigorous growing condition, included but not limited to:

.1 Mowing grass regularly to maintain height between 50 and 70mm.

.2 Trim edges of sod areas neatly, by hand clipping if necessary, and remove all clippings from planting beds, tree saucers and pavement.

.3 Roll sod to remove depressions and irregularities.

.4 Water, when necessary, with sufficient amount to saturate sod and upper 100mm of topsoil.

.5 Weed, insect and fungus control shall be carried out when required following manufacturer's recommendations and provincial laws.

.6 Re-sod areas which show deterioration, or which are thin, bare or burned out. Repair all damages resulting from erosion and washouts or any other cause.

.7 Ensuing sod is fully rooted and knit with no evidence of seams or joints.

3.6 ACCEPTANCE

.1 Sod will be accepted at the end of the establishment period provided that:

.1 Sod is properly established, including full root support

.2 Sod is free of dead or bare spots.

.3 No surface soil is visible when grass has been cut to a height of 50mm.

.4 No seams or joints are visible.

.2 All sod areas shall be freshly mowed with clippings removed at the end of the establishment period to facilitate inspection.

END OF SECTION

Part 1 General

1. RELATED SECTIONS

.1 32 01 90 – Landscape Maintenance

.2 32 91 13.16 – Mulches

.3 32 92 93 – Sod

.4 32 9 19.13 –Topsoil and Fine Grading

1.2 REFERENCES

.1 Nomenclature: to "International Code of Nomenclature for Cultivated Plants".

.2 Canadian Standards for Nursery Stock: latest edition by Canadian Nursery Landscape Association

.3 Pruning methods: "Tree Pruning Guidelines" from the International Society of Arboriculture (ISA) and in accordance with ANSI A-300 Pruning Standards.

1.3 SUBMITTALS

.1 Submit the following though not limited to:

.1 Submit to the PM or Departmental Representative 500 g sample of topsoil intended to be used on this project. Store samples in clean containers with label indicating source of material, date of sampling and project name.

.2 Submit list of all plant sources minimum 10 working days prior to commencement of work for PM or Departmental Representative approval. Ensure plant species availability and inform PM or Departmental Representative immediately if sourcing is an issue.

.3 Submit work schedule indicating approximates dates for each item of work.

.4 Submit samples of rock materials, edging, geotextile fabric, and deep root barrier material including source of supply and manufacturer’s data (as applicable) for approval. Submit samples of other planting accessories and fertilizers as directed by PM or Departmental Representative.

.5 Submit copy of all permits and licenses as applicable to work of this contract. Contractor shall pay all required costs.

1.4 EXAMINATION

.1 Report to the PM or Departmental Representative, in writing, of any conditions or defects encountered on the site during or before construction on which work of this section depends and which may adversely affect its performance.

.2 Do not commence work until such conditions or defects have been investigated and corrected.

1.5 QUALITY ASSURANCE

.1 Contractor: shall be a member in good standing of LANTA (Landscape Alberta Nursery Trades Association). Submit credentials prior to commencement of work.

.2 Site Supervisor: provide a competent, experienced and knowledgeable site supervisor to direct and supervise all staff and work of contract. Supervisor shall possess a Landscape Journeyman Gardner certification and have a minimum of five years of progressive supervisory experience. Submit name and credentials of site supervisor to the PM or Departmental Representative for approval prior to commencement of work.

.3 Staffing: provide experienced, competent and trained landscape personnel to perform all tasks and services in a knowledgeable and professional manner. Workers shall act appropriately and professionally at all times while working on site. Contractor shall not assign any worker that the PM or Departmental Representative deems incompetent, careless, insubordinate, or otherwise objectionable to work on site.

.4 Contractor shall be responsible for ensuring that contract specifications are being adhered to. Failure of the PM or Departmental Representative to immediately reject unsatisfactory workmanship or to notify the Contractor of their deviation from the specification shall not relieve the Contractor of their responsibility to repair and/or replace unsatisfactory work.

.5 Contractor shall obtain approvals for suppliers, sub-contractors, and all materials used in this section of work as specified and as directed by PM or Departmental Representative.

1.6 PLANT INSPECTIONS

.1 The PM or Departmental Representative and/or Minister shall inspect, select and tag plants at their place of growth and/or place of supply before they are prepared for transplanting and delivery to site. Plant material must be available for inspection and selection within a distance of 50 km from site unless approved otherwise by the PM or Departmental Representative.

.2 Contractor shall ensure all required plants will be available at nursery and meet specifications before arranging inspection. All major plants will be tagged.

.3 The PM or Departmental Representative reserves the right to charge Contractor for all travel and other expenses for inspecting and selecting plants where distance from site exceeds 50 km and where scheduled trips to plant nurseries do not result in finding any suitable and quantity of plants that meet specifications.

.4 Approval of plants at source of supply does not impair the right of the PM or Departmental Representative to inspect plants on site during project construction. Any plant which has been damaged by pests or mechanical equipment, substituted without authorization, does not conform to specifications or where PM or Departmental Representative installed tags have been removed by Contractor or are missing will be rejected.

.5 PM or Departmental Representative retains the right to review all plant material anytime during work of contract to verify size and condition of root balls and root systems, review unapproved plant substitutions, evaluate plant quality, verify pest damages, plant injuries and latent defects and to reject unsatisfactory or defective material at any time during progress of work.

.6 The PM or Departmental Representative shall inspect:

.1 proposed plant locations before any excavation commences;

.2 during and after all plants are installed;

.3 periodically during the maintenance/warranty period and;

.4 at end of maintenance period.

.5 Provide minimum three days notice in advance of required inspection.

1.7 SUBSTITUTIONS

.1 All plants shall be supplied as specified on Contract Documents. Substitutions will not be accepted unless approved, in writing, by the PM or Departmental Representative. Give timely notice, in writing, to PM or Departmental Representative when applying for substitutions and provide proof that specified plants are not available.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Handle plant material with reasonable care and skill to prevent injuries to trunk, branches, roots and root balls. Trees with damaged, broken or abraded trunks or branches will be rejected by the PM or Departmental Representative.

.2 Protect plants during shipment with tarpaulin, windscreen or other suitable covering. Take all precautions to prevent excessive drying from sun and wind and breakage from wind and equipment. Pad all points of contact between plant and equipment.

.3 Provide adequate site protection to root balls, trunks, branches and leaves of plants from drying, frost, equipment, breakage, vandalism and other damage.

.4 Do not use plants when root ball has been cracked or broken or when burlap and ropes or wire basket required for transplanting have been removed. Do not use plants damaged during contact with equipment, or plants that are wilted, wind burned or stressed.

.5 All materials which are subject to deterioration resulting from weather or any other cause, shall be stored on the site in a dry, weatherproof place in such a manner that their effectiveness will not be impaired.

.6 Install plants within 24 hours of delivery to site. Store and heel plants in with topsoil or mulch in suitable shaded location when planting cannot be completed on time. Keep all plants moist until planted.

.7 Do not transport trees in open trucks when the temperature is in excess of 25ºC, or at speeds in excess of 60 km/h.

1.9 SOIL ANALYSIS

.1 Contractor shall arrange and pay for services of accredited testing laboratory, approved by the PM or Departmental Representative, to perform complete soil quality analysis on all sources imported topsoil (if required). Submit original copy of each soil analysis to the PM or Departmental Representative.

.2 If required, the Contractor shall be responsible for ensuring all required tests for imported soil are completed well in advance of commencement of work. Imported soils shall not be placed on site until approved by the PM or Departmental Representative. All soil tests shall be current.

.3 Soil analysis shall include results for: existing soil nutrients; soil pH value; total soluble salts (electrical conductivity); percentage of organic matter; soil texture and percentage of sand, silt and clay; fertilizer recommendations; and recommendations for soil amendments.

.4 The PM or Departmental Representative reserves the right to inspect and evaluate all sources of topsoil selected by Contractor.

.5 Contractor shall provide additional soil tests on supplied topsoil and native soil during work of contract to confirm compliance with recommendations for soil amendments and to maintain quality control. The PM or Departmental Representative shall randomly select various locations to be retested.

1.10 WARRANTY

.1 Contractor shall provide warranty for all plant materials, related works and materials for a minimum of two years that shall include two full and complete growing seasons (May 1st to October 31st) commencing from the Date of Substantial Completion of the Work. All plant maintenance requirements will be extended to October 31st of the second year of the warranty period, which may extend beyond the Final Acceptance date of the warranty period and work. Note: The Owner has the option to waive the Contractors warranty and maintenance period and turn this work over to a Landscape Maintenance Contractor. If this option is applied, a formal Construction Completion Review of all work will be completed by all parties prior to and acceptance agreement by the Owner, Contractor and Landscape Maintenance Contractor. Once accepted, all further Contractor warranty is waived by the Owner.

.2 Contractor shall replace plants found dead, unhealthy, unappealing or in unsatisfactory growing condition or in any other way that does not meet the requirements of the specifications anytime during the warranty period or when directed by the Contractor. Warranty replacements shall be performed in accordance with contract specifications.

.3 All plants that require replacement shall be immediately removed from site during the warranty period. Plants that show more than 25% dead or unhealthy growth shall be considered unacceptable and promptly replaced during the warranty period.

.4 The Contractor reserves the right to extend warranty on all plants not fully established, where replacement plantings have been delayed by Contractor and where leaf development and growth is not sufficient to ensure future survival.

1.11 MAINTENANCE PERIOD

.1 Maintain all plants and other work for a minimum of two years that shall include two full and complete growing seasons (May 1st to October 31st) commencing from Date of Substantial Completion of the Work. See Section 32 01 90–Landscape Maintenance for maintenance details.

Part 2 Products

2.1 PLANT MATERIALS

.1 Supply trees that are nursery grown in Alberta. Supply container grown plants that are nursery grown in Alberta or from a nursery under a agricultural climate zone similar to project site. All plants shall conform to federal and provincial regulations.

.2 Nursery Grown Plants:

.1 All plants shall be true to genus, species and cultivar specified and grown in a recognized nursery, in accordance with good horticultural practices as advocated by the Canadian Nursery Landscape Association.

.2 Specimen Standard: all plants shall be of specimen quality, exceptionally heavy, and so trained or favoured in development and appearance as to be unquestionably and outstandingly superior in form, compactness, branching and symmetry. Plants shall exhibit vigorous growth, be well branched and densely foliated in leaf; free of disease, insects, eggs, or larvae; free of dead branches and dead branch tips; and shall have healthy, well developed root systems. Plants shall be free from physical damage or other conditions that would prevent vigorous growth.

.3 Uniform Height and Spread: where formal arrangements or consecutive order of trees and other plants are required in plan, all required plants shall be selected for a uniform height and spread. Minister reserves the right to reject all plants at source where available plant quantity does not meet such requirements.

.4 Deciduous Trees: straight single stem trees; multiple leaders are not acceptable. Trees with damaged, broken or crooked leader, bark abrasions or scars, sun-scald, frost cracks, disfiguring knots, insect damage or infestations are not acceptable. Trunks shall be clean and free of stubs, decay, splits or other damage.

.5 Clump or multi-stem plants will have a minimum of three (3) stems originating from common base at ground level.

.6 Coniferous trees shall have one straight central leader. Trees with broken leaders or multiple leaders are not acceptable.

.7 Heeled-in plants or plants from cold storage are not acceptable.

.8 Plants which have been top worked, unnaturally sheared or colour-treated are not acceptable.

2.2 PLANT MEASUREMENTS AND ROOT BALLS

.1 Trees shall be properly machine dug with firm and natural root balls at minimum size and shape as specified in Canadian Standards for Nursery Stock. Root balls shall be firmly wrapped and secured in burlap lined wire baskets with rope or rottable twine. Plant trunks shall be in centre of root ball.

.2 Caliper Size: caliper measurements, in millimetres, shall be the determining measurement. Measure tree caliper 15 cm above ground on trees up to 100 mm caliper size. Larger sized trees, 100 mm caliper and over, shall be measured 30 cm above ground.

.3 Root ball size shall be sufficiently large to contain at least 75% of fibrous root system with a ball depth not less than 50% of ball diameter. Adjust root ball size according to growing habits of plants.

.4 Undersized, broken, loose or other defective root balls will be rejected. Root balls shall be free from pernicious perennial weeds and grass and their roots.

.5 Supply root ball for trees in size as specified below:

.1 Deciduous

Caliper (mm)	Root Ball Diameter (cm)\
25	50
50	70
60	70
70	80
80	90
100	100

.2 Coniferous

Height (m)	Root Ball Diameter (cm)
1.75	70
2.00	90
2.50	100
3.00	120

.6 Bare root stock: locally grown native field stock; repotted into large enough containers to comprise entire root system and grown for minimum of three months or as directed otherwise by the PM or Departmental Representative.

.7 Collected Plants: native plants indigenous to area. Maximum 40 mm in caliper, with well developed crowns and characteristically branched; no more than 40% of overall height may be free of branches.

.8 Supply container grown plants that conform to measurements specified on drawing. Measure height and spread, in centimetres, with branches in their normal positions in accordance with Canadian Standards For Nursery Stock. Plants shall possess normal balance between height and spread.

.9 Herbaceous Perennials: healthy and vigorous crowns, well rooted and established, not less than two years old and twice transplanted. All plants shall be multi-stemmed. Single stem plant materials will not be accepted. Supply in minimum #1 containers or as approved otherwise.

.10 Ground Covers: healthy, vigorous, well rooted and established in container. Size proportionate to root development.

.11 Container plants shall be grown in sufficiently sized containers for minimum of three months in accordance with Canadian Standards for Nursery Stock.

.12 Plants shall have healthy and well-established roots throughout the growing medium that holds soil together when removed from container. Containers containing over established plants with girdling or excessive root growth encircling the inside of the container are not acceptable.

2.3 WATER

.1 Contractor shall supply clean fresh water, water tanker, equipment, sprinklers, and labour necessary for use in seeding operations and to adequately and efficiently apply water to all seeded areas during maintenance period.

.2 Water shall be clean fresh and free of substances or matter that would inhibit vigorous and healthy seed growth.

.3 Record quantity of water supplied and applied on site in maintenance log.

.4 The Owner will supply Contractor with a limited supply and access to water on site using building source but only if available.

2.4 PLANTING SOIL

.1 Imported Topsoil: fertile natural loam, capable of sustaining healthy growth. Topsoil shall be loose and friable, free of subsoil, clay lumps, stones, live plants, roots or any other deleterious material greater than 20 mm diameter. Topsoil shall be free of litter, foreign matter and toxic materials harmful to plant growth. Topsoil containing construction debris, sod clumps, quack grass or other noxious weeds is not acceptable. Supply of topsoil shall meet the following requirements:

.1 Acidity/alkalinity shall range from 6.0 pH to 7.5 pH.

.2 Electrical Conductivity (E.C.) - level of soluble salts shall not exceed 1.5 dS/m.

.3 Texture: "Loam Topsoil" in accordance with Canadian System of Soil Classification. Topsoil should fall within the following allowance:

.4 Sand – 35 % (+/- 5%) by dry mass; Silt – 35% (+/- 5%) by dry mass; and Clay – 30% (+/- 5%) by dry mass. Organic Matter – 5% - 10% by dry mass.

.5 Sodium Absorption – less than 6.

.2 Bonemeal: finely ground and with a minimum analysis of four (4%) percent nitrogen and twenty (20%) percent phosphoric acid. Mix bonemeal at 0.6kg/m3 of planting soil.

.3 Native Soil: on-site native soil shall be tested by Contractor and amended to meet specifications for imported soil before being acceptable for use. Contractor shall ensure soil is reasonably free of subsoil, slag, clay, stones, lumps, foreign plants and their roots, sticks and other extraneous matter.

2.5 PLANT ACCESSORIES

.1 Support posts: T-rail studded 40 mm x 40 mm metal stakes, minimum 2.1 m long.

.2 Guy wire: #12 pliable galvanized steel wire.

.3 Bark protector: Contractor to wrap and tie all deciduous tree trunks with 2 full wraps of chicken wire, 1.0m minimum height to protect against rabbit damage.

.4 Tree trunk guard: Contractor to wrap and tie all deciduous tree trunks with 2 full wraps of chicken wire, 1.0m minimum height to protect against rabbit damage.

.5 Geotextile Landscape Fabric: HD fabric as indicated on drawing. Submit sample for approval.

.6 Edgers: Steel edge material shall be minimum 3 mm thick and 100mm wide and installed with 600mm depth stakes. Top of edger shall be embedded flush with adjacent surfaces surface. Subcontractor shall submit sample for review and approval prior to installation.

.7 Deep Root Barrier: install in as indicated on drawings. Deep root barrier to be DeepRoot (or approved equivalent) Universal Root Barrier (UB 36-2) installed according to manufacturers specifications.

.8 Underground Anchoring: as an alternate to items 2.5.1 and 2.5.2 above. ArborGuy (SASMP - citygreen) or approved equivalent underground anchoring system. Anchoring installation to be reviewed and accepted by the PM or Departmental Representative prior to backfill and mulching. The Contractor is to ensure that all trees are planted as per municipal specifications prior to backfill and mulching.

2.6 MULCHES

.1 Refer to Section 32 91 13.16 - Mulches

.2 Samples of all mulches to be proved by the Contractor for PM or Departmental Representative review prior to installation.

Part 3 Execution

3.1 SITE PREPARATION REQUIREMENTS

.1 Locate and stake locations of all underground electrical services, utility lines, and other underground obstructions. Maintain minimum required offset distance when locating trees near underground services.

.2 Where conflict exists between existing underground services and proposed plantings, promptly notify the PM or Departmental Representative and await further instruction. Adjustments to plant locations require PM or Departmental Representative approval.

.3 Stake out locations of all individual trees and other major plants including planting beds with wood stakes or other acceptable material. Maintain adequate offset distances in locating trees adjacent to walkways, property lines, curbs, intersections, entrances, light standards, site signage and buildings unless directed otherwise by the PM or Departmental Representative. Do not locate any tree within minimum 1.5 m of a ditch line.

.4 Obtain PM or Departmental Representative approval of plant locations before the start of planting work. Plants installed by Contractor without PM or Departmental Representative approval of location shall be relocated at Contractor’s expense.

3.2 EXCAVATE TREE PITS AND PLANT BEDS

.1 Plant Beds: excavate shrub beds to minimum depth of 600mm. excavate perennial and ornamental grass beds to a minimum depth of 450mm.

.2 Trees: excavate a broad planting pit as shown on the drawings. Ensure excavation allows for placement of minimum 300mm of planting soil around root ball.

.3 Trees - Parking Lot Islands: excavate area between curbs and within complete area of the deep root barrier installations. Excavate to minimum 300mm below bottom of root ball depth. See planting details.

.4 Immediately remove all excavated subsoil material from site. Do not mix with planting soil or use as backfill.

.5 Do not excavate plant pits unless trees are scheduled for installation the same day. Cover and/or clearly flag all excavated plant pits left unattended for any length of time that may present a hazard.

.6 Cultivate native soil at bottom of excavated planting beds to minimum depth of 150 mm. Place a blended mix of topsoil, peat moss and sand with native soil and roto-till.

.7 Place fertile topsoil in plant beds to full depth of excavation and slightly higher than adjacent undisturbed finish grade. Place topsoil in appropriate layers and tamp to eliminate all settlement. Slope grade away from building as applicable.

3.3 PLANTING

.1 Scarify and roughen sub-grade soil within tree pit to depth of 150mm to eliminate smooth glazed walls before placing soil and planting.

.2 Place ball and burlap plants plumb in centre of pit on undisturbed soil. Ensure tree is straight and top of root flare is slightly above finish grade of surrounding soil. In parking islands top of root ball shall be set above finish grade of concrete curbs as shown on drawing. Face all plants for best appearance and relationship to adjacent structures.

.3 Container plants: remove containers and keep soil ball intact while placing plant in pit. Gently separate or split roots before planting to ensure proper root development. Backfill planting soil evenly to finish grade and tamp to eliminate air pockets.

.4 Backfill tree pit with fertile topsoil around root ball in layers of 150mm and firmly tamp to eliminate voids and air pockets. Ensure all trees have minimum 300mm of topsoil surrounding the sides of root ball.

.5 When tree pit is approximately 1/2 full of topsoil, thoroughly water planting hole allowing water to completely penetrate topsoil.

.6 Cut and remove all wire, rope, burlap and twine from minimum top 1/2 of root ball. Do not place additional backfill topsoil until wire basket and associated materials have been cut and removed. Discard of all basket debris off site. Do not bury debris in tree pit.

.7 Failure to cut and remove wire, burlap, ropes, and twine will result in rejection of tree plantings by the PM or Departmental Representative.

.8 Complete backfilling around root ball to grade in layers and firmly tamp in place. Place additional topsoil to correct any settlement.

.9 Create a neat circular soil saucer out from edge of root ball as shown on drawing and as directed by the PM or Departmental Representative. In parking islands and other confined locations adjust size of soil saucer to suit location and maintenance requirements. Fill saucer with water and allow it to be completely absorbed. Place topsoil as necessary.

.10 Cover tree well area and planting beds with 100mm of rock mulch. Keep mulch away from trunks and stems of plants.

.11 Thoroughly water all plants. Install trunk guard around base of deciduous trees to protect from damage.

.12 Refer to the drawings development areas requiring root barrier installation requirements.

3.4 STAKING AND GUYING

.1 Support trees immediately after installation. See planting details.

.2 Anchor post minimum 300 mm into undisturbed ground away from root ball and branches. Place stakes equally around plant and perpendicular to prevailing wind.

.3 Provide each tree support with a bark protector and tie secured at approximately 60% of tree height. Cover wires with rubber hose at points of contact with bark. Keep ties taut and tree plumb.

3.5 PRUNING

.1 Perform pruning in accordance with proper practices and standards (ANSI-A300) of the International Society of Arboriculture. Consult with the PM or Departmental Representative before pruning any plant.

3.6 PROTECTION

.1 Protect all plant materials and other site work from all damage, disturbance, or other construction activity from commencement of work to final acceptance of work. Remove protection after plants are properly established or when directed by the PM or Departmental Representative.

.2 Damaged or unhealthy plants and other work resulting from inadequate protection including inadequate watering shall be repaired or replaced as directed by the PM or Departmental Representative at Contractor's expense. All damages shall be corrected prior to final acceptance.

.3 Keep plant pit and plant bed excavations dry. Remove all excess water before planting.

3.7 MAINTENANCE

.1 See Section 32 01 90 for all maintenance requirements in contract.

3.8 ACCEPTANCE

.1 Plants will be accepted by the PM or Departmental Representative at end of maintenance period provided:

.1 Plants meet requirements of the specifications.

.2 Plants are alive and in healthy, acceptable growing condition.

.3 Plants are properly planted, staked and pruned.

.4 Plants are recently and thoroughly watered.

.5 Plant pits and beds are cultivated and free of weeds, grass and debris.

.6 Planting accessories are properly installed and in good condition.

.7 Contractor shall use specified materials to correct plant installations that do not comply with requirements for acceptance and continue with specified

maintenance/establishment until deemed acceptable by the PM or Departmental Representative.

3.9 RESTORATION

.1 Restore pavement, concrete, grassed area, planted areas, structures, and other site features damaged or disturbed during execution of project, in manner satisfactory to the PM or Departmental Representative.

3.10 CLEAN UP

.1 Keep all hard surfaces clean and tidy. Sweep all pavements and walkways to maintain clean appearances at all times. Clear soil and rubble from catch basins, manholes, valves and other site features.

.2 Remove and dispose of excess soil and waste materials, including subsoil, litter, foreign debris, pots, wire cages and burlap, and unacceptable plants at approved disposal site. Contractor shall be responsible for all disposal costs. Remove all tags, plant labels, flagging tape, rope, and other plant debris after planting is completed to prevent girdling.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 23 38 – Trench Excavation and Backfill.

.2 Section 33 31 00 – Sanitary and Storm Utility Piping.

.3 Section 33 05 16.13 – Concrete for Utility Structures.

1.2 SECTION INCLUDES

.1 This Section specifies requirements for constructing new manholes and catch basins, and adjusting existing manholes.

1.3 PRODUCT QUALITY ASSURANCE AND QUALITY CONTROL

.1 Precast Concrete:

.1 Upon request, submit manufacturer's test data and certification that materials meet the requirements of this Section. Include manufacturer's drawings, information, and shop drawings where pertinent.

.2 Frames and Covers:

.1 Upon request, submit manufacturer's test data and certification that materials meet the requirements of this Section. Include manufacturer's drawings, information, and shop drawings where pertinent.

Part 2 Products

2.1 CONCRETE

.1 Cast-in-Place Concrete: To Section 33 05 16.13 – Concrete for Utility Structures.

2.2 PRECAST MANHOLE AND CATCH BASIN SECTIONS

.1 Precast manhole sections, catch basins, adjusting neck rings, and manhole steps shall conform to CAN/CSA-A257.4 and be manufactured using Type 50 sulphate-resistant Portland cement. All manhole sections shall have flexible watertight joints using flexible joint sealants. All preformed flexible joint sealants shall meet ASTM C990, Section 6.2.1, butyl rubber sealants and contain 50% minimum butyl rubber (hydrocarbon blends), percent by weight.

.2 Manhole joints shall meet requirements of CAN/CSA-A257.3.

.3 All precast units shall be marked with manufacturer's identification, date of casting, type of cement, and CSA Standard.

.4 All pipe-to-structure connections shall meet the physical property and performance requirements of ASTM C923-02. In addition, all mechanical devices, including castings, bolt assemblies, and take up clamps shall be constructed of 300 Series stainless steel and use no plastic or plastic parts.

2.3 SAFETY STEPS

.1 Safety steps shall be of the shape and size as shown on standard Drawings, and material shall be either of the following:

.1 25mm diameter mild steel and deformed bar conforming to ASTM A615, hot bent at temperature of at least 8700°C and galvanized in accordance with ASTM A123/A123M.

.2 Minimum 20mm diameter aluminum forged from 6061-T6, 6351-T6, or equal alloy, having minimum tensile strength of 260 MPa.

2.4 FRAMES, GRATINGS, COVERS

.1 Frames, gratings, and covers as shown on the standard Drawings and complying with the following requirements:

.1 Castings shall conform to all requirements of ASTM A48 and ASTM A536.

.2 The material for gray iron castings shall have a minimum yield strength of the Class shown on the standard Drawings.

.3 The material for ductile iron castings shall have a minimum yield strength of the Grade shown on the standard Drawings.

.4 Castings shall be sandblasted or cleaned and ground to eliminate surface imperfections. All castings shall be free of defects, true to pattern, and free from cracks, porosity, flaws, and excessive shrinkage. Coated castings will not be accepted.

.5 Castings shall be marked with identification markings which will include series designation (local standard), foundry identification, and month and year of casting. These markings shall be located in such a manner that they are easily identifiable after installation.

.6 Cover castings shall be guaranteed not to rock when installed in corresponding mating frame.

2.5 RUBBER RISER RINGS

.1 Rubber riser rings used for final elevation adjustments of a manhole frame in the manhole neck area shall consist of recycled rubber and polyurethane elastomer, with the following physical properties:

.1 Density of 70 lbs / cu ft in accordance with ASTM C642.

.2 Tensile strength of minimum 145 psi in accordance with ASTM D412.

.3 Compression set less that 4% at 145 psi in accordance with ASTM D395.

.4 Thermal expansion coefficient of 6 x 10-5 in/in/oF.

.5 No loss of structural properties after exposure to fifty (50) cycles of de-icing chemical.

.6 No loss of hardness, compressive strength, tensile strength, or elongation properties when exposed to weathering of seventy (70) hours at 158°F, in accordance with ASTM D573.

.7 Maximum thickness of ring is 63.5mm (2 ½").

2.6 OTHER MATERIAL

.1 PVC stubs with factory-applied casting of silica sand to facilitate pipe connections to catch basins only.

.2 Mortar: **T**o requirements of CSA-A179, Type S, using Type 50 sulphate-resistant Portland cement.

.3 Washed Gravel: Washed, crushed, or screened stone or gravel consisting of hard and durable particles meeting the following gradation limits; and free from sand, clay, cementitious, organic, and other deleterious material:

Sieve Size (mm)	Percent Passing by Mass
25	100
5	maximum 10
0.08	maximum 2

.4 Sand Bedding Material: Sand, free of organic matter and graded within the following limits:

Sieve Size (mm)	Percent Passing by Mass
10	100
5	70 – 100
0.16	5 – 20
0.08	0 -12

Part 3 Execution

3.1 EXCAVATION AND BACKFILL

.1 Excavate and backfill in accordance with Section 31 23 38 – Trench Excavation and Backfill.

.2 Install manholes and catch basins in accordance with the design.

3.2 CONCRETE WORK

.1 Do cast-in-place concrete Work in accordance with Section 33 05 16.13 – Concrete for Water and Drainage Structures

.2 Place concrete reinforcement in accordance with Section 32 20 00 – Sitework Concrete Reinforcing Steel.

3.3 INSTALLATION

.1 Construct units plumb and true to alignments and grade.

.2 Complete units as pipe laying progresses.

.3 Pump excavation free of standing water and remove soft, frozen, and foreign material.

.4 Check all precast units for required stamps. Any precast unit without stamp is to be rejected.

.5 Inspect all precast units for damage in shipment. Reject all damaged units and advise the supplier.

.6 Manholes shall be installed without field cutting.

.7 Standard Manholes:

.1 Standard manholes shall be constructed as shown on the Construction Drawings and in accordance with the Standard Drawings.

.2 Set precast, pre-benched base on minimum 100mm to maximum 300mm of washed gravel material.

.3 As an exception, and subject to the Engineer’s approval, cast-in-place manhole base can be used. Place concrete directly on undisturbed ground and embed the first manhole section in the concrete. A layer of reinforcement shall be placed above the midpoint and shall have a minimum cross sectional area of 250mm2 per linear meter of concrete, in

both directions. Form the channel and benching by casting the sloping manhole floor around the pipe to the spring line, cutting and trimming the pipe evenly with the concrete surface after the concrete has set sufficiently. Place additional concrete to form the upper channel sides and benching as shown on the Standard Drawings. Steel trowel finish required for benching. 'Perched' manholes are not permitted on new construction.

.4 Assemble manhole out of precast sections. Make each joint watertight by using gaskets.

.5 Manholes are to be oriented so safety steps are on the centerline perpendicular to the main floor channel. Safety steps should be aligned so that a person exiting from the manhole would face oncoming traffic, where this does not conflict with the previous requirement. The safety steps shall be installed in all precast manhole sections, including the neck and in the cast-in-place section to form a continuous ladder, with rungs equally spaced at a maximum of 410mm, from within 300mm below the cover, to within 600mm of the base or benching. The steps shall be cast firmly in place or secured with a suitable mechanical anchorage to prevent pullout and maintain water tightness.

.6 The neck section shall be within the height limits shown on the Standard Drawings. A manhole step is required in the appropriate joints within the neck section. The joint with a manhole rung shall be mortared. All other joints between precast rings within the neck section shall have a removable gasket installed.

.7 As required, install a maximum of one (1) rubber riser ring for a final elevation adjustment of the manhole frame and cover. Maximum allowable height of rubber riser ring is 63.5mm (2 ½"). Use a sealer / adhesive such as PL Premium or as recommended by the rubber ring manufacturer between the concrete and the rubber ring.

.8 The manholes shall be fitted with frame and cover specified on the Drawings.

.9 The Contractor shall follow the manufacturer's instructions for installation of the floating frame and covers (Type 80 and Type 90), ensuring that the frame is supported by the paving material and not by the manhole.

.8 Catch Basins:

.1 Catch basins shall be constructed as shown on the Drawings and in accordance with the Standard Drawings.

.2 Set the precast catch basin on 100mm of compacted granular course.

.3 All joints between precast components shall be sealed with Kent seal or equivalent.

.4 The neck section shall be within the height limits shown on the Standard Drawings.

.5 Rubber riser rings may be inserted as required, as outlined in Section 2.9.7 – Standard Manholes.

.6 The catch basins shall be fitted with frame and cover specified on the Drawings.

.9 Connecting Pipe to Manholes and Catch Basins:

.1 Pipes shall be connected to the manhole precast, pre-benched base with integral gasket for each connection. All pipe-to-structure connections shall be made with a resilient connector cast into the manhole in a manner that meets the performance requirements of ASTM C923-02. Not more than two (2) service connections are permitted to a standard sanitary manhole.

.2 Plug lifting holes with low-shrink grout set in cement mortar.

.10 Place and compact backfill in accordance with Section 31 23 38 – Trench Excavation and Backfill.

3.4 ADJUSTING TOPS OF EXISTING MANHOLES

.1 Remove existing grating, frames, and covers, without breaking; and store for re-use at locations designated by Engineer.

.2 Raise or lower by adjusting the number of concrete neck rings. Refer to the Standard Drawings for neck section height limits.

.3 Where raising or lowering with neck rings exceeds the neck height limits, rebuild the top section of the manhole by adding or removing precast sections as required, in accordance with the Standard Drawings.

.4 If required, install rubber riser ring as outlined in Section 2.9.7 – Standard Manholes.

.5 Install additional safety steps in adjusted portion of units as required.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 00 10 – Geotechnical Sitework Testing.

.2 Section 32 10 00 – Sitework Concrete Forms and Accessories.

.3 Section 32 20 00 – Sitework Reinforcing Steel.

1.2 SECTION INCLUDES

.1 Supply and installation of Portland cement concrete for water and drainage structures outside the building envelope, excluding precast concrete.

1.3 QUALITY CONTROL

.1 The Client shall retain and pay for the services of a testing laboratory to perform field tests on the concrete produced and installed. The minimum test requirements shall be:

.1 Air Content: Every batch delivered until air content is established to within Specifications, minimum once per day. Every third batch thereafter, unless specifications are not met.

.2 Slump: Every batch delivered until Specifications are met, minimum once per day. Every third batch thereafter.

.3 Strength: In accordance with CSA-A23-2, standard tests for strength will be conducted at a frequency of not less than one (1) strength test for each 50m3 poured, or portion thereof, with minimum of one (1) test per project. The standard strength test shall consist of three (3) cylinders, laboratory moist cured, except when temperature is below 5oC, when cylinders shall be field cured. Slump and air content taken with cylinders. One (1) cylinder shall be broken at seven (7) days, and one (1) cylinder at twenty-eight (28) days.

.4 Field Cured Cylinders: Two (2) additional cylinders shall be cast when the ambient temperature is 5oC, or lower. Field cured cylinders shall be cured on the job site under the same conditions as the concrete they represent. One (1) cylinder shall be broken at seven (7) days, and one (1) cylinder at twenty-eight (28) days.

.2 Failure to meet Specifications shall result in the Engineer requesting, at the Contractor's cost:

.1 A change in mix design or supplier.

.2 Additional testing (coring, etc.).

.3 Remedial work or replacement.

.4 Other work as deemed necessary.

Part 2 Products

2.1 MATERIALS

.1 Portland Cement: to CSA-A3000, Type HS, sulphate-resistant

.2 Aggregates: to CSA-A23.1

.3 Water: to CSA-A23.1

.4 Air Entraining Admixture: to ASTM C260

.5 Chemical Admixture: to ASTM C494. Engineer to approve accelerating or set retarding admixtures during cold and hot weather placing.

2.2 NON-SHRINK GROUT

.1 Premixed compound consisting of non-ferrous aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength at 16.5 MPa at two (2) days and 48 MPa at twenty-eight (28) days.

2.3 CURING COMPOUND

.1 Non-membrane, colourless, non-yellowing chemical liquid curing compound conforming to CSA-A23.1 and to ASTM C309.

2.4 FLOOR HARDENER

.1 Non-metallic, natural aggregate surface hardener.

2.5 BONDING AGENT

.1 Two-component, epoxy resin.

2.6 WATERSTOPS

.1 PVC Waterstop: Extruded PVC of sizes as indicated in the Drawings, to conform to CGSB 41-GP-35M. Waterstop type and profile to be pre-approved by the Engineer.

2.7 DAMPROOFING FOR DRAINAGE STRUCTURES

.1 Emulsified asphalt, mineral colloid type, unfilled to CAN/CGSB-37.2.

2.8 WATERPROFFING FOR DRAINAGE STRUCTURES

.1 Cementitious waterproofing such as Xypex, Vandex, or approved equal.

2.9 JOINT SEALANT

.1 Control and expansion joints, on the interior and exterior of concrete walls as shown on drawings. Sealant to CAN/CGSB-19.13, one-component, elastomeric, chemical curing sealing compound. Refer to Drawings for joint details and sealants for other joint types.

2.10 OTHER MATERIALS

.1 All other materials, not specifically described but required for a complete and proper installation of all cast-in-place concrete, shall be as selected by the Contractor subject to the approval of the Engineer.

2.11 MIX DESIGN

.1 Submittals: In accordance with CSA-A23.1, Table 11, it is the intent that the Engineer follows Alternative 1 method of specifying concrete. The concrete supplier assumes responsibility for the concrete mix proportions, and in conjunction with the Contractor, shall submit a design to the Engineer for review that will comply with the requirements of the Geotechnical Engineer.

.2 As a minimum, and unless specified by the Engineer elsewhere, for concrete used in water and sewage facilities, the properties of the concrete shall be:

.1 The minimum 28-day compressive strength requirement is 32 MPa.

.2 The maximum water/cementing material ration is 0.50.

.3 Air content to be 5% to 8%.

.4 The slump for concrete shall be 80mm, ± 30mm, unless specified elsewhere by the Engineer. The specified slump for pumping of concrete may be increased with the use of superplasticizing admixtures, upon arrival of the mix design by the Engineer.

.5 Maximum aggregate size of 20mm, unless specified otherwise elsewhere. Concrete density shall be normal.

.3 Accelerating admixtures may be used in cold weather subject to approval of the Engineer. If approved, the use of admixture will not relax the cold weather placement requirements. Use of the chloride shall not be permitted.

.4 Set retarding admixtures may be used during hot weather to allow for proper finishing of concrete, subject to approval of Engineer.

.5 The ratio of supplementary cementitious materials to total cementitious materials shall not exceed 0.20.

Part 3 Execution

3.1 DELIVERY OF CONCRETE

.1 Concrete shall be delivered to the job site according to Clause 18, CSA-23.1 as supplemented or modified below.

.2 The drum shall be rotated on the job site at mixing speed for three (3) minutes just before discharge.

.3 Water shall not be added after initial introduction of mixing water at the plant except when the slump at initial discharge is less than specified. If water is added, it is the responsibility of the supplier to ensure that the specified slump is not exceeded, and the specified strength is attained. Slumps exceeding the specified slump will be a cause for rejection.

.4 Re-tempering with air on site shall be performed by a quality control technician working for the concrete supplier. The quality control technician shall perform an air content test on each load of concrete re-tempered with air and shall provide results upon request.

.5 The slump shall be measured in accordance with CSA-A23.2-5C.

.6 The total air content shall be measured in accordance with CSA-A23.2-4C.

.7 Concrete shall arrive at the work site with a temperature of not less than 10˚C and not greater than 30˚C.

.8 Concrete shall be delivered to the site and discharged within two (2) hours after introduction of the mixing water to the cement and aggregates.

.9 The delivery ticket shall show batch plan location, supplier's name, ticket and truck numbers, mechanically punched date and time of initial plant mixing, mix design designation, water added, volume of concrete, site arrival and discharge time and any other information requested by the Engineer. Non-compliance of any of the requirements above shall be reasons for rejection of concrete by the Engineer.

3.2 PREPARATION

.1 Obtain the Engineer's approval before placing concrete. Provide twenty-four (24) hours notice prior to placing concrete.

.2 Pumping of concrete is permitted only after approval of equipment and mix.

.3 Ensure reinforcement and inserts are not disturbed during concrete placement.

.4 Prior to placing of concrete obtain Engineer's approval of proposed method for protection of concrete during placing and curing.

.5 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

.6 Do not place load upon new concrete until authorized by the Engineer.

3.3 CONSTRUCTION

.1 Do cast-in-place concrete work in accordance with CSA-A23.1.

.2 Sleeves and Inserts:

.1 No sleeves, ducts, pipes or other openings shall pass through joists, beams, column capitals or columns, except where indicated or approved by the Engineer.

.2 Where approved by the Engineer, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 mm x 100 mm not indicated shall be approved by the Engineer.

.3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from the Engineer before placing of concrete.

.4 Check locations and sizes of sleeves and openings shown on drawings.

.5 Set special inserts for strength testing as indicated and if required by non-destructive method of testing concrete. Refer to 1.3 – Quality Control above.

.3 Anchor Bolts:

.1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.

.2 With approval of the Engineer grout anchor bolts in pre-formed holes or holes drilled after concrete has set.

.3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.

.4 Set bolts and fill holes with shrinkage compensating grout.

.5 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.

.4 Waterstops:

.1 Install waterstops in all construction joints as shown on detailed drawings, or located below finished grade. Install them to provide a continuous water seal. Do not distort or pierce waterstop in such a way as to hamper performance. Do not displace reinforcement when installing waterstops.

.2 Use only straight heat sealed butt joints in field. Use factory welded corners and intersections unless otherwise approved by the Engineer.

.5 Joints:

.1 Locate and form all isolation or expansion joints as indicated on the Drawings. Install joint filler, sealer and primer to manufacturer's instructions.

.2 Install a polyethylene strip over joint filler to prevent bonding to joint sealer.

.3 The Contractor shall submit a plan that shows the proposed location of joints and pour breaks to the Engineer for approval.

.4 Do not allow reinforcing steel to run through expansion joints or isolation joints unless otherwise indicated.

.6 Finishing:

.1 Finish concrete in accordance with CSA-A23.1.

.2 Use procedures acceptable to the Engineer or those noted in CSA-A23.1 to remove excess bleed water. Ensure surface is not damaged.

.7 Floor Finishes:

.1 Plain Floor Finish (all covered floors and roof):

.1 Finish concrete floors to CSA-A23.1 as specified below.

.2 Use two (2) passes of steel trowelling to produce smooth burnished surface to within 5mm tolerance when measured in any direction using 3m straight edge.

.3 At areas with floor drains, maintain floors level at walls, pitch floor uniformly to drains at a minimum rate of one half of one percent (5mm per m) or as shown on the Drawings.

.2 Hardened Floor Finish (all exposed floors):

.1 Finish concrete floors as per 3.3.7.1 above, and apply hardener at a rate specified by the manufacturer.

.3 Textured Non-Slip Finish (all exterior flatwork):

.1 Immediately after first trowelling of the 'Plain Floor Finish', swirl-trowel, brush or broom the surface to a uniformly textured non-slip finish, as described in CSA-A23.1, Clause 22.6.1.

.8 Wall Finishes:

.1 In accordance with CSA-A23.1, leave concrete with a rough form finish for use on surfaces not exposed to view in the structure. Chip off fins and irregular projections, and patch form tie holes.

.2 For walls and surfaces exposed to view, the Contractor shall provide a sack rubbed finish as described in CSA-A23.1.

.9 Protection and Curing:

.1 Cure all concrete in accordance with CSA-A23.1, Section 21.

.2 Loosen wall forms within twenty-four (24) hours as outlined in Section 03 10 00 – Concrete Forms and Accessories.

.3 Initial curing: ensure the concrete surface is kept continuously moist until the temperature produced by the heat of hydration of the cement has peaked and dropped at least 8°C.

.4 Final curing: immediately after initial curing, additional curing shall be applied and maintained for a period of seven (7) days, to ensure that the specified concrete strength and quality has been obtained.

.10 Damp-proofing and Waterproofing of Drainage Structures:

.1 Apply damp-proofing compound to exterior of structural wall below grade where shown on drawings, according to manufacturer's recommendations.

.2 Apply waterproofing material onto interior surfaces of structural base and wall as indicated on drawings, within seventy-two (72) hours of stripping forms, and as recommended by the manufacture of the waterproofing materials. Cure the waterproofing compound as recommended by the manufacturer.

.11 Repairing Concrete:

.1 Cut back metal form ties and voids not less than 20mm from surface and fill with non-shrink grout.

.12 Bonding New Concrete to Old:

.1 Clean old concrete surface and protruding reinforcing steel concrete for a distance shown on detailed drawings.

.2 Roughen cleaned surfaces to expose the coarse aggregate of the existing concrete.

.3 Immediately prior to placing new concrete, apply a coating of bonding agent to the existing surface, in strict accordance with the manufacturer's recommendation.

.4 In locations where new concrete is doweled to existing work, drill holes in existing concrete and insert steel dowels and pack solidly with non-shrink grout to positively position and anchor dowels, or as indicated on the Drawings.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 21 13 – Cash Allowances.

.2 Section 31 00 10 – Geotechnical Sitework Testing.

.3 Section 31 05 16 – Aggregate Materials.

.4 Section 31 23 38 – Trench Excavation and Backfill.

.5 Section 32 05 23 – Sitework Cement and Concrete.

1.2 MATERIAL CERTIFICATION

.1 Upon request, submit manufacturer's test data and certification that pipe materials and other materials meet the requirements of this Section. Include manufacturer's drawings, information and shop drawings where pertinent.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Unload and store materials on site with care to prevent damage.

.2 Store materials so that they are left clean.

.3 Store pipe in accordance with manufacturer's recommendations.

1.4 SCHEDULING OF WORK

.1 Schedule work to minimize interruptions to existing services.

.2 Submit schedule of expected interruptions for approval and adhere to approved schedule.

.3 Notify building occupants a minimum of 24 hours in advance of any interruption in service.

.4 Notify fire department of any planned or accidental interruption of water supply to hydrants.

.5 Notify local municipality minimum of 48 hours in advance of any work on or in the vicinity of water infrastructure owned by the municipality.

1.5 SERVICE CONNECTIONS

.1 The 200mm water main service stub from the existing service road shall be utilized.

.2 The Contractor is responsible to coordinate with the Town of Coaldale for the above service connections.

1.6 QUALITY CONTROL

.1 Pipe Zone Material:

.1 For pipe installed by trenching methods, the Contractor shall supply a sample of pipe zone material and associated moisture density curves to ASTM D698 and sieve analysis to ASTM C136.

.2 Contractor to perform field density tests to ASTM D2167 or to ASTM D2922.

.3 The Contractor shall perform as many tests as are necessary to ensure that the work conforms to the requirements of the contract. Under no circumstances shall the frequency of testing be less than 1 density test per straight section of water main.

.1 Concrete Thrust Blocks:

.1 Collect at minimum one set of concrete samples from representative concrete used for thrust blocks. Conduct quality assurance testing in accordance with Section 32 05 23.

Part 2 Products

2.1 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

.1 PVC water mains shall have standard nominal diameters as indicated on the drawings.

.2 Pipe materials and fabrication shall conform to AWWA C900 or C905, as applicable. An Affidavit of Compliance to the AWWA C900 or C905 standards must be provided to the Engineer upon request.

.3 PVC water mains 100 mm through 300 mm diameter shall conform to AWWA C900 and shall have a dimension ratio (DR) of 18, unless otherwise specified.

.4 PVC water mains greater than 300 mm in diameter shall conform to AWWA C905 and shall have a dimension ratio (DR) of 25, unless otherwise specified.

.5 Test PVC pipe in accordance with AWWA C900 or C905 and CSA B137.3. The manufacturer shall maintain a record of all quality control tests for a period of not less than two years and shall submit pertinent records to the Engineer upon request.

.6 Gasket material shall be in accordance with the physical requirements specified in ASTM F477.

.7 Joint lubricants must be certified for potable water use in accordance with National Sanitation Foundation Standard 61 and must:

.1 Impart no taste or odour to potable water containing free or combined chlorine disinfectants.

.2 Create no turbidity in potable water.

.3 Promote no bacterial growth.

.4 Be compatible with rubber and neoprene gasket materials.

.8 Pipe age must not exceed two years at the time of rehabilitation.

2.2 FITTINGS, VALVES AND HYDRANTS

.1 PVC Injection-Moulded and Fabricated Fittings:

.1 Use with PVC or ductile iron pipe.

.2 Injection moulded fittings to conform to AWWA C907 for C.I.O.D. pipe.

.3 Fabricated fittings to conform to CSA B137.3.

.4 Use “push-on” type ends complete with one gasket for each ball.

.2 Gate Valves:

.1 Use only for pipe 100 mm to 400 mm in diameter. Use a valve size equal to the pipe size, or as directed on the approved construction drawings.

.2 Conform to AWWA C500, or C509; non-rising stem, bell ends, single ring gasket, push-on joints for connecting to PVC pipe.

.3 All external nuts and bolts to be Type 304 stainless steel or better.

.4 Provide a 50 mm square operating nut; that turns clockwise to close.

.5 Valve stem to be Type 304 stainless steel or grade B, C, D, or E bronze as per Table 1 of AWWA C509.

.6 Provide Type B (Screw Type) valve casing set with plug.

.7 Provide Type B (Screw Type) middle extension for valves with depths in excess of 3.0 m from top of operating nut to surface grade of valve box.

.8 Castings to have no cracks, gas holes or flaws. Surfaces shall be reasonably smooth with no burnt on sand. Casting runners, risers and fins shall be removed.

.9 Castings shall be true to pattern and with industry standard dimensional tolerances with no excessive shrinkage or deformity. Gray iron castings shall conform to ASTM A48, Class 30B. Ductile iron castings (plugs and bonnets) shall conform to ASTM A536, grade 60-40-18.

.10 Depth of operating nut not to exceed 3.0 m to surface grade. Use valve stem risers (extensions) with stone catcher flange, as required.

.11 Minimum depth of valve operating nut or riser shall be 3.0 m to surface grade.

.3 Fire Hydrants:

.1 Conform to AWWA C502

.2 Provide compression type hydrants, which close with the line pressure, bottom connection with drip valve.

.3 The barrel of the hydrant to be a minimum of 150 mm inside diameter in two flanged section with the upper section being 300 mm in length and terminating at the ground flange, 50 mm above ground level. The lower section to be of sufficient length to provide a minimum of 3.0 m from ground surface to the invert of the inlet pipe. Flanges to have a minimum of 4 bolts.

.4 The hydrant head is to have one pumper connection and two hose connections at least 415 mm above the ground flange; hose connections must be at 90 degrees on each side of the pumper connection. Nipples to be provided with caps, without chains or cables. Valve stem in hydrant head to have "O" ring seals and to be equipped with a thrust bearing. Lubrication, where required, to be applied by regular automotive style grease gun.

.5 Hydrant connection nipples shall have threads conforming to local municipal standards.

.6 Nipples are to be threaded into the hydrant head, rather than leaded in, unless a positive locking device is provided to prevent blow-out of the nipples.

.7 The operating nut on the hydrant valve stem and on the hose and pumper nipple caps, to be 3 sided, each side being an arc 36.5 mm long. The hydrant valve, hose and pumper caps shall open counter-clockwise.

.8 All external nuts and bolts, excluding ground flange, are to be Type 304 stainless steel or better.

.9 Provide a bottom connection, flanged to the barrel, with a single gasket, push-on type joint for ductile iron or PVC pipe, 150 mm in diameter only, complete with harnessing lugs.

.10 Internal paint: Hydrant body, top section – to be painted to AWWA C502 or AWWA C550. Alternatively internal surfaces may be left bare.

.11 External paint: Hydrant bodies (top section, domes, nozzle caps and steamers) are to be painted to AWWA C550 – yellow, in accordance with NFPA 291 standards.

.12 Supply and install hydrant extensions, as required.

2.3 PIPE BEDDING MATERIAL

.1 Granular Materials:

.1 Gradation shall be within specified limits when tested to ASTM C136 and ASTM C117 and giving a smooth curve without sharp breaks when plotted on a semi-log grading chart.

.1 Bedding Sand:

.1 Natural sand or crushed rock screening to following grading requirements:

ASTM Sieve Size	% Passing
9.50 mm	100
4.75 mm	50-100
2.00 mm	30-90
.425 mm	10-50
0.075 mm	0-10

.2 Liquid Limit: ASTM D423 – 66, maximum 25.

.1 Plasticity Index: ASTM D424-59, maximum 6.

.2 Drain Rock: Crushed stone or crushed gravel to follow grading requirements:

ASTM Sieve Size	% Passing
20.0 mm	100
14.0 mm	90-100
10.0 mm	45-75
5.0 mm	1-15
2.5 mm	0-5

.3 Concrete required for cradles, easement, supports:

.1 To Section 32 05 23.

.2 Concrete mix designed to produce 32 MPa minimum compressive strength at 28d using Sulphate resistant cement (Type 50) and containing 28 mm maximum size, 5 mm minimum size coarse aggregate, with water/cement ratio to CAN3-A23. A-M Table 7, and 80 mm maximum slump at time and point of deposit. Air entrainment to CAN3-A23.1M Table 8, 5-8%.

.3 Mix design to be approved by Engineer.

Part 3 Execution

3.1 PREPARATION

.1 Clean pipes, fittings, valves, hydrants and appurtenances of accumulated debris and water before installation. Carefully inspect materials for defects. Remove defective materials from site.

3.2 TRENCHING AND BACKFILL

.1 Do trenching and backfill in accordance with Section 31 23 38.

.2 Trench depth to provide minimum cover over pipe of 3.0 m from finished grade or as indicated.

.3 Trench alignments and depth require Engineer’s approval prior to placing bedding material and pipe.

.4 Do not backfill trenches until installed work has been checked and accepted by Engineer.

3.3 CONCRETE AND ENCASEMENT

.1 Do concrete work in accordance with Section 32 05 23. Place concrete to details indicated or directed.

.2 Do concrete work in accordance with Section 32 05 23. Place concrete to details indicated or directed.

.3 Pipe may be positioned on concrete blocks to facilitate placing of concrete. When necessary, rigidly anchor or weight pipe to prevent flotation when concrete is placed.

.4 Do not backfill over concrete within 24 hours after placing concrete.

3.4 GRANULAR BEDDING

.1 Place bedding sand to details indicated or directed.

.2 Shape bed true to grade to provide continuous uniform bearing surface for pipe exterior. Do not use blocks when bedding pipe.

.3 Shape transverse depressions in bedding as required to make joints.

.4 Compact full width of bed to at least 95% of Standard Proctor Density (ASTM D698). Testing frequency shall be a minimum of one test every 100m of trench length.

.5 Place bedding stone instead of sand bedding material when directed.

.6 Fill any excavation below level of bottom of specified bedding with crushed stone and compact as directed.

3.5 INSTALLATION TOLERANCES

.1 Lay pipes in accordance with AWWA C600 and manufacturer's standards instructions and specifications, as applicable. Do not use blocks to support pipe.

.2 Join pipes in accordance with AWWA C600 and manufacturer's recommendations, as applicable.

.3 Handle pipe by approved methods to avoid damage to machined ends of pipe. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.

.4 Lay pipes on prepared bed, true to line and grade. Ensure barrel of each pipe is in contact with shaped bed throughout its full length. Take up and replace defective pipe. Correct pipe with is not true alignment or grade or pipe which shows undue settlement after installation.

.5 Face socket ends of pipe in direction of laying.

.6 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.

.7 Keep jointing materials and installed pipe free of dirt and water and other foreign materials. Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe in direction of laying.

.8 Position and joint pipes with approved equipment. Do not use excavating equipment to force pipe sections together.

.9 Cut pipes as required for specials, fittings or closure pieces, in a neat manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave a smooth end at tight angles to axis of pipe.

.10 Use 1 m maximum pipe lengths where 150 mm diameter watermain connects to fittings, valves or rigid structures.

.11 Use 2 m maximum pipe lengths where 200 mm or larger diameter water mains connect to fittings, valves or rigid structures.

.12 Align pipes carefully before jointing.

.13 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

.14 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed or contaminated shall be removed, cleaned, lubricated and replaced before jointing is attempted again.

.15 Complete each joint before laying next length of pipe.

.16 Minimize deflection after joint has been made.

.17 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.

.18 Ensure completed joints are restrained by compacting bedding material alongside and over installed.

.19 When stoppage of work occurs, block pipes in an approved manner to prevent creep during downtime.

.20 Recheck plastic pipe joint assembled above ground after placing in trench to ensure that no movement of joint has taken place.

.21 Do not lay pipe on frozen bedding.

.22 Protect hydrants, valves and appurtenances from freezing.

.23 Upon completion of pipe laying and after Engineer has inspected work in place surround and cover pipes between joints with approved granular material placed in the pipe zone to dimensions indicated or directed.

.24 Hand place granular material in uniform layers not exceeding 150 mm thick to minimum 300 mm over top of pipe. Dumping of material directly on top of pipe is not permitted.

.25 Place layers uniformly and simultaneously on each side of pipe to prevent lateral displacement of pipe.

.26 Compact each layer to at least 95% of Standard Proctor Density (ASTM D698). Testing frequency shall be a minimum of one test every 100m of trench length.

.27 When hydrostatic and leakage test results are acceptable to Engineer, surround and cover joints and fittings with granular material placed and compacted as specified herein. Backfill trench in accordance with Section 31 23 38.

3.6 FITTINGS INSTALLATION

.1 Install fittings to manufacturer's recommendations at locations indicated.

3.7 VALVE INSTALLATION AND VALVE BOX

.1 Install valves to manufacturer's recommendations at locations indicated.

.2 Support valves with 150 mm thick concrete pad. Valves shall not be supported by pipe.

.3 Install valve boxes plumb and support to prevent transmission of strain or shock to the valve.

.4 Set valve boxes flush with finish grade or as directed.

.5 Compact backfill for 1.5 m radius all around valves for full depth of trench.

.6 Mark location of each valve with 38 x 89 mm stake 1 m long driven 600 mm into ground at the property line opposite the valve. Paint marker stakes red.

3.8 HYDRANT INSTALLATION

.1 Install hydrants at locations indicated or directed.

.2 Install hydrants in accordance with AWWA Manual of Practice M17.

.3 Install 150 mm gate valve and cast iron valve box on hydrant service leads as indicated.

.4 Set hydrants plumb with hydrant bowl on 150 mm thick concrete pad, with hose outlets parallel with edge of pavement or curb line, with pumper connection facing roadway and with body flange set at elevation of 50 mm above final grade.

.5 Place concrete thrust blocks as indicated and specified ensuring that drain holes are unobstructed.

.6 Where hydrants can be drained, excavate a pit measuring not less than 1.0 x 1.0 x 0.5 deep and backfill with coarse gravel or crushed stone to a level of 150 mm above drain holes. Otherwise plug hydrant drain.

.7 Compact backfill for 1.5 m radius all around hydrants for full depth of trench.

3.9 PLUGGING OF DEAD ENDS

.1 Insert standard plugs into bell ends of fittings or pipe bells.

.2 Place caps over spigot ends of fittings or pipes.

.3 Ensure plugs and caps are watertight.

3.10 CONNECTION TO EXISTING WATER MAINS

.1 Connect to existing water mains at locations indicated.

.2 Exercise caution in uncovering existing pipe to ensure no damage occurs.

.3 Interrupt service in the existing system for a minimum period of time.

3.11 THRUST BLOCKS

.1 Do concrete work to Section 32 05 23.

.2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Engineers.

.3 Bearing area of thrust blocks to be as indicated.

.4 Keep joints and couplings free of concrete.

.5 Do not backfill concrete within 24 hours after placing.

3.12 CATHODIC PROTECTION FOR BURIED FITTINGS, VALVES AND HYDRANTS

.1 All buried metal fittings and valves shall be cathodically protected with 2.3 kg (5 lb.) zinc anodes and all hydrants shall be cathodically protected with 5.5 kg (12 lb.) zinc anodes.

.1 Zinc anodes shall conform to AASTM B418-73 Type II shall have the following composition:

Aluminum	0.005% maximum
Cadmium	0.003%
Iron	0.00%
Zinc	remainder

.2 The packaged zinc anode shall be supplied with 2 m of AWG #10/7 copper wire.

.3 Anodes shall be packaged in a permeable cloth bag or cardboard chip type tube containing acceptable backfill mixture.

.4 The shipping container shall be watertight plastic and is to be removed prior to installation. Anodes shall carry a label identifying the manufacturer, type of anode, metal and backfill composition and the set weight of the anode.

3.13 PRESSURE AND LEAKAGE TESTING

.1 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.

.2 Notify Engineer at least 24 hours in advance of all proposed tests. Perform tests in presence of Engineer.

.3 Where any section of system is provided with concrete thrust blocks, do not conduct tests until at least 5 d after placing concrete or 2 d if high early strength concrete is used.

.4 Apply a leakage test pressure of 1035 kPa, after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for a period of 2 h. Test every valve in the system for leakage in the closed position.

.5 Define leakage as amount of water supplied from water storage tank in order to maintain test pressure of 2 h.

.6 Do not exceed allowable leakage determined from formula below or shown in following table:

L = NDP in which 128,300
L = allowable leakage in litres per hour.
N = number of bolted, mechanical, or push-on joints in the test section
D = nominal diameter of pipe in mm
P = square root of average test pressure during leakage test in kilopascals
Each service connection included in the test section will be counted as one joint.

.7 Locate and repair defects if leakage is greater than amount specified.

.8 Repeat test until leakage is within specified allowance for full length of water main.

Leakage Allowance in Litres per 100 Joints Per Hour
Test Pressure (kPa)

Pipe Dia (mm)	345	515	690	860	1035	1380	1550
150	2.17	2.65	3.07	3.42	3.76	4.34	4.60
200	2.89	3.54	4.09	4.57	5.02	5.79	6.14
250	3.62	4.42	5.19	5.71	6.27	7.24	7.67
300	4.34	5.31	6.14	6.86	7.52	8.69	9.21
450	6.51	7.96	9.21	10.29	11.28	13.03	13.81
600	8.69	10.61	12.28	13.71	15.05	17.37	18.41
750	10.86	13.27	15.35	17.14	18.81	21.72	13.01
900	13.03	15.92	18.42	20.57	22.57	26.06	27.62
Allowable Leakage Allowances Calculated From The Above Formula From AWWA Manual No. M23 (Pvc Pipe – Design And Installation)							

3.14 FLUSHING AND DISINFECTING

.1 Boundary values are only to be operated by Town of Coaldale.

.2 All flushing, disinfection and bacteriological testing to be completed in accordance with to Town of Coaldale practices. Provide a minimum of 48 hours' notice to Town of Coaldale prior to flushing.

.3 Disinfect watermains to AWWA C651-86.

.4 Provide connections and pumps as required.

.5 Flushing and disinfecting operations shall be witnessed by Engineer. Notify Engineer at least 4 d in advance of proposed date when disinfecting operations will commence.

.6 Flush water mains through available outlets with sufficient flow to provide a velocity of 1.5 m/s, within pipe for 10 minutes, or until foreign materials have been removed and flushed water is clear.

.7 Open and close valves, hydrants and service connections to ensure thorough flushing.

.8 When flushing has been completed, introduce a solution of chlorine while discharging water at end of section being disinfected and ensure that it is distributed throughout entire system to a concentration of 25-30 mg/l.

.9 Operate valves, hydrants and appurtenances while main contains chlorine solution.

.10 Measure chlorine residuals after 24 hours. If less than 10 mg/l, flush and rechlorinate.

.11 After satisfactory chlorination for 24 hour minimum, flush line to remove chlorine solution. Dechlorinate if required.

.12 High, low and residual chlorine levels shall be reported to the Engineer.

.13 Bacteriological samples to be obtained after chlorine solution has been flushed out. Flush each sampling point for 5 minutes before sampling. Perform sampling in presence of Engineer.

.14 Should contamination remain or recur during this period, repeat disinfecting procedure.

3.15 RESTORATION

.1 Upon completion of work, remove excess materials and debris and leave work site clean.

.2 Upon receipt of acceptable bacteriological sample results, the Engineer will contact Town of Coaldale and request that the boundary valve(s) be operated and left in the "on" position.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Pipe and fittings, valves, sprinkler heads, emitter pipe, accessories

.2 Control system

1.2 RELATED SECTIONS

.1 Section 22 11 16 - Plumbing: Domestic Water Piping

.2 Section 22 42 01 - Plumbing: Plumbing Specialties and Accessories

.3 Section 26 05 20 – Electrical: Wire and Box Connectors 0–1000 V

.4 Section 26 05 21 – Electrical: Wires and Cables 0–1000 V

.5 Section 26 05 22 – Electrical: Connectors and Terminations

.6 Section 26 05 29 – Electrical: Hangers and Supports for Electrical Systems

.7 Section 26 05 31 – Electrical: Splitters, Junction, Pull Boxes and Cabinets

.8 Section 26 05 32 – Electrical: Outlet Boxes, Conduit Boxes and Fittings

.9 Section 26 05 34 – Electrical: Conduit, Conduit Fastenings and Conduit Fittings

.10 Section 32 01 90 – Exterior Improvements: Landscape Maintenance

.11 Section 32 91 19.13 – Exterior Improvements: Topsoil and Fine Grading

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Handling of PVC pipe and fittings: The Contractor shall exercise care in handling, loading, unloading, and storing PVC pipe and fittings. All PVC pipe shall be transported in a vehicle which allows the length of pipe to lie flat so as not to subject it to undue bending or concentrated external load at any point. Any section of pipe that has been dented or damaged will be discarded, and, if installed, shall be replaced with new piping.

.2 Any fitting that has been dented or damaged will be discarded, and, if installed, shall be at the Contractor's expense replaced with a new fitting(s).

.3 Handling of Equipment and Controls: The Contractor shall exercise care in handling, loading, unloading, and storing equipment and controls. All equipment and controls shall be transported in a vehicle which allows the equipment and controls to lie flat so as not to subject it to undue bending or concentrated external load at any point. All equipment

and controls shall be inspected before installation. Any equipment and/or control that has been dented or damaged or the Contractor suspects is damaged in any way will be discarded, and, if installed, shall be replaced at the Contractor's expense with new equipment and/or controls.

1.4 SUBMITTALS

.1 Materials List

.1 All equipment and materials shall be approved by CSA or ULC or other agency acceptable to the Owner

.2 Complete material list shall be submitted prior to performing any work. Material list shall include the manufacturer, model number and description of all materials and equipment to be used.

.3 Equipment or materials installed or furnished without prior acceptance of the PM or Departmental Representative shall be rejected and removed from the site at Contractors expense.

.4 Manufacturer's warranties shall not relieve the Contractor of liability under the guarantee. Such warranties shall only supplement the guarantee.

.2 Records and As-built Drawings

.1 Provide and keep up to date a complete "as-built" record set of prints which shall be corrected daily and show every change from the original Drawings and Specifications and the exact "as-built" locations, sizes and kinds of equipment. Prints for this purpose may be obtained from the Architect at cost. This set of Drawings shall be kept on the site and shall be used only as a record set.

.2 These Drawings shall also serve as work progress sheets, and the Contractor shall make neat and legible annotations thereon daily as the work proceeds, showing the work as actually installed. These Drawings shall be available at all times for review on-site.

.3 Before the date of the final review, transfer all information from the as-built prints to a reproducible drawing, procured from the PM or Departmental Representative at cost. All work shall be neat, in ink, and subject to the approval of the PM or Departmental Representative.

.4 Dimension from two (2) permanent points of reference, building corners, sidewalk or road intersections, etc., the location of the following items:

.1 Connection to existing water lines.

.2 Connection to existing electrical power.

.3 Isolation valves.

.4 Routing of sprinkler pressure pipes and lateral pipes.

.5 Sprinkler control valves.

.6 Routing of control wiring.

.7 Quick coupling valves and drain valves.

.8 Other related equipment as directed by the PM or Departmental Representative.

.5 Deliver the corrected and completed as-built reproducible prints to the PM or Departmental Representative thirty (30) days before the date of final review. Delivery of the reproducible prints will not relieve the Contractor of the responsibility of furnishing required information that may be omitted from the prints.

.3 Controller Charts

.1 As-built reproducible prints shall be reviewed by the PM or Departmental Representative before controller charts are prepared.

.2 Provide one controller chart for each controller supplied.

.3 The chart shall show the area controlled by the automatic controller and shall be the maximum size which the controller door will allow.

.4 The chart is to be a reduced drawing of the approved as-built reproducible prints. In the event the controller sequence is not legible when the drawing is reduced, it shall be enlarged to a size that will be readable.

.5 The chart shall be a reproducible drawing and a different color shall be used to indicate the area of coverage for each station.

.6 When completed and approved, the chart shall be hermetically sealed between two pieces of plastic, minimum 6 mil.

.7 These charts shall be completed and approved by the PM or Departmental Representative prior to final review of the irrigation system.

.8 Controller charts shall be attached to the inside surface of the corresponding controller enclosure prior to final review.

.4 Operations and Maintenance Manuals

.1 Prepare and deliver to the PM or Departmental Representative within ten (10) calendar days prior to completion of construction, a cover binder with three rings containing the following information:

.2 Index sheet stating Contractor's address and telephone number, list of equipment with name and addresses of local manufacturer's representatives.

.3 Catalog and parts sheets on every material and equipment installed under this Contract.

.4 Guarantee statement.

.5 Complete operating and maintenance instructions on all major equipment.

.6 Construction details from project.

.7 Complete trouble shooting guide to common irrigation problems.

.8 Winterization and spring start up procedures.

.9 Chart of approximate watering times for spring, summer, fall and winter.

.10 In addition to the above-mentioned maintenance manuals, provide the Owner's maintenance personnel with instructions for major equipment and show evidence in writing to the PM or Departmental Representative at the conclusion of the project that this service has been rendered.

.5 Maintenance Materials

.1 Supply as a part of this Contract, the following tools

.1 Two sets of tools required for removing, disassembling and adjusting each type of emitter pipe and valve supplied on this project.

.2 Two keys for each automatic controller.

.3 Three quick coupler keys and matching hose swivels for each type of quick coupling valve installed.

.2 Drip line Equipment, including the following

.1 10 feet (3 m) of emitter tubing for each emitter interval and discharge rate,

.2 Six barbed couplings

.3 Six barbed 90 elbows fittings

.4 Six barbed tee fittings

.5 Six 180 2-way adapter tees

.5 Six male adapters with 3/4-inch (19 mm) FPT

.6 Two flushing valves

.3 The above-mentioned equipment shall be turned over to the Owner at the conclusion of the project. Before final review can occur, evidence that the Owner has received material must be shown to the PM or Departmental Representative.

.6 Guarantee

.1 The guarantee for the irrigation system shall be made in accordance with the attached form. The General Conditions and Supplementary Conditions of these Specifications shall be filed with the Owner or his representative prior to acceptance of the irrigation system.

.2 A copy of the guarantee form shall be included in the operations and maintenance manual.

.3 All guarantee, warranty, and maintenance to conform to the guidelines defined in Section 32 01 90.

.4 The guarantee form shall be retyped onto the Contractor's letterhead and contain the following information:

GUARANTEE FOR IRRIGATION SYSTEM

We hereby guarantee that the irrigation system we have furnished and installed is free from defects in materials and workmanship, and the work has been completed in accordance with the Drawings and Specifications, ordinary wear and tear and unusual abuse, or neglect excepted. We agree to repair or replace any defects in material or workmanship which may develop during the period of one (1) year from date of final acceptance and also to repair or replace any damage resulting from the repairing or replacing of such defects at no additional cost to the Owner. We shall make such repairs or replacements within a reasonable time, as determined by the Owner, after receipt of written notice. In the event of our failure to make such repairs or replacements within a reasonable time after receipt of written notice from the Owner, we authorize the Owner to proceed to have said repairs or replacements made at our expense and we will pay the costs and charges therefore upon demand.

PROJECT: _____

LOCATION: _____

_____

SIGNED: _____

CONTRACTOR ADDRESS: _____

_____

PHONE: _____

DATE OF ACCEPTANCE: _____

1.5 FIELD QUALITY CONTROL AND SITE VISITS

.1 Required Site Visits during Construction

.1 Irrigation System Layout Review: Contractor, Installer, PM or Departmental Representative, Irrigation PM or Departmental Representative, Owner's Representative, and other pertinent parties

.2 PM or Departmental Representative will make up to six (6) site review visits before, during and following construction to review the irrigation system at the following stages:

.1 On-site pre-tender meeting

.2 On-site start-up meeting

.3 Irrigation system layout review

.4 Open trench review – mainline pressure test/lateral piping

.5 Partial completion review – 60% completion

.6 Total performance completion review – 100% completion

.2 Required Site Visit after Construction:

.1 PM or Departmental Representative will make a one (1) year Guarantee Site Visit following final acceptance.

.3 Submit reports of site visits to Architect and Owner.

.4 Site Visit Schedule

.1 Contractor shall be responsible for notifying the PM or Departmental Representative and Owner's Representative in advance for the following reviews, according to the time indicated:

.1 Irrigation System Layout Review: Three (3) business days.

.2 Mainline Pressure Test and Lateral Review: Three (3) business days.

.3 Partial Completion Review: Three (3) business days.

.4 Total Completion Review: Three (3) business days.

.5 One-Year Guarantee Site Visit: 3 (3) business days

PART 2 Products

2.1 MATERIALS

.1 General: Use only new materials of brands and types noted on Drawings and specified herein.

.2 PVC Pressure Main Line Pipe and Fittings

.1 Pressure main line piping shall be PVC Class 160 or 200

.2 Pipe shall be made from an NSF approved Type I, Grade I, PVC compound conforming to ASTM resin specification D1784. All pipe must meet

requirements as set forth in Federal Specification PS-22-70, with an appropriate standard dimension ratio (S.D.R.). (Solvent-weld pipe).

.3 Pipe shall be made from NSF approved Type I, Grade I PVC compound conforming to ASTM resin specification 1785. All pipe must meet requirements as set forth in Federal Specification PS-21.70. (Solvent-weld pipe).

.4 PVC solvent-weld fittings shall be Schedule 40, 1-2, II-I NSF approved conforming to ASTM test procedure D2466.

.5 Solvent cement and primer for PVC solvent-weld pipe and fittings shall be of type and installation methods prescribed by the manufacturer.

.6 All PVC pipe must bear the following markings:

.1 Manufacturer's name

.2 Nominal pipe size

.3 Schedule or class

.4 Pressure rating in P.S.I.

.5 CSA approval

.7 All fittings shall bear the manufacturer's name or trademark, material designation, size, applicable I.P.S. schedule and NSF seal of approval.

.3 PVC Non-Pressure Lateral Line Piping and Sleeving

.1 Non-pressure buried lateral line piping shall be PVC Class 160 or 200 with solvent-weld joints or low-density polyethylene joined using insert fittings and all stainless steel clamps.

.2 PVC pipe shall be made from NSF approved, Type I, Grade II, PVC compound conforming to ASTM resin specification D1784. All pipe must meet requirements set forth in Federal Specification PS-22-70 with an appropriate standard dimension ratio (S.D.R.).

.4 Connections between main lines and control valves shall be of Schedule 80 PVC (threaded both ends) nipples and fittings.

.5 All PVC pipe used on the site shall be from the same manufacturer.

.4 Polyethylene Non-Pressure Lateral Line Piping

.1 LDPE pipe shall be manufactured to meet CSA standard B137.1 and shall be connected using insert fittings and all stainless-steel clamps.

.5 Emitter Pipe

.1 Emitter pipe shall be as listed on the Drawings.

.2 Irrigation contractor shall install emitter pipe per the “Irrigation Notes” located in the drawing set.

.6 Insert Barbed Fittings

.1 All insert barbed fittings shall be constructed of molded, ultra-violet-resistant, plastic. Each fitting shall have a minimum of two ridges or bars per outlet. All fittings shall be of one manufacturer and shall be available in one of the following end configurations:

.1 barbed insert fittings

.2 male pipe threads (MPT) with barbed insert fittings or

.3 female pipe threads (FPT) with barbed insert fittings.

.7 Controller

.1 Controllers shall be as listed on the Drawings.

.2 Provide and install automatic irrigation controller in approximate location shown on Drawings. All 120 VAC wiring shall be installed according to local code.

.3 Final electrical hook-up shall be the responsibility of the irrigation contractor.

.8 Flush Valves

.1 Flush valves were not placed on the drawing, but the irrigation contractor shall install flush valves per the "Irrigation Notes" located in the drawing set.

.2 The line flushing valve shall be constructed of molded plastic and shall be a normally closed hydraulic valve, which flushes based on volumetric quantities of water. Inlet and outlet configurations shall be of one of the following configurations:

.1 1/2-inch (12 mm) MPT, or Insert barbed fitting

.2 The top of the flush valve shall be domed-shaped to allow water-transported debris to drain away from one of the eight orifices in the top of the valve.

.3 The valve shall be non-serviceable and capable of automatically operating during initial system pressure build-up to discharge one gallon of water per 15 gpm demand at 25 psi maximum or 4 psi minimum.

.9 Remote Control Valves

.1 Remote control valves shall be as listed on the Drawings.

.10 Control Wire

.1 Control and common wires shall be single strand copper wires with UL approval for direct burial in ground, minimum size #14-1. Common ground wire(s) shall have white insulating jacket, minimum size #12-1.

.2 Control wires shall have insulating jacket of color other than white, minimum size #14-1; spare wires shall be yellow.

.3 Splices shall be made with DBY/DBR seal packs or approved alternative.

.11 Valve Boxes/Reach Wells

.1 Valve boxes and reach wells (a reach well is where wire connections, between valve boxes, are located) shall be constructed of HDPE, structural foam polyethylene or polymer concrete and be fitted with a locking lid

.2 Valve boxes shall be large enough to allow disassembling and/or removal of complete component(s) housed within it, through the opening at the top of the valve box without excavating or removing the valve box.

.3 Reach well opening shall be at least twice the diameter of the wire bundle housed within it

.4 Provide valve box/reach well extensions as required to ensure boxes/wells tops are flush with finish grade.

.12 Air/Vacuum Relief Valves

.1 Air/vacuum relief valves shall be constructed of plastic with an internal sliding poppet valve that is capable of venting air or vacuum to the atmosphere only. The main body shall have a 1/2-inch (12 mm) male pipe thread (MPT).

.2 Operating pressure range for the air/vacuum relief valve shall be 7 psi minimum to 140 psi maximum.

.13 Backflow Prevention Device

.1 Backflow prevention device shall be of the size and type listed on the Drawings. Install backflow prevention units in accord with irrigation construction details, with positive drainage and room for servicing.

.2 Wye strainers at backflow prevention units shall have a 125-lb (57 kg) flanged cast iron body with 100 mesh screen

.14 Gate Valves

.1 Gate valves 2-1/2 inches (65 mm) and smaller shall be 125-lb (57 kg) SWP bronze gate valve with screw-in bonnet, non-rising steam and solid wedge disc. Red & White or approved equivalent.

.15 Drain Rock

.1 Un-fractured rock, 100 percent passing a 1-1/2-inch (38 mm) square sieve and 0 percent passing a 3/4-inch (19 mm) sieve.

.16 Protective Sleeves with Locking Caps

.1 Protective sleeves shall have an inside diameter that is twice the diameter of the handle of the isolation or drain valve that it houses and shall be constructed of Class 200 or Schedule 40 PVC, length as required.

.2 Enclose all isolation and drain valves in protective sleeves with locking caps.

.17 Sleeves

.1 PVC schedule 40 or SDR 35 depending on application, sizes as noted on the Drawing, depth as required for piping.

.2 Extend piping 12 inches (300 mm) into planter, plug ends and mark at grade with flag label.

.18 Stainless Steel Clamps

.1 Tubing clamps shall be constructed of 304 AISI stainless steel and shall be one "ear" type. This "ear" shall be capable of being pinched with a pinching tool to secure the tubing around the insert barbed fitting.

.2 Interior clamp wall shall be smooth to prevent crimping or pinching of tubing.

.19 Miscellaneous Installation Materials

.1 Solvent cement and primers for solvent weld joints shall be of make and type approved by manufacturer(s) of pipe and fittings. Cement shall be maintained at proper consistency throughout use.

.20 Miscellaneous Equipment

.1 Provide all equipment called for by the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

.1 Site Conditions

.1 All scaled dimensions are approximate. Verify all size dimensions and receive Owner approval prior to proceeding with work under this section.

.2 Contractor shall have all utilities located prior to commencing work

.3 Exercise extreme care in excavating and working near existing utilities. Contractor shall be responsible for damages to utilities, which are caused by his operations or neglect.

.4 Coordinate installation of piping so there shall be no interference with utilities, other construction activities or difficulty in planting trees, shrubs, and ground cover

.5 Contractor shall carefully check all grades to ensure that he may safely proceed before starting work

.6 Coordinate installation of sleeves with other trades

.2 Preparation

.1 Physical Layout:

.1 Prior to installation, stake out all sleeve locations, pipe routing, valve box and other component locations

.2 Make minor changes to conform to ground conditions and note the changes on as-built Drawings

.3 Mark tubing intervals on the ground with flags, paint, or some other markings that can be maintained throughout the installation

.4 Begin emitter tubing layout 4 to 6 inches (100 to 150 mm) away from both hard surfaces; (i.e., concrete sidewalks, curbs, asphalt, and/or undefined edges; i.e. shovel-cut headers)

.5 Confirm water source location, size, flow and pressure before beginning installation.

3.2 WORKMANSHIP AND APPLICATION

.1 Installation

.1 Water Supply

.1 Connect to the water supply at the point of connection as indicated on the Drawings.

.2 Contractor is responsible for minor changes caused by actual site conditions.

.2 Electrical Supply

.1 Electrical connections for automatic controller shall be made to electrical points of connections as indicated on the Drawings.

.2 Contractor is responsible for minor changes caused by actual site conditions.

.2 Excavating and Trenching

.1 Excavation shall be in all cases ample in size to permit the pipes to be laid at the elevations intended and to permit ample space for joining.

.2 Make trenches for pipelines deep enough to provide minimum cover from finish grade as follows:

.1 15 inches (375 mm) minimum cover over main lines to control valves and quick coupling valves.

.2 15 inches (375 mm) minimum cover over control wires from controller to valves.

.3 12 inches (300 mm) minimum cover over lateral lines to sprinkler heads.

.4 All lines shall have a minimum clearance of 6 inches (150 mm) from each other and from lines of other trades. Parallel lines shall not be installed directly over one another.

.5 Emitter pipe to be installed on soil surface under landscape fabric and mulch.

.3 Restore surfaces, existing underground installations, etc., damaged or cut as a result of excavations, to original conditions in manner approved by the PM or Departmental Representative or Owner's Representative.

.4 Where other utilities interfere with irrigation trenching and pipe work, adjust the trench depth as instructed by the PM or Departmental Representative.

.3 Backfilling

.1 Backfill only after piping has been tested, reviewed and accepted.

.2 Backfill material shall be the earth excavated from the trenches, free from rocks, concrete chunks, and other foreign or course materials. Carefully select backfill that is to be placed next to plastic pipe to avoid any sharp objects which may damage the pipe. Place sufficient quantities of soil on emitter pipe tubing to keep them in place and maintain row spacing if required. If soil is rock-laden, isolate from pipe with minimum 2 inches (50 mm) of clean, coarse sand.

.3 Place backfill materials in 6 inches (150 mm) layers and compact by jetting or tamping to a minimum compaction of 90 percent of original soil density.

.4 Dress off areas to finish grades and remove excess soil, rocks or debris remaining after backfill is completed.

.5 If settlement occurs along trenches, around valve boxes, paving etc. the Contractor shall make all necessary repairs so all setting is corrected to match the permanent grads. The Contractor shall also repair/adjust pipes, valves boxes, sprinkler heads etc. to correct component alignments the proper level to match the permanent grade. This work shall be completed to the satisfaction of the Owner and at no cost to the Owner.

.4 Components

.1 All components shall be installed per manufacturers' guidelines and the Irrigation Notes located in the drawing set

.1 Pipe

.1 Use piping as indicated on Drawings. Install in accordance with industry standards and manufacturer's recommendations.

.2 Install all PVC piping using two-step solvent weld process only. Cure joints at least 24 hours.

.3 Paint all galvanized pipe below grade with at least one heavy coat of approved paint to prevent corrosion.

.4 Cap or plug openings as pipeline is assembled to prevent entrance of dirt or obstruction. Remove caps or plugs only when necessary to continue assembly.

.5 Where pipes or control wires pass through sleeves, provide removable non-decaying plug at ends of sleeve to prevent entrance of earth.

.6 All pipe installed under asphalt paving or concrete shall be sleeved.

.5 Emitter Tubing

.1 Emitter tubing can be installed in one of the following methods:

.2 Over-excavation: In small areas where no mulch or sod is used, over-excavate the entire area to a depth of 4 inches (100 mm) below finish grade. Plant all specimen trees and shrubs, 15 gallon size and larger, then place tubing at the row spacing interval indicated on the plans.

.3 Pipe Pulling: In larger areas where ground disruption is to be minimized, pneumatic tire, pipe pulling machinery shall be used. Excavate holes at the ends of each run for making connection to supply and exhaust headers of rigid PVC pipe. Maintain 4-inch (100 mm) cover.

.4 Emitter tubing can be installed with the water outlets facing to side. Offset the water outlets to form a triangular pattern throughout the tubing layout. In irregular areas, water outlets too close to fixed improvements shall be capped off with a emitter plug ring. Secure pipe in place using properly sized staples.

.5 Barbed Fittings: Connect emitter tubing to barbed fittings by pushing on and over both barbs until the tubing has seated against another piece of tubing or has butted against another portion of the barbed fitting.

.6 Pipe Clamping: When operating pressure exceeds 45 psi, stainless steel pipe clamps shall be used. Slip clamps over tubing before slipping tubing over insert barbed fitting. Place clamp between the first and second ridge of the barbed fittings and crimp the "ear" of the clamp tightly. Crimp the "ear" twice to ensure proper seating.

.6 Remote Control Valves

.1 Install where shown and group together in straight lines where practical

.2 Locate valves no closer than 12 inches (300 mm) from walk edges, building and walls

.3 Install valve box parallel to walk, curb or edge

.4 Thoroughly flush main line before installing valve

.5 Install in planting areas where possible.

.7 Air/Vacuum Relief Valves

.1 Install the air/vacuum relief valve below grade and at the highest elevation within each zone. Depending on the site conditions and tubing layout, multiple air/vacuum relief valves will be required. Place the valve within a round valve box with a locking cover and a 1 cu. ft., 3/4-inch (19 mm) gravel sump as noted on the details.

.2 Interconnect tubing with an air/vacuum relief lateral perpendicular to other tubing laterals for systems that are located on mounds or berms with more than a 3-foot (900 mm) elevation differential.

.8 Flush Valves

.1 Install the line flushing valve horizontally level and below grade at each exhaust header. Locate in a valve box with the dome-shape of the valve facing upward. Include a minimum of 1 cu. ft. of 3/4-inch (19 mm) gravel in the bottom of the valve box.

.9 Control Wire

.1 Run lines along mains wherever practical. Tie wires in bundles with pipe wrapping tape at 10-foot (3-meter) intervals and allow slack for contraction between strappings.

.2 Loop a minimum of 3 feet (900 mm) of extra wire in each valve box; for control wire, spares and ground wire.

.3 Splicing will be permitted only on runs exceeding 500 feet (150 m). All splices shall only be made within valve boxes or reach wells. All splicing shall be made with 3M DBR or DBY connectors or approved equivalents.

.1 Where control wires lines pass under paving or concrete, they shall pass through PVC class 200 sleeves.

.2 Provide two complete spare wire runs from controller through every valve box for future use. Test for continuity at punch list. Provide an extra 3 feet (900 mm) (in each valve box and permanently label "Spare".

.10 Controller

.1 Connect control lines to controller in sequential arrangement according to assigned identification number of valve. Control lines shall be labeled at controller with permanent non-fading labels indicated identification number of valve controlled.

.11 System Flushing

.1 After all new sprinkler pipe lines and risers are in place and connected, all necessary diversion work has been completed, and prior to installation of sprinkler heads, open control valves and use full flow of water to flush out the system.

.12 Field Quality Control

.1 Adjustment of the System

.1 The Contractor shall flush and adjust all drip lines for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible.

.2 If it is determined that adjustments to the irrigation equipment will provide proper and more adequate coverage, the Contractor shall make such adjustments prior to planting. Adjustments may also include changes in nozzle and degrees of arc.

.3 All sprinkler heads shall be set perpendicular to finish grades unless otherwise designated on the Drawings.

.13 Testing of Irrigation System

.1 The Contractor shall request the presence of the PM or Departmental Representative in writing at least 3 business days in advance of testing.

.2 Test all pressure lines under hydrostatic pressure of 150 pounds per square inch, and prove watertight for 1/2 hour with maximum 5 psi loss.

.3 Sustain pressure in lines for not less than two hours. If leaks develop, replace joints and repeat test until entire system is proven watertight.

.4 All hydrostatic tests shall be made only in the presence of the PM or Departmental Representative. No pipe shall be backfilled until it has been reviewed, tested and accepted in writing.

.5 Furnish necessary force pump and all other test equipment.

.6 When the landscape irrigation system is completed, perform a coverage test in the presence of the PM or Departmental Representative to determine if the water coverage for planting areas is complete and adequate. Furnish all materials and perform all work required to correct any inadequacies of coverage due to deviations from plans, or where the system has been willfully installed as indicated on the Drawings when it is obviously inadequate, without bringing this to the attention of the PM or Departmental Representative. This test shall be accomplished before any ground cover is planted.

.7 Upon completion of each phase of work, entire system shall be tested and adjusted to meet site requirements.

.14 Maintenance

.1 The PM or Departmental Representative reserves the right to waive or shorten the operation period.

.15 Extended Maintenance

.1 In addition to the maintenance required until final acceptance, provide irrigation maintenance for a period of one year after final acceptance of the site.

.2 All guarantee, warranty, and maintenance to conform to the guidelines defined in Section 32 01 90.

3.3 PROTECTION AND CLEAN-UP

.1 Existing Trees

.1 Where it is necessary to excavate adjacent to existing trees, the Contractor shall use all possible care to avoid injury to trees and tree roots.

.2 Excavation in areas where 2 inches (50 mm) and larger roots occur shall be done by hand.

.3 All roots 2 inches (50 mm) and larger in diameter directly in the path of pipe or conduit, shall be tunneled under and shall be heavily wrapped with burlap, to prevent scarring or excessive drying.

.4 Where a trenching machine is run close to trees having roots smaller than 2 inches (50 mm) in diameter, the wall of the trench adjacent to the tree shall be hand trimmed, making clean cuts through.

.5 Trenches adjacent to trees shall be closed within 24 hours; and, where this is not possible, the side of the adjacent to the trees shall be kept shaded with burlap or canvas.

3.4 CLEAN-UP

.1 Clean-up as each portion of work progresses. Remove refuse and excess dirt from the site. Sweep or wash all walks and paving. Repair any damage sustained to the work of others to original conditions.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 31 00 10 – Geotechnical Sitework Testing.

.2 Section 31 23 38 – Trench Excavation and Backfill.

.3 Section 33 05 13 – Manholes and Structures.

.4 Section 33 05 16.13 – Concrete for Utility Structures.

1.2 SECTION INCLUDES

.1 This Section specifies requirements for supplying and installing sewers.

1.3 SUBMITTALS

.1 At least fifteen (15) working days prior to commencing work inform the Geotechnical Engineer of the proposed source of bedding material and provide access for sampling.

1.4 SERVICE CONNECTIONS

.1 The existing 200mm sanitary sewer service stub from the existing service road shall be utilized.

.2 The existing 300mm storm sewer service stub from the existing service road shall be utilized.

.3 The Contractor is responsible to coordinate with the Town of Coaldale for the above service connections.

1.5 AS-BUILT DRAWINGS

.1 Provide as-built drawings on completion of contract. Give details of pipe material, strength and/or wall thickness designation, rim and invert elevations at manholes, catch basins and connections, location of tees, bends, cleanouts, manholes, service connections, laterals and caps.

.2 Record abandonments on the as-built drawings.

1.6 QUALITY CONTROL

.1 Pipe Zone Material:

.1 For pipe installed by trenching methods, the Contractor shall supply a sample of pipe zone material and associated moisture density curves to ASTM D698 and sieve analysis to ASTM C136.

.2 Contractor to perform field density tests to ASTM D2167 or to ASTM D2922.

.3 The Contractor shall perform as many tests as are necessary to ensure that the work conforms to the requirements of the contract. Under no circumstances shall the frequency of testing be less than 1 density test per MH-to-MH section.

1.7 WARRANTY

.1 All sewers, plus appurtenances, constructed within the municipal rights-of-way (insert roadways here) shall be subject to a two (2) year warranty from the date of Construction Completion approval from the Town of Coaldale. A Final Acceptance inspection will be conducted with the Town of Coaldale to identify deficiencies at the end of the warranty period. The Contractor shall

be responsible to undertake any identified repairs. The Consultant shall assign responsibility for payment of the repairs to the Contractor or the Owner.

Part 2 Products

2.1 CONCRETE PIPE

.1 Production:

.1 Manufacturers producing circular concrete pipe shall possess a current Prequalification Certificate, issued under the Plant Prequalification Program as outlined in the publication, Prequalification Requirements for Precast Concrete Drainage Products.

.2 Markings:

.1 Markings for indirect design projects shall be according to CAN/CSA A257.2. In addition, pipes shall be marked with the Prequalification Stamp as outlined in the publication, Prequalification Requirements for Precast Concrete Drainage Products.

.2 Markings for direct design projects shall conform to ASCE Standard Practice 15 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations.

.3 Product:

.1 Non-Reinforced Circular Concrete Pipe and Fittings: to CAN/CSA-A257.1 Class 3, designed for flexible rubber gasket joints to CAN/CSA-A257.3 made with Type 50 sulphate resistant Portland cement to CSA-A3000.

.2 Reinforced Circular Concrete Pipe and Fittings: to CAN/CSA-A257.2 with flexible rubber gasket joints to CAN/CSA-A257.3, made with Type 50 sulphate resistant Portland cement to CSA-A3000. Elliptical reinforcement is not acceptable unless specific approval is given by the Engineer prior to the manufacture of the pipe.

.3 Lifting Systems:

.1 Pipe lifting systems shall be provided. However, the following rules shall be observed:

.1 Pipe 900 mm and less in diameter, no lift holes.

.2 Pipe greater than 900mm diameter; designed lifting systems with cast-in anchors that are compatible with a '*Swift Lift*' System shall be provided.

.2 Seal lift holes watertight after installation of pipe.

2.2 PLASTIC PIPE

.1 PVC (PSM Type) Pipe:

.1 Smooth wall PVC pipe products and fittings shall conform to Sections 4 and 5 of CSA Standard B182.2 for all basic material requirements and manufactured quality and dimensional tolerance.

.2 Materials used for pipe shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM Standard D 1784. Materials used for moulded fittings shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 13343-C as defined in ASTM Standard D 1784.

.1 Notwithstanding the requirements of Section 4 of CSA Standard B182.2, compounds with different cell classifications than that noted above shall not be used without the prior approval of the Engineer.

.2 Minimum wall thickness shall be as required for SDR 35 unless otherwise approved by the Engineer.

.3 Pipe shall be installed within two (2) years from the production date indicated on the pipe.

.2 Open Profile Wall PVC Pipe:

.1 Closed profile and dual-wall corrugated pipe and open profile PVC pipe products and fittings shall conform to Sections 4 and 5 of CSA Standard B182.4 for all basic material requirements and manufactured quality and dimensional tolerance.

.2 Materials used for pipe and fittings shall come from a single compound manufacturer and shall have a cell classification of 12454-B, 12454-C, or 12364-C as defined in ASTM Standard D 1784.

.3 Notwithstanding the requirements of Section 4 of CSA Standard B182.4, compounds with different cell classifications than that noted above shall not be used without the prior approval of the Engineer.

.4 Minimum waterway wall thickness shall conform to CSA-B182.4 Table 3 for pipe stiffness of 320 kPa.

.5 Pipe shall be installed within two years from the production date indicated on the pipe.

2.3 PIPE EMBEDMENT ZONE MATERIALS

.1 Materials for use as foundation, embedment, and backfill include natural, manufactured, and processed aggregates and the soil types classified according to ASTM Test Method D 2487.

.1 Class I, Class II, and Class III materials are suitable for use as foundation material and in the embedment zone subject to the limitations noted herein.

.2 Class IV-A materials should only be used in the embedment zone in special design cases, as they would not normally be construed as a desirable embedment material for flexible pipe.

.3 Class IV-B, Class V Soils, and Frozen Materials are not recommended for embedment, and should be excluded from the final backfill except where specifically allowed by project specifications.

.4 For ease of compactability and to facilitate proper placement of material in the haunch area of the pipe, a suggested gradation for sand within the pipe embedment zone are the following limits:

Sieve Size (mm)	Percent Passing by Mass
10	100
5	70 – 100
0.16	5 – 20
0.08	0 –12

The above material is an example of a Class B embedment material.

.5 Washed gravel: Where specifically specified for use, washed gravel shall consist of washed, crushed or screened stone or gravel consisting of hard and durable particles meeting the following gradation limits and free from sand, clay, cementitious, organic and other deleterious material:

Sieve Size (mm.)	Percent Passing by Mass
25	100
5	Maximum 10
0.08	Maximum 2

Washed gravel meets the technical requirements for classification as a Class I embedment material.

2.4 **CONCRETE**

.1 Concrete mixes and materials for bedding, cradles, encasement and supports to be in accordance with Section 33 05 16-13.

2.5 **QUALITY CONTROL FOR PIPE, FITTINGS, AND APPUTENANCES MATERIAL**

.1 Concrete Pipe:

.1 For indirect design projects the manufacturer of concrete pipe shall perform quality control and quality assurance testing in accordance with CAN/CSA-A257.0, CAN/CSA-A257.1, CAN/CSA-A257.2 and CAN/CSA-A257.3.

.2 For direct design projects the manufacturer of concrete pipe shall perform quality control and quality assurance testing in accordance with ASCE Standard Practice 15 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations. Hydrostatic joint integrity shall also be demonstrated in accordance with Section 7 of CSA A257.0.

.2 PVC (PSM Type) Pipe:

.1 The manufacturer of PVC (PSM Type) pipe shall perform quality control and quality assurance testing in accordance with CSA-B182.2.

.3 Profile Wall PVC Pipe:

.1 The manufacturer of Profile Wall PVC pipe shall perform quality control and quality assurance testing in accordance with CAN/CSA-B182.4 in conjunction with ASTM F794 with minimum waterway wall thickness as per Table 3.

Part 3 Execution

3.1 PREPARATION OF PIPE

.1 Clean pipes and fittings of debris, dirt, mud, ice and snow before installation. Inspect materials for defects before installing. Remove defective materials from site.

.2 Inspect every pipe for damage in shipment. Reject any damaged pipe and have it removed from the site.

3.2 **PIPE EMBEDMENT ZONE CLASSIFICATION AND CONSTRUCTION**

.1 The pipe embedment zone is detailed on the Engineering drawings. The pipe embedment zone consists of the foundation (where required), bedding and haunch, and initial backfill as detailed on the standard drawing.

.1 Construction requirements within the pipe embedment zone for both concrete pipe and flexible pipes (PVC pipes) shall be based on the following modified ASCE 15 Standard Installation Types as depicted on Drawings. Embedment installation shall be compacted to a minimum of 95% Standard Proctor. Testing frequency shall be a minimum of one test every 100m of trench length.

3.3 FOUNDATION ZONE REQUIREMENTS AND CONSTRUCTION

.1 The foundation soil shall be moderately firm to hard in situ soil, stabilized soil, or compacted fill material.

.2 When unsuitable or unstable material is encountered, the foundation shall be stabilized.

.3 Where groundwater and soil characteristics may contribute to the migration of soil fines into or out of the foundation, embedment soils, sidefill, and/or backfill materials, methods to prevent migration shall be provided.

3.4 VERIFICATION THAT PROPOSED CONSTRUCTION METHOD IS CONSISTENT WITH DESIGN INTENT

.1 Project specific design requirements for the in-place density of outside bedding material, haunch material, and initial backfill shall be noted on the plans or in the project specifications or as detailed herein. As the precise measurement of these densities in the bedding and haunch zones during construction is often not technically feasible, the contractor shall demonstrate to the Engineer for the project that their proposed method of placement of these materials is sufficient to achieve the specified results, through a trial compaction demonstration.

.2 Should the materials proposed for use in the embedment zone change during the course of the works the contractor shall notify the Engineer and carry out additional compaction trials, sufficient to demonstrate that their proposed method of placement is consistent with achieving the specified requirements.

.3 The trial compaction demonstration shall in no way relieve the contractor from their contractual requirement of meeting the minimum performance criteria for completed installations as specified herein.

3.5 BEDDING AND HAUNCH CONSTRUCTION

.1 The bedding shall be constructed as per the specified installation type and in accordance with the contractors proposed construction method as verified in the compaction trial demonstration. Bedding shall be placed in such a manner to maximize the bedding angle achieved, to provide uniform load-bearing reaction, and to maintain the specified pipe grade.

.2 Shape bedding true to grade and to provide continuous, uniform bearing surface for barrel of pipe. Do not use blocks when bedding pipe.

.3 Lay pipe on an uncompacted layer of pipe zone material of minimum depth as shown on the drawings. Place pipe zone material under haunches of pipe, tamping and compacting material to ensure that no voids remain in the haunch zone. Compact outer bedding and haunch zones to Standard Proctor density specified for appropriate installation Type.

.4 Bell holes shall be excavated in the bedding when installing pipe with expanded bells such that the barrel and not the pipe bells support the pipe.

.5 Placement of haunching materials shall be carried out by methods that will not disturb or damage the pipe.

.6 The haunching material shall be worked in and tamped in the area between the bedding and the underside of the pipe before placement and compaction of the remainder of the material in the embedment zone.

.7 Compaction equipment and methods used in the haunch zone shall be compatible with the materials used, the location in the trench, and the in-place densities required.

.8 Where groundwater and soil characteristics may contribute to the migration of soil fines into or out of the bedding and haunch zones with the native soils, foundation materials, and/or other backfill materials; methods to prevent migration shall be provided.

.1 When native soils conditions are adverse or where indicated by project specifications, use washed gravel in lieu of sand.

.2 When washed gravel used, use filter cloth to separate sand and washed gravel.

.9 Where trench bottom is rock, lay pipe on a 150 mm cushion of washed gravel or bedding sand.

.10 When concrete bedding is specified, the pipe may be positioned on concrete blocks to facilitate placing of concrete. Anchor or weight pipe to prevent flotation when concrete is placed. Do not backfill over cast-in place concrete within 24 hours after placing.

3.6 INITIAL BACKFILL

.1 Placement of initial backfill material shall be carried out by methods that will not disturb or damage the pipe.

.2 Compaction equipment and methods shall be compatible with the materials used, the location in the trench, and the in-place densities required.

.3 A primary purpose of initial backfill is to protect the pipe from any impact damage that may arise from the placement of overfill materials. Minimum thickness of the initial backfill layer shall be as indicated on the standard installation drawings. In instances where final backfill material contains large objects or is required to be deposited from very high heights, initial backfill shall be extended to such additional height above the pipe as is necessary to prevent damage from occurring to the pipe during backfilling operations.

.4 Before using heavy compaction or construction equipment directly over the pipe, ensure that sufficient backfill has been placed over the pipe to prevent damaging either the pipe or the embedment zone materials.

3.7 INSTALLATION OF PIPE

.1 Lay and join pipes in accordance with manufacturer's recommendations.

.2 Installation of PVC pipe and fittings shall conform to CSA-B182.11.

.3 Installation requirements for Direct Design concrete pipe shall conform to the supplemental construction requirements identified in with ASCE Standard Practice 15 – Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations

.4 Handle pipe with approved equipment. Do not use chains or cables passed through pipe bore so that weight of pipe bears upon pipe ends.

.5 Lay pipes on prepared bedding, true to line and grade, with pipe invert smooth and free of sags or high points. Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.6 Commence laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.

.7 Do not exceed maximum joint deflection recommended by pipe manufacturer.

.8 Do not allow water to flow through pipe during construction, except as may be permitted by Engineer.

.9 Whenever work is suspended, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.10 Position and join pipes by approved methods. Do not use excavating equipment to force pipe sections together.

.11 Block pipes as required when any stoppage of work occurs to prevent creep during down time.

.12 Plug lifting holes with non-shrink grout.

.13 Cut pipes as required for special inserts, fittings or closure pieces in a neat manner, as recommended by pipe manufacturer, without damaging pipe and to leave a smooth end at right angles to axis of pipe.

.14 Connect pipe to manholes in accordance with Section 33 05 13.

.15 Use approved field connections for connecting pipes to existing sewer pipes.

.16 When complete, the sewer must be thoroughly cleaned out of all dirt, stones and rubbish.

3.8 PIPE JOINTING

.1 Install gaskets in accordance with manufacturer's recommendations.

.2 Support pipes with hand slings or crane as required to minimise lateral pressure on gasket and maintain concentricity until gasket is properly positioned.

.3 Align pipes carefully before jointing.

.4 Maintain pipe joints free from mud, silt, gravel and other foreign material.

.5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall be removed, cleaned and lubricated and replaced before joining is attempted.

.6 Complete each joint before laying next length of pipe.

.7 Minimize joint deflection after joint has been made to avoid joint damage.

.8 At rigid structures, install the first pipe joints not more than 1.2 metres from the side of the structure.

.9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

3.9 TRENCH AND FINAL BACKFILL

.1 Trench and final backfill in accordance with Section 31 23 38.

.2 Do not allow contents of existing sewer or sewer connection to flow into trench.

.3 Trench line, depth and bottom of trench excavation require approval by the Engineer prior to placing bedding material and pipe.

.4 Do not use heavy vibratory equipment for compaction until at least 1 metre of backfill has been placed above the elevation of the top of the pipe.

3.10 TOLERANCE OF SANITARY SEWERS

.1 Alignment:

.1 The centre line of 900 mm and smaller diameter pipes shall not be more than 150 mm off the designated alignment. The centre line of pipe greater than 900 mm shall not be more than 50 mm per 300 mm of diameter off the designated alignment. Where the pipeline alignment is supposed to be straight between manholes a line of sight through the pipe shall exist from manhole to manhole.

.2 Grade:

.1 The invert of the sewer main shall not deviate from the designated grade by an amount greater than the total of 6 mm plus 20 mm per metre of diameter of sewer pipe.

.2 Sags with a water depth between 12.5 mm and 25.0 mm may need to be repaired, as the discretion of the Engineer. Sags with a water depth over 25.0 mm must be repaired.

.3 Joints:

.1 Deflections at joints of concrete pipe shall not exceed those as permitted in the specifications for concrete pipe CAN/CSA-A257. Deflections at the joints of other pipe material shall not exceed those recommended by the manufacturer.

3.11 VISUAL INSPECTION AND ACCEPTANCE CRITERIA

.1 Carry out visual walk-through inspection of the completed sewers.

.2 Perform inspection after all mains, manholes and service connections have been installed.

.3 Repair all defects which will impair the structural integrity or the performance of the sewer system including, but not limited to improper joints, cracked, sheared or excessively deflected pipe, sags and rises which pond water in excess of twice the allowable deviation from grade, protruding service connections and visible infiltration or exfiltration.

.4 Flexible Pipe Defects:

.1 Where there is visual evidence of excessive or non-symmetrical deflection (e.g. a non-elliptical deformation pattern), formal deflection tests shall be conducted.

.2 For DR35 PVC pipe or profile pipe with equivalent pipe stiffness, the maximum allowable deflection shall be 5% of the CSA base inside diameter (BID) for short term observations (i.e. more than 30 days and less than 1 year) and 7.5% of CSA BID for long term observations (1 year or greater).

.3 Excessive or non-symmetrical deflection shall be reviewed by the Engineer and a determination shall be made as to whether the deformation is in excess of the strain limits for the pipe. Deformation less than the allowable strain limits can be re-excavated and have the embedment zone re-built to resolve the deficiency.

.4 Deformation in excess of the strain limit of the pipe material shall have the corresponding section of pipe removed and replaced.

.5 Under circumstances where the excavation of a pipe to resolve an excessive deformation deficiency is not technically feasible due to its depth or its location relative to other utilities and the amount of deformation is determined by the Engineer to be within the strain limits of the pipe, the contractor may make special application to the Engineer to achieve resolution of the deficiency through the use of an approved re-rounding device specially designed for use in the re-round of flexible pipes. Approval for the use of re-rounding devices will only be made in special circumstances on a case-by-case basis and

will always be subject to an increased monitoring period for acceptance at the contractor's expense. The length of the monitoring period shall be determined by the Engineer on a case-by-case basis. Only re-rounding devices that work on the principle of imparting vibration to the surrounding embedment zone as a means of stabilizing the pipe-soil structure will be considered for use.

.6 Defects in flexible pipe that involve cracks and fractures to the pipe structure shall be cut out and replaced. Minor scratches from handling or inspection activities that are less than 10% of the wall thickness of the pipe are not defective, while pronounced scratches and scratches deeper than 10% of the wall thickness shall be deemed to be defective and shall be cut out and replaced.

.5 Rigid Pipe Defects:

.1 Cracks in concrete pipe shall be reviewed by the Engineer to make a determination as to whether they are in excess of the design crack width for service cracking. While project specific requirements may vary, acceptable service cracking is generally deemed to be cracks that measure 0.25 mm (0.01") in width at a distance of the lesser of 25 mm away from the inner pipe surface or at the interface with the reinforcing steel. This may result in cracks at the surface that are slightly in excess of the service crack width limit. A crack comparator or other suitable means shall be used to aid in the determination.

.2 Cracks in excess of the service crack limit shall be deemed to be defective and shall be repaired while cracks within service crack limit tolerances shall be deemed to be acceptable. In making their determination, the Engineer shall also consider the time-history of loading on the pipe. Full long term loading conditions shall not be deemed to have occurred until after 1 year after completion of backfilling. Therefore, very minor cracks can be determined to be acceptable but cracks near the limit of service crack tolerance shall be re-inspected to confirm whether they are acceptable or not after full loading is deemed to have developed on the pipe.

.3 For cracks deemed to be defective, the Engineer shall also make a determination as to whether the nature of the cracks compromises the structural integrity of the pipe. Cracks that are deemed to compromise the structural integrity of the pipe shall be taken out and replaced while non-structural cracks may be reviewed for alternate repair methods. Where alternate repair methods are proposed, the contractor shall make a specific proposal for the Engineer's review and approval.

.4 Under circumstances where the excavation of a pipe to resolve a structural performance deficiency is not technically feasible due to its depth or its location relative to other utilities and the nature of the deficiency is determined by the Engineer to be feasible for repair by trenchless methods, the contractor may make special application to the Engineer to achieve resolution of the deficiency by effecting an appropriately designed trenchless point repair. Approval for the rectification of structural deficiencies will only be made in special circumstances on a case-by-case basis and will always be subject to an increased monitoring period for acceptance at the contractor's expense. The length of the monitoring period shall be determined by the Engineer on a case-by-case basis.

.6 Joint Defects:

.1 Significant joint defects, cracked or offset joints shall be cut out and replaced in a manner acceptable to the Engineer.

.2 Joint defects such as hanging or improperly installed or improperly functioning gaskets shall be reviewed on a case-by-case basis to establish the most feasible means of repair. In all cases the joint may be cut out and replaced as a suitable means of repair. For minor

joint deficiencies alternate repair methods may be considered. Where alternate repair methods are considered the contractor shall seek the approval of the Engineer.

.3 Under circumstances where the excavation of a pipe to resolve a joint deficiency is not technically feasible due to its depth or its location relative to other utilities and the nature of the joint deficiency is determined by the Engineer to be feasible for repair by trenchless methods, the contractor may make special application to the Engineer to achieve resolution of the deficiency by effecting an appropriately designed trenchless point repair and by the use of an appropriately selected grouting technology. Approval for the rectification of joint deficiencies by trenchless point repair or by the use of grouting technologies will only be made in special circumstances on a case-by-case basis and will always be subject to an increased monitoring period for acceptance at the contractor's expense. The length of the monitoring period shall be determined by the Engineer on a case-by-case basis.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 33 31 00 – Sanitary and Storm Utility Piping.

1.2 SECTION INCLUDES

.1 This section specifies requirements for the inspection of gravity sewer lines, including:

.1 Closed circuit television (CCTV)

.2 Manhole Inspection

.2 The purpose of the sewer inspection is for the requirements of construction completion The Inspection Service Levels are defined herein, and the requirements for this project shall be Level 2.

.3 The work of this section includes:

.1 Supply of all materials, equipment, labour and supervision.

.2 Cleaning of sewers immediately before inspection.

1.3 DEFINITIONS

.1 Inspection Service Levels: The description of the various levels of service required for complete CCTV inspection of sewer pipes. Levels are further defined below:

.1 Level 1: Refers to performing CCTV inspection with sewers in existing condition, with no cleaning or flushing.

.2 Level 2: Refers to performing CCTV inspection with sewers being cleaned with one pass by flushing and cleaning equipment prior to televising.

.3 Level 3: Refers to performing CCTV inspection with sewers cleaned to Level 2, plus removal of sediments, solids, roots, encrustations and protruding services to allow passage of CCTV equipment.

.4 Level 4 Refers to performing CCTV inspection with sewers cleaned as specified in Section 02953. This is a level associated with preparations of sewers prior to CIPP relining. It includes a Level 3 cleaning plus any requirement of the lining design and installation, including close fit of the lining, removal of grease, removal of water, etc.

1.4 SAFETY PROCEDURES

.1 The Contractor shall pay strict attention to the Alberta Occupational Health and Safety Act and Regulations and other construction safety measures as outlined in Section 00800 – Occupational Health and Safety Regulations, Volume 1 General.

.2 Contractors shall provide a copy of their confined space entry procedures prior to commencing work.

.3 All documents and safety equipment required shall be available for inspection on demand.

Part 2 Products

2.1 CLOSED CIRCUIT TELEVISION INSPECTION EQUIPMENT

.1 Television equipment shall consist of a self-contained camera and a monitoring unit connected by a coaxial cable. This equipment shall be specifically designed and constructed for such inspection

purposes. The camera shall be mounted on adjustable skids, or wheels, or have a height adjustment to facilitate the inspection of different sizes of pipe and to allow for visual judgment of ovality, by centring the camera within the pipe. The camera shall be waterproof and shall have a remote controlled self-contained lighting system capable of producing effective illumination for all sizes of pipe. The lighting system shall be capable of lighting the entire periphery of the pipe.

.2 For inspection of existing sewers and new sewers the camera shall have pan and tilt capabilities.

.3 Recorded picture quality and definition shall be to the satisfaction of the Engineer.

.4 Location measurement of defects shall be made by devices having a proven accuracy of plus or minus 1.5% or 2 metres, whichever is greater.

.5 Equipment shall be mounted in an appropriate vehicle. Electrical power for the system shall be self-contained and shall not require removal for each set-up. External power sources from public or private residences shall not be permitted. Sound dampening shall be applied to the vehicle and equipment.

.6 Stub lines and other locations where access is limited to one manhole shall be televised using a crawler equipped camera.

.7 The Engineer shall not be responsible for any loss or damage to the Contractor's equipment. The Contractor shall carry all necessary insurance to cover loss, damage, and/or retrieval during inspection. The Contractor shall be responsible for any damages due to sewer back-up or flooding that are caused by his cleaning or inspection operations. The Contractor shall promptly inform the Engineer if any such damages occur.

2.2 CCTV INSPECTION REPORTS

.1 A digital video shall be provided accompanied by an inspection report. This report shall be in accordance with the local municipality standards. It shall be a record of the exact location of each leak or fault discovered by the television - e.g. open joints, broken, cracked, deformed or collapsed pipe, presence of grease, roots, debris, accumulation, obstruction, infiltration, water depth variations and other points of significance. The reference location for distance measurements shall be the centreline of the launch manhole (chainage 0+00). If the inspection includes an intermediate manhole, chainage shall be reset to 0+00 in the centre of the intermediate manhole.

.2 All videos shall be in digital mpeg2 format at a minimum resolution of 640 x 480 and a data rate of 6000 kbps. CCTV reports submitted in digital media shall not contain any Player software or other embedded programs.

.3 The report shall include the location of all service connections together with a statement of opinion as to whether or not the service connections are subject to joint infiltration. Protrusions of service connections into the main line shall be noted with reference to the degree of protrusion.

.4 Photographs of sewer defects shall be taken. The photographs shall be co-ordinated with the written report by reference numbers. A minimum of one photograph per line or manhole to manhole segment shall be taken to show a representative view of the workmanship.

.5 Each manhole to manhole section of pipe shall be located on the report form in such a way as to be readily identifiable. Identify such items as name of subdivision, street names, manhole numbers, type of pipe, joint length, direction of flows, pipe diameter, manhole depth, inspection date, names of the inspection technician, persons viewing, and videotape identification numbers.

.6 Two copies of the final CCTV report with corresponding video shall be provided to the Engineer within two weeks after the completion of the inspection. The report shall be submitted on DVD. Media submitted shall become the property of the Client.

.7 All DVD's shall be numbered and cross-indexed to the written report. Video footage shall indicate the size of the sewer, the manhole to manhole segment being inspected, plus the street address or location.

.8 To insure photographic quality in reports, colour video printers shall be used.

Part 3 Execution

3.1 GENERAL

.1 The Engineer will supply all maps and drawings required for locating the manholes on the lines to be inspected. The Contractor will be responsible for locating and identifying the manholes and lines in the field. The Contractor shall advise the Engineer of buried or non-locatable manholes in writing. Any discrepancies found should be noted and reported to the Engineer.

3.2 CLEANING

.1 Prior to inspection, sewer lines are to be cleaned utilizing low pressure flushing.

.2 Sludge, dirt, sand and other debris resulting from the cleaning operations shall be removed from the downstream manhole of the section being cleaned. Passing material from the section being cleaned to the downstream sewer section shall not be permitted.

.3 Where the initial CCTV inspection indicates the presence of sags greater than 25% of the internal diameter of the sewer, the Contractor shall high-pressure flush that section of line. The section shall then be re-televised twice, firstly with a flusher a short distance ahead of the camera and then without a flusher active. All three records shall be forwarded to the Engineer.

.4 All debris flushed from the lines shall be removed and the Contractor shall be responsible for the proper disposal of the material.

.5 Water for flushing shall be made available from fire hydrants located on the job site or from a source approved by the Engineer or local municipality.

3.3 TRAFFIC CONTROL

.1 Interference to the normal flow of traffic shall be kept to a minimum.

.2 Traffic control, barricades, guards, and other safety precautions shall be used as necessary.

3.4 CLOSED CIRCUIT TELEVISION INSPECTION

.1 The CCTV inspection shall provide a full record of the condition of the pipes, manholes, and appurtenances along the designated section of sewer.

.2 The Contractor shall not attempt a CCTV inspection if water levels in the pipe obstruct the camera's view, unless instructed by the Engineer.

.3 When required, a small diameter polyethylene rope or similar line shall be installed in the sewer in advance of the inspection in order that the camera traction cable may be drawn through the sewer. This line shall be installed on a manhole to manhole basis with the line being tied off at each individual manhole to facilitate the quick removal of the equipment should the need arise due to mainline sewer blockages or other emergency situations.

.4 Direct communication shall be established between the monitoring station and the camera towing device operator. No loudspeaker devices shall be allowed.

.5 The camera advance rate shall not exceed 40 metres per minute to allow adequate time for operator interpretation. The advance rate shall normally not be less than 15 meters per minute in a

sewer with minimal defects. This is shall ensure digital files are not excessively large. A uniform rate of speed shall prevail.

.6 The CCTV inspection shall document a complete visual survey of the sewer line from manhole to manhole, except as directed by the Engineer.

.7 If, during the inspection procedures the television camera will not pass through the entire pipe section between manholes, the Contractor will reset the equipment in such a manner so that the inspection can be performed from the opposite manhole.

.8 The camera operator shall, during the inspection, pan the camera to focus on observable deficiencies in the pipe that may be located off-center to the direction of camera travel. This shall include all services, joints to the top, left or right, cracks and fractures or surface deterioration of the pipe walls.

.9 On completion the Contractor shall provide television reports and digital media as detailed in Section 2.2 above.

END OF SECTION