BID DOCUMENTS & SPECIFICATIONS

For Tender, Permit & Construction

CASTLE Lab

for

Queen's University
RFQ No. Q-2023-031-EL

VOLUME II

Date: **May 11, 2023**
Project Nº **21075**

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PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.
  .1 This Section applies to and governs the Work of all Mechanical Sections.
  .2 Where other Mechanical Trades Sections conflict with requirements specified in this Section the Specifications of that particular Section govern.

1.2 RELATED SECTIONS

.1 Conform to Section 26 01 00, Electrical General Requirements.

.2 Excavating, backfilling and rough grading for mechanical work:
Section 31 23 10, Excavation and Backfill.

.3 Flashings for mechanical work located on or passing through roof except integral flashing collars on equipment and piping where available as standard or optional component: Section 07 55 53 - Roofing

1.3 DESCRIPTION

.1 Provide work in accordance with the full intent and meaning of the Drawings and Specifications as required to result in complete operating systems.

1.4 APPORTIONMENT OF THE WORK

.1 Classify and apportion all materials and the performance of all labour to the several trades involved in accordance with all local customs, rules, regulations, jurisdictional awards, decisions, etc., insofar as they may apply and as required to efficiently execute the work involved in this Contract.

1.5 PERMITS AND FEES

.1 Obtain all permits required for the installation of mechanical trades work, arrange for inspections and tests therewith and pay all fees and costs for the permits, inspections and fees. Obtain permits immediately after notification of award of Contract.

.2 Obtain copies of Drawings from the Engineer for submission with application for permits.

1.6 MATERIALS AND EQUIPMENT

.1 Bear all costs for modification of curbs and floor/roof openings resulting from failure to notify the Engineer prior to the fabrication or construction of opening framing and curb.

1.7 SUBMITTALS

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with the General Conditions of the Contract for items hereinafter listed which are exactly as specified. Supplement Shop Drawings with brochures where necessary or as required. The initial submission of Shop Drawings for any one trade shall include a checklist of all related specified items for that trade to ensure complete submittal and review.

.2 Stamp as follows: - CHECKED FOR CONSTRUCTION IN ACCORDANCE WITH CONTRACT DOCUMENTS.

.3 Record purpose submissions shall include:

- Plumbing Fixtures
- Plumbing Specialties
- Piping Specialties

.4 Submit one electronic pdf copy of such Drawings or Brochures to the Consultant, who will review such Drawings or Brochures.

.5 Submit Shop Drawings (1 PDF electronic copy) for all mechanical equipment in accordance with the requirement outlined in the General Conditions of the Contract.

.6 Prepare Shop Drawings specifically for this work by qualified drafters and in sufficient detail to avoid decisions being made in the shop or field.

.7 General Shop Drawings showing more than one size or model will not be considered unless properly marked up.

.8 Include performance data and characteristic curves with all fan and pump Shop Drawings.

.9 Submit Shop Drawings for suspension systems for all suspended equipment. Indicate the location of suspension for the equipment, the maximum load at each of the suspension points, the size of suspension rods or members and details of supplementary structural steel framing members.

.10 Include wiring diagrams and schematics for all equipment which has electrical controls or devices furnished with the equipment. Wiring diagrams alone are not sufficient; schematic and interconnecting drawings, and sequence of operation of equipment are required for review.

.11 Clearly indicate the materials and/or equipment being supplied, all details of construction, finish, accurate dimensions, capacities and performance on Shop Drawings and brochures. Have all drawings certified correct for construction by the manufacturer, before submission. Identify equipment Shop Drawings with designations as shown on the Drawings or in the Specifications. If not complied with, Shop Drawings will not be reviewed and will be returned to the Contractor.

.12 Each Shop Drawing and/or brochure must bear the stamp and signature of a responsible official in the Contractor's and the Subcontractor's organization for each submission as evidence that the drawing has been checked against the requirements as called for in the Specifications and Drawings. Also, in the case where the equipment attaches to and/or where there is external wiring connecting to other equipment, that it has been properly coordinated with this equipment, whether supplied under this or other contracts.

.13 Revisions to Shop Drawings will not be allowed after they are reviewed unless further review and submission is required.

.2 'As-Built' Drawings: Maintain an accurate dimensional record of all underground piping and all deviations and changes in above ground piping, ductwork and equipment from the Contract Drawings. Transfer this information to two (2) sets of 'As-built' drawings filed at the job site and submit to the Engineer at the completion of the job.

.3 Installation and Start-up Instructions: Furnish PDF copy of installation instructions and PDF copy of start-up instructions for any item of equipment when requested by the Consultant.

.4 Operating and Maintenance Instruction Manuals

.1 Provide one pdf copy electronically of complete operating and maintenance instructions for equipment furnished under this Contract

.2 Provide one pdf copy electrically. Provide a complete index. When more than one volume is required, include in the first book a complete index of all volumes and an individual index in each succeeding volume. Include the following manuals:

- Schematic diagram of electrical, or gas systems.
- List of contacts for all equipment suppliers.
- Equipment Shop Drawings.
- Equipment start up forms.
- Valve tag charts.
- Balancing reports.
- Control Shop Drawings and operating sequence including wiring of components.
- Wiring diagram of control panels.
- Non-dimensional layout showing location of all electrical devices on mechanical equipment.
- Operating instructions, including start-up and shut-down procedure.
- Maintenance instructions including preventive maintenance instructions for components of the equipment.
- Lubricating instructions and recommended cycle of lubrication for each item of equipment, including various types of lubricants.
- Complete parts list of assemblies and their component parts, showing manufacturer's name, catalogue number, and nearest replacement source.
- List of recommended spare parts and quantity of each item to be stocked.
- Manufacturers' warranties and guarantees.

- All the above applies to component parts of equipment whether they are manufactured by the supplier of the equipment or are supplied as a component part of an item of equipment.

1.8 QUALITY ASSURANCE

.1 Regulatory Requirements

.1 Conform to governing Municipal or Federal Codes, Rules and Regulations and/or Authorities having jurisdiction.

.2 Codes and Standards referred to hereinafter are by inference, in each case, the latest issue of the Specified Code or Standard, including all revisions and amendments thereto as adopted and published at date of tender closing.

.3 Do all work and supply all equipment in accordance with the requirements and recommendations of the latest issue of the applicable standards and codes of the:

- National Standards of Canada (NS Can)
- Canadian General Standards Board (CGSB)
- Canadian Standards Association (CSA)
- Canadian Building Code O. Reg. 403/97, as amended
- Canadian Fire Code
- Ministry of Labour
- Sheetmetal and Air Conditioning Contractors' National Association (SMACNA)
- National Research Council Canada – Model Energy Code of Canada for Buildings 1997
- American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Standard 90.1-2001 - Energy Standard For Buildings Except Low-Rise Residential Buildings
- Ontario Building Code 0 Reg. 350/06

1.9 ELECTRICAL REQUIREMENTS

.1 General

.1 Comply with the requirements of the Electrical Safety Code.

.2 All equipment specified in Mechanical Specification or shown on the Mechanical Drawings to be supplied and installed by the Mechanical Contractor and wired by the electrical contractor unless specifically indicated otherwise. Generally, all wiring above 50 volts by the electrical contractor and all low voltage control wiring below 50 volts by the mechanical contractor unless otherwise indicated.

.3 The nominal electrical service available for mechanical equipment is 208 volts 3 ph, 60 Hz, and 120 volts, 1 ph, 60 Hz, unless specifically stated otherwise on the Drawings.

.4 Provide motors with all electrically driven equipment furnished under this Contract.

.2 Motors

.1 Provide motors of 0.37 kW and larger having a nameplate rating of 575 volts, 3 ph, 60 Hz, and motors of 0.25 kW and less with a nameplate rating of 115 volts, 1 ph, 60 Hz, unless otherwise specified hereinafter or otherwise shown on the Drawings.

.2 For types of motors required for this project refer to and comply with requirements of Electrical Division.

.3 Use motors of 0.7 kW and larger that are approved by the Canadian Safety Code.

.4 All motors must meet the minimum nominal efficiency requirements of CSA C390-98.

.5 Fan Motors must be capable of variable system flow as prescribed by MNECB1997 and ASHRAE 90.1-2001.

.3 Starters, Disconnects, Motor Control Centres, etc.

.1 Manual motor starter shall be toggle operated with following general construction features:

- Quick-Make, Quick-Break mechanism with double-break contracts.
- Overload protection heaters, one per phase and speed.
- Enclosure to suit application.
- Pilot light, neon lamp.
- Cover engraved with "On-Trip-Off".

.2 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:

- Quick-Make, Quick-Break mechanism with double-break contacts.
- Fuse holders to accept specified fuses, one per phase.
- Adjustable overload relays, one per phase.
- CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
- "Reset" button.
- Pilot Lights of transformer type incandescent with amber safety lens cap.
- Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
- Scheduled cover mounted control devices with standard duty double break contact blocks.
- Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).

.3 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses, Merson or Cooper Bussmann rated for load, and with enclosed continuous current rating of at least 125% of connected full load.

.4 "Double Voltage Relays" shall be CGE Model CR120 LXMC, Schneider or Omron with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.

.5 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.

.6 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.

.7 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.

.8 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.

.9 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.

.10 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:

- Proposed equipment nameplate data
- Actual full load amperes of motor
- Speed of motor
- Temperature Class in degrees Celsius rise and insulation class
- Circuit breaker or fuse type and proposed rating
- Type of motor, duty and service factor

.11 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.

.12 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.

.13 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.

.4 Identification of Electrical Equipment: As specified in Section 21 05 01.

.5 Identification of Motors: Provide all motors with brass tags attached by small chain loop, bearing the equipment identification of the driven equipment as described on the Mechanical Equipment Schedules. Stamp or engrave identification information with lettering of 9 mm (d") high min.

.6 Wiring: Provide power and control wiring as defined under respective Sections of Mechanical and Electrical Divisions.

PART 2 - PRODUCTS

2.1 DRIVES AND ACCESSORIES

.1 Drives

.1 Select v-belt drives for 150 percent of the motor size rating. Provide sheaves of cast iron construction with machined grooves. Provide sheaves of 75 mm (3") size and larger diameter with taper lock bushings. Statically and dynamically balance all sheaves as an operating unit. For multi-belt drives use matched sets.

.2 Provide adjustable pitch sheaves on motors of less than 11 kW rating, with diameter range selected to obtain specified RPM of the driven equipment at approximately the mid-point setting of the sheave.

.3 Provide solid type drive sheaves on motors of 11 kW and greater. Should such sheaves not provide design requirements under operating conditions, supply and install a new drive sheave of proper size at no additional cost to the Minister.

.4 Submit drive data with Shop Drawings of each item of driven equipment.

.2 Lubricating Devices

.1 Furnish equipment with oil reservoirs with level indicators, or pressure grease fittings. Where fittings are not readily accessible, provide extended tubes to an accessible location. Grease fittings may be Zerk, Lincoln or Alemite but all fittings on the Project shall be one type.

2.2 PIPE SLEEVE SEALS

.1 Thunderline "Link-Seal" Series LS

.2 Fernco

.3 Thermacor

2.3 BONDING AGENTS

.1 Sika "Sikadur 32" Hi-Mod

.2 Probond

.3 Dupond

2.4 MOTORS, STARTERS, DISCONNETS

.1 Canadian General Electric

.2 Klockner Moeller

.3 Cutler hammer

.4 Furnas Electric

.5 Square ‘D’

2.5 ACCESS DOORS

.1 Acudor

.2 Titus

.3 Williams (S.M.S.)

.4 E.H. Price

2.6 ISOLATING UNIONS

1. Epco

2. Marpac "Petro"

3. Corrosion Service

2.7 CAULKING COMPOUNDS

1. Denso-Plast

2. Ecco Shield

3. CBR

2.8 ELECTRIC PIPE TRACING

.1 Electric pipe tracing shall be Raychem or Approval Equal for freeze protection where noted. Provide 5XL-TRACE c/w thermostat for freeze protection and HWATT Plus for temperature maintenance purposes rated for ~~*120/1/60*~~ *208V/1/60*.

.2 Each tracing cable shall be in sections to suit pipe traced. Each total section shall have splicing kit, thermostat, tee kit and end seals for cables is required.

PART 3 - EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

.1 General

Conform with applicable requirements of the Occupational Health and Safety Act and Regulations for Construction Projects, Ontario Regulation 213/91 Amended to O. Reg 527/00.

.2 Measurements and Deviations

.1 Where any parts of the mechanical work are specifically located by dimensions on the Drawings, check and verify these dimensions on the site prior to installation.

.2 Before installing piping, review architectural, structural and electrical drawings with mechanical drawings. Where interference may occur and departures from arrangements as shown are required, consult with other trades involved, come to agreement as to changed locations or elevations and obtain approval of the Engineer for proposed changes before proceeding with the work.

.3 Examine work of other trades or contractors, prior to commencement of mechanical installations. Report in writing, to the Engineer, any discrepancies which will affect mechanical installations. Failure to do so shall be considered acceptance of the conditions.

.4 Where Site conditions require minor deviations from indicated arrangements or locations, make such changes on approval of the Engineer without additional cost to the Engineer.

.5 Should any discrepancies occur during installation of mechanical work which will necessitate major revisions to the mechanical trades work or the work of other trades or contractors, notify the Engineer immediately and obtain his written authorization before proceeding with the work.

.3 Scaffolding and Hoisting Equipment

.1 Refer to and comply with the requirements of 01 5100, Temporary Utilities and Controls.

.2 Do not drill, cut or weld the building steel or building structure for erection of materials or equipment without prior written approval of the Engineer.

.4 Overloading

.1 During installation of mechanical work, do not load any part of the building structure with a load greater than it is capable of bearing. Bear full responsibility should any accident occur or damage result through the violation of this requirement.

.2 Any temporary supports used during installation must be as strong as permanent supports.

.5 Attachment to Building Construction

.1 Use welding studs of size not larger than 10 mm for attaching miscellaneous materials and equipment to building steel. If the weight of materials or equipment require bolts or studs larger than 10 mm dia., use steel clips or brackets, secured to building steel by welding or bolting as approved by the Engineer.

.2 Use self drilling expansion type concrete inserts for securing miscellaneous equipment and materials to masonry or concrete construction already in place, of sufficient number and size to prevent concrete from breaking away. The use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from the Engineer.

.3 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.

.4 Furnish beam clamps of 2-bolt design and of such type that the rod load is transmitted only concentrically to the beam web centreline. The use of "C" and "I" beam side clamps, etc., will not be allowed without written consent of the Engineer.

.5 Where the roof or floor framing consists of open web or long span steel joists, ensure that hangers are located at or within 150 mm of the joist top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist spacing. Design suspension assembly such that the hanger load is transmitted only concentrically to the supporting joist. Do not use "C" and "I" beam side clamps, brackets, etc., without written consent of the Engineer.

.6 Locate secondary structural steel members between joists at or within 150 mm of top or bottom chord panel points. Where the secondary structural steel member cannot be located at or near a joist panel point, provide additional diagonal structural steel web member/members designed for the applicable load to the nearest panel point in the opposite chord member. This condition may be waived if the load to be suspended between panel points is not in excess of 45 kg. Diagonal hangers which will induce lateral stresses in the chord members of the joist will not be permitted. Submit Shop Drawings of the suspension assembly indicating the location of suspension or support points, the maximum load at each suspension point, location and size of hangers, brackets and intermediate framing members when required, and also details of connection to building structure.

.6 Cutting, Patching, Excavation and Backfill

.1 Cutting of holes up to 200 mm in diameter and related patching shall be done under Mechanical Division. Holes and other openings larger than 200 mm in diameter, all chases, bulk-heads, furring and related patching shall be done under Division 1. Read same for detailed information regarding cutting and patching.

.2 Do not cut, remove or burn structural parts or sections of the building, whether they are steel, concrete or masonry, without the written authorization of the Engineer.

.3 Should cutting, repairing, and patching of previously finished work of other trades be required to allow installation of mechanical work, pay all costs for the trade concerned to perform the work.

.4 Perform necessary excavating for work of this Division. Ensure bottoms of trenches are excavated so that full length of each pipe will be supported on solid bed of undisturbed earth. Build approved concrete pad, solid block or concrete piers properly reinforced under piping below grade where solid undisturbed earth bed is not obtainable to meet Plumbing Code.

.5 Remove excavated materials not used as backfill from site unless otherwise directed.

.6 Provide 100 mm bed of 20 mm crusher run limestone compacted to 98% Modified Proctor under all piping not laid in sandy ground or other approved bedding. For copper and plastic piping, bedding shall be clean sand.

.7 Backfill at least first 150 mm above top of piping with clean coarse sand hand placed in 75 mm layers and compacted to 98% density Proctor Modified (ASTM #D1527). Note conditions and Details and conform thereto.

.8 Backfill inside building with M.T.C. granular 'B' or clean coarse sand in 150 mm layers mechanically compacted to give minimum of 98% density Modified Proctor (ASTM #D-1527 STD) compaction.

.9 Scan and perform x-ray of surfaces before any cutting or excavation begins.

3.2 EQUIPMENT INSTALLATION

.1 General

.1 Erect equipment in a compact, neat and workmanlike manner. Align, level and adjust for satisfactory operation. Install in such a manner that connecting and disconnecting of piping and accessories can be made readily and that all parts are easily accessible for inspection, operation, maintenance and repair.

.2 Install and start up items of equipment in complete accordance with the manufacturer's printed installation and operating instructions.

.2 Firestopping and smoke seal

.1 Be responsible for installation of firestopping and smoke seal inside mechanical assemblies (i.e. fire dampers).

.2 Firestopping and smoke seals around outside of mechanical assemblies, where they penetrate fire rated separations shall be part of work of Section 07840, Firestopping and Smoke Seals and shall be carried out under supervision of this Division.

.3 Be responsible for any additional cost incurred as a result of oversizing of openings during cutting and patching operation of openings to be firestopped up to 200 mm (8") in diameter.

.4 Install sheet steel covers supplied by Section 05500, Metal Fabrication over temporarily unused sleeves provided in fire separations for future mechanical installations.

.5 Noise and Vibration: Select noise and vibration levels of equipment and systems to conform to design intent. If unnecessary noise or vibration should be created by any mechanical equipment and systems and transmitted to occupied portions of building or other mechanical work, make all necessary changes and additions as approved by the Engineer without additional cost.

.6 Lubrication: Lubricate all equipment prior to start up, in accordance with the manufacturer's printed instructions. Provide all lubrication including sufficient quantity for drainage and refilling of oil sumps, etc., when required by manufacturer's instructions.

.3 Equipment Bases and Pads

.1 Verify size of bases shown on Drawings with actual requirements and advise the Engineer and the respective trades if change in size or shape of pad is required.

.2 Construct bases and pads at least 150 mm high unless specifically stated or shown as less on the Drawings or directed by the Engineer. Extend bases 75 mm beyond centreline of anchor bolts or to a minimum of 50 mm beyond equipment base. Chamfer all upper perimeter edges of base.

.3 Supply anchor bolts and sleeves to trade constructing bases in sufficient time for setting in formwork prior to placing concrete and provide anchor bolt location drawing or template for locating anchor bolts. Check anchor bolt locations for proper position before concrete is poured.

3.3 PIPING CONSTRUCTION METHODS

.1 General

.1 Unless specified otherwise herein, construct and install all piping in accordance with ANSI Sections B31.1 to B31.9 as applicable to service, except that soldered joints will not be permitted in compressed air piping.

.2 To avoid unnecessary cutting of masonry, provide inserts, sleeves and anchors to other trades for building in as the work proceeds. Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical work.

.3 Inspect pipe and fittings for soundness and clean of all dirt and other foreign matter immediately prior to installation. Reject all damaged items.

.4 Install piping in the most direct, straight and functional manner possible. Except where otherwise shown, install all vertical lines plumb, and run horizontal lines parallel to building walls. Install piping close to walls, partitions and ceilings. On multiple runs of piping, space piping to allow for installation of insulation and for proper servicing of valves.

.5 Ensure that trenches for piping below grade are dry and firm when laying pipe.

.6 In fill areas, provide a minimum clearance of 100 mm (4") on all sides of the pipe passing under or through building grade beams to prevent possible damage from settling of building. If a greater settlement can be expected, increase the clearance to prevent possible damage.

.7 Conceal all piping in finished areas and rooms within walls or ceilings, and in furred spaces elsewhere. Provide access doors or panels as hereinafter specified for access to concealed piping specialties etc.

.2 Expansion and Contraction

.1 Install all piping so as to be free from strain and distortion due to expansion and contraction and governed by requirements of Section 6, Chapter 3 of ANSI B31.1, except as hereinafter modified. Allow for expansion and contraction by offsets, expansion U-bends or loops. Do not use expansion joints of any type unless specifically indicated on the Drawings or specified under another Section of Mechanical Specifications for a particular installation.

.2 Base provision for expansion and contraction on 25 mm movement per 30 m of steel pipe and 38 mm movement per 30 m of copper or brass pipe for each 55 de C temperature difference from 21 deg C ambient. Fabricate expansion bends in steel pipe from pipe sections and long radius welding elbows.

.3 Use swing or swivel joints on all steam or hot water heating piping for connections from mains to risers and from risers to radiation and other heating units. Use at least five fittings from main to riser including tee in main. Use at least four fittings from riser to heating unit including tee in riser.

.3 Lines, Grades and Slopes

.1 Install piping in conformity with elevations and grades indicated on the Drawings using axis lines and bench marks provided under General Construction; verify such axis lines and bench marks. Each trade shall lay out his work and be responsible for lines, elevations, measurements, etc., required for installation of his work.

.2 Slope piping drains and sewers as indicated on the drawings. Install so that slope between elevations shown on the Drawings is even and constant.

.3 Install liquid and air lines free of pockets and pitch to drain at low points in the line with valves or traps installed as required for drainage of the lines.

.4 When slope is not shown on the Drawings, install piping to the following slopes:

- Drainage piping - 1:50 on drains of NPS 3" size and less and 1:100 on drains of NPS 4" and larger. In special circumstances as provided for under the Codes and Regulations and the express approval of the Engineer, drains of NPS 4" size and larger may be laid at a lesser slope.
- Domestic water lines - pitch to low points so that all lines may be completely drained. Natural gas - slope down 1:1000 in direction of flow.

.4 Immersion Wells and Sensing Bulbs

.1 Where a temperature sensing bulb or immersion well is installed in piping of NPS 22" size and less, increase the tee fitting and piping as required in which the bulb or well is inserted a minimum of one pipe size larger than the adjoining pipe to prevent restriction of flow of liquid.

.2 To improve heat transfer pack all immersion wells in piping for liquids up to a temperature of 150 deg C with a mineral type grease prior to installation of sensing bulb.

.5 Pipe Joints

.1 Ream all pipe ends and thoroughly clean all dirt, cuttings and foreign matter from pipe after cutting and threading. Thoroughly clean all fittings, valves and equipment before connections are made. Cut copper tubing with a tube cutter and clean the joining surfaces of the tubing and fitting with fine emery cloth. Wipe clean with a dry cloth.

.2 Make screwed joints with Teflon tape or Masters metallic compound with the compound applied to the male threads only and particular care taken to prevent the compound from reaching the interior of the pipe or fittings.

.3 Install sleeve type couplings for cast iron plain end soil pipe, such as Titan Foundry Type MJ, or Bibby MJ Series 2000 or Dayton in strict accordance with manufacturer's printed instructions.

.4 Make joints on cast iron bell and spigot soil pipe with either neoprene compression type preformed gaskets such as Bibby "Bi-seal", or lead and oakum with a minimum of 0.5 kg of lead per 25 mm of pipe diameter, and caulk in such a manner to produce a permanently tight joint. Cold caulking compound in cord form such as W.R. Meadows PC4 may also be used. Assemble preformed neoprene gaskets to manufacturer's printed instructions.

.5 Assemble mechanical joint on ductile iron pressure pipe with cast iron gland, rubber sealing gasket and high strength malleable iron bolts in accordance with the manufacturer's recommendations.

.6 Install couplings, fittings, etc. on grooved end piping systems in accordance with manufacturer's printed instructions.

.7 Make soldered joints on copper tubing in accordance with the following usage:

	Service	Solder	Type
.1	Dom. Hot and Cold water		lead free with matching flux
.2	Drain, Waste, Vent		50/50 with matching flux
.3	Hot water heating		95/5 with matching flux

.8 Do not use core type solder. Use solder conforming to ASTM requirements.

.9 Make carbon steel welded joints in compliance with latest acceptable practices, either by electric arc welding, gas metal arc welding, or oxy-acetylene gas welding.

.10 Employ qualified welders holding a current up-to-date Provincial Certificate for the process and rating involved as required by the Provincial Regulations.

.11 Conform to ANSI B31.1 Section IX for welding and be responsible to ensure that supervisory staff, fitters and welders are fully conversant with the requirements laid down by that Standard prior to the commencement of welding.

.12 Unless more stringent methods of inspections are specified the Engineer will visually inspect welded joints for fusion of metal, icicles, alignment, etc. Remove any defects and remake the joint to his satisfaction.

.13 For welding of materials other than carbon steel conform to the requirements specified in the relevant section of the Specification.

.14 Subject all steam, condensate, nitrogen and airlines to a 10% radiography of welded joints in accordance with ASME Boiler and Pressure Vessel Code, Section V.

.15 If more than the allowable number of welds prove to be unacceptable pay all costs for a complete radiographic test of all joints in the affected piping system.

.16 Re-weld and re-test unacceptable joints at no additional cost to the Minister.

.6 Unions and Flanges

.1 Provide unions or flanges in the following locations:

- For bypasses around equipment or control valves or devices in piping systems.
- At connection to steam traps and in by-passes around traps.
- At connections to equipment. Locate between shut-off valve and equipment.
- In screwed or solder joint drainage tubing at inlet side of trap.

.2 Do not conceal unions in walls, partitions or ceilings unless access thereto is provided.

.3 Provide dielectric unions or isolating type companion flanges at all connections between copper tubing and ferrous piping.

.4 Assemble flanged joints with appropriate flanges, gaskets and bolting. Provide clearance between flange faces such that the connections can be gasketed and bolted tight without undue strain on the piping system with flange faces parallel and bores concentric. Centre gaskets on the flange faces so as not to Project into the bore. Lubricate bolts before assembly to assure uniform bolt stressing. Machine off raised face flanges when joining to a flat companion flange and use a full face gasket.

.7 Fittings

.1 The use of couplings between fittings, valves or equipment, will not be permitted except on long runs in pipe sizes NPS 2" or smaller. Where the length of pipe between fittings requires a connection, make the joint by welding. Do not use running couplings in any pipeline.

.2 Fittings and ancillary items installed in systems operating at pressures in excess of 103 kPa (15 psig) must be registered in accordance with CSA B51.

.3 Use eccentric reducing fittings in locations where piping changes size and at connections to equipment and control valves, to provide proper drainage or venting of the lines. Do not use bushings.

.4 Tee connections in welded piping may utilize either of the following:

- Factory fabricated standard buttweld fittings.
- Bonney Forge "Weldolets", "Thredolets" or "Sockolets".

.5 Mitering, notching or direct welding of branches to mains, will not be permitted.

.6 Use standard pipe fittings for changing direction of piping. No mitered joints or field fabricated pipe bends are permitted. Use long radius welded steel elbows unless short radius elbows are specifically authorized by the Engineer.

.7 In copper tubing, direct connection of branch into main using "T-Drill" method may be used where allowed by Ontario Building Code.

.8 Piping Connections to Mains

.1 Make branch connections of steam, gas and compressed air lines to respective horizontal piping of larger diameter to the upper quadrant of the larger pipe.

.2 Make down feed piping connections of all water piping to horizontal supply and return mains to the bottom quadrant of the mains.

.9 Sleeves

.1 Install sleeves where piping passes through foundations, above grade floors and walls. Fabricate sleeves of Sch. 40 black steel pipe or type "K" copper tubing for installation in foundations or floors, and of 1 mm (20 ga.) galvanized sheet steel where installed in above grade walls.

.2 Sleeves for piping passing through roofs will be supplied and installed under other Contracts or under Roofing Section, unless specifically shown otherwise on the Drawings.

.3 Make sleeves large enough to pass full thickness of pipe covering where same is used, and with sufficient clearance between pipe and sleeve to allow for any lateral movement of piping due to expansion and contraction.

.4 Terminate sleeves flush with finished ceilings, walls and floors on grade. For piping passing through floors above grade extend sleeve a minimum of 75 mm above the floor.

.5 For pipes entering structures from below grade, seal the annular space between sleeve and pipe with prefabricated seals.

.6 In the case of pipes passing through firewalls or through walls, partitions or floors which are considered as serving as fire stops and in partitions around washrooms, seal the space around the pipe, in the sleeve.

.7 Fill sleeves for future use with lime mortar.

.8 Assume all responsibility for the setting of all sleeves necessary for this work in masonry walls during construction or in concrete forms before concrete is poured.

.9 Coat exterior surface of all sleeves of ferrous material with a heavy asphalt emulsion.

.10 Firestopping shall be installed and applied as required by NBCC and FMOG-ENG-4003. Fire stopping shall be in accordance with CAN/ULC-5115: Fire tests of Firestop Systems.

.10 Escutcheon Plates

.1 Provide escutcheon plates on bare piping passing through finished walls or floors.

.2 Use escutcheon plates made of cast brass or stamped metal, either one to be heavy chromium plated and, if constructed in two pieces, fitted with substantial hinges and positive latches. Provide plates with tempered springs to ensure positive attachment to the pipe.

.11 Valves

.1 Supply and install valves in all locations shown on the Drawings, at all piping connections to equipment, at all connections to control valves or control devices, and where required for sectionalizing a system or floor.

.2 Use gate or butterfly valves for shut-off purposes and globe or plug valves for throttling purposes.

.3 Install check valves wherever required to ensure flow of liquid in one direction.

.4 Provide drain valves with hose thread outlet connection or valve with long nipple on outlet at all low points of each water system and above all riser or branch stop valves for proper drainage of lines.

.12 Piping Subject to Freezing

.1 Where horizontal or vertical piping is run along an outside building wall and concealed in a pipe space, circulation of interior air shall be maintained in the pipe space by means of air grille(s) located at the top and bottom of pipe space, facing the interior of building.

.2 Where horizontal piping is run in a ceiling space under uninsulated roof, the insulated pipe shall be encased in slab insulation on both sides and top and circulation of interior air shall be maintained in the encasement by means of air grilles located in the ceiling below, facing down into the interior of the building. The spacing of grilles shall be not less than 3000 mm o.c.

.13 Air Venting: Install all vents at high points of all water piping systems and connect to nearest drain.

3.4 MISCELLANEOUS STEEL

.1 Painting and Cleaning

.1 Touch up minor damage to finish on equipment with standard factory applied baked enamel finish. If, in the Engineer's opinion, the damage is too extensive to be remedied by touch up, replace damaged equipment.

.2 Clean steel by scraping, wire brushing or other effective means to remove base scale, rust, oil, dirt or other foreign matter.

.3 Apply one coat of zinc chromate iron oxide primer, conforming to CAN/CGSB-1.40M to all miscellaneous steel.

.4 In the field, touch up all bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as hereinbefore specified.

.5 Give two coats of primer to all surfaces which will be inaccessible after erection.

.6 Thoroughly remove all foreign matter from steelwork on completion of installation.

3.5 CONCRETE INSERTS

.1 Install all inserts required for attachment of hangers, either for suspension of piping or equipment.

.2 For masonry or poured concrete construction use expansion type units. Insert into the concrete after concrete has cured. Anchors or inserts installed by explosive means shall not be used.

3.6 FLASHINGS

.1 Furnish and set all required counter-flashings for vent stacks.

.2 For safety vents, plumbing vents and all other pipes passing through roofs, stack flashings will be supplied and installed by roofing trade.

3.7 ACCESS DOORS

.1 Access doors in ductwork are specified in Section 23 33 00 Ductwork Accessories.

.2 Supply access doors for installation by other trades in walls or ceilings where accessibility is required for the operation and/or maintenance of concealed valves, traps, cleanouts, dampers and control equipment. Unless otherwise specified on the Drawings or in other divisions of the Specifications, or as required to replace or repair said equipment, provide access doors at least 200 mm x 200 mm (8" x 8") size, fabricated of bonderized steel, with concealed hinges and screwdriver lock. Provide doors of a type and fire rating to suit the particular type of wall or ceiling construction in which they are to be installed.

.3 All access panels and doors shall be Acudor BP58 Bauco Plus Access Doors or equivalent from alternate manufacturers listed above.

3.8 PROTECTION

.1 Protect all work and materials before and after erection from weather and other hazards and keep in a clean and orderly manner.

.2 Protect pipe ends, valves and parts of equipment left unconnected to prevent damage or intrusion of foreign matter. Provide pipe caps for threaded male connections and plugs for threaded female connections.

.3 Protect plumbing fixtures or mechanical equipment having a baked enamel finish by covering with polyethylene sheet securely held in place.

3.9 PAINTING

.1 With the exception of prime painting of miscellaneous steel or any other specific requirements as specified under the respective Sections of the Mechanical Trades Work, or equipment otherwise factory painted, all painting will be provided under General Trades Work.

3.10 STERILIZATION OF POTABLE WATER SYSTEMS

.1 Flush each system after completion by allowing full flow of water through the system for a period of fifteen minutes or longer when directed by the Engineer.

.2 After flushing of the system is completed, provide a 24 hour contact sterilization treatment by treating the water with 50 ppm of chlorine as recommended in AWWA Specification C-651. After sterilization period has elapsed, flush system to reduce chlorine content to an acceptable level.

3.11 PRESSURE TESTS

.1 Make specified pressure tests on all piping included in this Contract. Furnish all pumps, compressors, gauges and connectors necessary for the tests.

.2 Conduct tests in the presence of the Engineer and all other personnel of governing authorities having jurisdiction. Notify all parties in ample time to permit them to be present. Conduct tests before piping is painted, covered or concealed.

.3 Conduct hydrostatic tests for a minimum period of 2 hours, or longer when requested by the Engineer or governing authority at the test pressure specified under the respective Section of the Specifications.

.4 During this time the pressure shall remain constant and the exterior surfaces of pipe or fittings shall not show any cracks or other form of leak.

.5 For pneumatic tests, first pressurize the system with air to approximately one-half the specified pressure but not to exceed 345 kPa (50 psig) and examine all joints for leaks with a soapsuds solution. After any repairs have been made and the soap test has been met satisfactorily, pressure the system with air to the test pressure specified under the respective Section of the Specifications.

.6 Conduct final tests on natural or propane gas piping in accordance with the requirements of the local Utility or governing authority. If feasible, make tests when ambient air temperature is approximately constant. Take into account corrections for pressure change due to temperature differential as approved by the Engineer.

.7 Disconnect pumps or compressors used for applying the test pressure, during the test period.

.8 Disconnect and/or remove equipment or specialties not designed to withstand the test pressure during the test and reconnect same after completion of test.

.9 Promptly correct any defects that develop through tests and re-test to the complete satisfaction of the Engineer and other parties involved.

.10 Forward copies of all final tests on all pressure and drainage piping and a copy of governing authority approvals to the Engineer immediately on acceptance of tests and/or approvals.

.11 Final payment for the work will not be made until the above has been received.

3.12 PERFORMANCE TESTING AND BALANCING

.1 Assume responsibility for testing, balancing and placing all air handling and liquid systems in operation, prior to final acceptance in presence and under direction of Engineer. See Section 23 05 93Testing, Adjusting and Balancing for HVAC.

.2 Standard test sheets are appended to this Section. Fill out applicable sheets during performance tests, start-up procedures, and commissioning procedures. Submit electronic pdf copy to Engineer prior to acceptance.

.3 Provide all instruments required to test and balance systems. Install test probe inlets in ductwork and equipment in locations selected by the Engineer. Balance systems in accordance with design requirements indicated on the Drawings. Report to the Engineer immediately any deficiencies in the systems or equipment performance resulting in design requirements being unobtainable.

.4 On completion of testing and balancing of all systems, submit to Engineer a typewritten report (pdf) of findings, including complete data of fan performance, static pressures, air quantities, final readings at all outlets, and ampere readings of all motors, taken at motor terminals when equipment is operating under full load conditions.

.5 Submit with each copy of the report, complete sets of duct layout prints neatly marked in red ink, showing all locations at which test readings were taken, the air volume, velocity and static pressure in each supply and return duct, and the final reading at all outlets. Obtain duct layout prints for mark-up purposes from the Engineer.

3.13 CLEANING, TESTING AND APPROVAL RECORDS

.1 Maintain records of all pressure tests and flushing and sterilization tests, glycol/water concentrations, inspections and approvals by the Plumbing Inspector, etc. and forward these to the Minister on completion of the work. Provide Engineer with copy of records on completion of each test, cleaning operation, etc.

3.14 ADJUSTMENT AND OPERATION OF SYSTEMS

.1 When the work is complete, adjust all equipment items of the various systems for proper operation within the framework of design intent, and the operating characteristics as published by the equipment manufacturer.

.2 Note: Additional instructions are specified under the respective Sections of this Division.

.3 The Engineer reserves the right to require the services of an authorized representative of the manufacturer in the event that any item of equipment is not adjusted properly. Arrange for such services and bear all incurred costs thereof. After completion of adjustments, place the systems in full operating condition and advise the Engineer that the work is ready for acceptance.

3.15 COMMISSIONING

.1 The mechanical contractor shall carry in his tender the cost for all performance testing of equipment and systems in accordance with the Project Specification and manufacturer's recommendations.

3.16 ACCEPTANCE

.1 After all equipment has been installed and adjusted and all systems balanced, conduct performance tests in the presence of the Engineer. Arrange the time for these tests at the convenience of the Engineer. Conduct tests under climatic circumstances to ensure complete and comprehensive tests and of such a manner and duration as the Engineer may deem necessary.

.2 During these tests, demonstrate the correct performance of all equipment items and of the systems they comprise. Should any system or any equipment item fail to function as required, make such changes, adjustments or replacements necessary to meet the performance requirements. Repeat tests until these requirements have been fully satisfied and all systems accepted by Engineer.

3.17 INTERFERENCE & DETAIL DRAWINGS

.1 Prepare and submit for approval, electronic pdf copy of Interference and Detail Drawings, minimum 1/50 scale, to co-ordinate work of this Division with all other Sections.

.2 Make Interference Drawings in conjunction with all parties and trades concerned showing sleeves and openings and passage of piping and ductwork through building structure. Drawings shall also show inserts, special hangers and other features to indicate routing through confined spaces, installation of silencers and other such items in such areas.

.3 Provide 1:25 scale Detail Drawings, fully dimensioned, of piping, ducts and equipment in ceilings. Base equipment drawings on "Reviewed" Shop Drawings and include, but do not necessarily limit to, details pertaining to access, clearances, tappings, sleeves, electrical connections, drains and service spaces and integral control drawings.

END OF SECTION

1 GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 Mechanical General Requirements.

1.2 RELATED SECTIONS

.1 Insulation of ductwork: Section 23 07 13 HVAC Insulation.

1.3 SUBMITTALS

.1 Shop Drawings: Before ordering any insulating materials, submit to the Engineer a list of proposed insulation materials, exterior jackets and adhesive for the various services and equipment on the project. Deviation from the approved list will not be allowed.

.2 Samples: Before ordering any insulation materials, prepare a sample board with a cross-section sample of all types of insulation, including exterior jacket, properly identified for the various services and equipment on the project and state types of adhesives used. After review and acceptance, the sample board will be kept in the 's site office for the duration of the project for reference. Deviation from the accepted samples will not be allowed.

2 PRODUCTS

2.1 DOMESTIC COLD WATER PIPING

.1 Fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K with all purpose APT Jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

.2 Fire retardant elastomeric closed cell foam or neoprene tubing of 10 mm (3/8") nom. thickness may be used instead of fibrous glass insulation on cold water runouts to plumbing fixtures, not exceeding 1.5 m (5'-0") in length, applied in accordance with the manufacturer's printed instructions using the recommended adhesive

Acceptable Products
Armstrong AP/Armaflex
Nomaco Therma-Cel
Rubatex R-1800

2.2 DOMESTIC HOT WATER AND HOT WATER RECIRC SYSTEMS

.1 Fibrous glass split sectional pipe insulation of the thickness hereinafter specified with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

.2 Unburied domestic recirculation and hot water piping: Pre-molded, glass fiber, rigid sectional sleeve type insulation with K factor of 0.23 Btu-in/hr-sq. ft – deg F (0.033 W/m-deg C) at a mean temperature of 75 deg F. (24 deg C) and jacketed with a factory applied reinforced vapor retarder facing having a longitudinal acrylic adhesive closure system. Thickness and application shall be: 25 mm thickness on piping up to 50 mm size, and 38 mm thickness on piping 63 mm and above.

.3 Fire retardant elastomeric closed cell foam or neoprene tubing of 10 mm (3/8") nom. thickness may be used instead of fibrous glass insulation on hot water runouts to plumbing fixtures, not exceeding 1.5 m (5'-0") in length, applied in accordance with the manufacturer's printed instructions using the recommended adhesive.

Acceptable Products
Armstrong AP/Armaflex
Nomaco Therma-Cel

2.3 SANITARY/STORM DRAIN PIPING

.1 Insulate above floor entire run of storm and sanitary drain piping within the building, with fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

.2 Insulate exposed waste pipe of all handicapped lavatories with fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K all purpose with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

2.4 EQUIPMENT DRAIN LINES, SAFETY VALVE VENTS, ETC.

.1 Insulate equipment drains carrying liquids at 38 C (100 F) or higher temperature, and safety valve vent piping to a height of 2.4 m (8 ft.) above any floor, step, catwalk, or platform from which personnel would be within reach of such piping with 25 mm (1") thick insulation.

Acceptable Products

Owens Corning Canada Inc.	850 with ASJ
Manson	Alley K with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200
Knauf	

Acceptable Products Mineral Wool

Owens Corning Canada Inc.	SSL II pipe Insulation
Fibrex Insulations Inc.	Fibrex Coreplus 1200 (metal jacket

.2 Insulate heat pumps condensate pipes with 25 mm piping insulation.

3 GENERAL

3.1 GENERAL

.1 Perform insulation work using qualified insulation applicators, in accordance with latest trade application methods and to the Engineer approval.

.2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean dry surfaces.

.3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.

.4 Do not apply insulation until piping and heat tracing, has been tested, inspected, verified, and accepted.

.5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Extend insulation through sleeves in walls (except fire walls) or other openings in building to make insulation and vapour barrier continuous and of uniform diameter.

.6 Terminate insulation at each side of fire walls and pack the space between wall sleeve and duct or pipe.

.7 Where asbestos-containing insulation has been removed from existing piping, reinsulate (to same extent as removal work) or (to extent as indicated on Drawings). Maintain same thermal value as existing.

.8 Replace insulation removed from existing piping to make tie-in connections with new insulation. Cut back existing insulation a sufficient distance to make a neat and firm butt joint between old and new insulation.

.9 At expansion joints in piping, apply insulation over a sleeve of 1.6 mm (16 gauge) metal, fabricated to fit around expansion joint without restricting its movement. Fabricate sleeve so it can be removed to allow for the repacking and lubrication of expansion joint without damaging the adjoining insulation. Extend sleeves a minimum of 75 mm (3") longer than expansion joint, fit with insulation retaining flanges and with a means of maintaining the position of sleeve over expansion joint.

.10 Where piping is specified to be heat traced, provide oversized insulation to accommodate tracing cable specified in Electrical Specifications.

3.2 INSULATION PROTECTION BEARING PLATES

.1 Each mechanical trade will supply and install bearing plates and temporary spacers at each hanger and support on insulated cold piping or tubing as specified in Section 23 05 29 – Hangers Supports for Piping and Equipment.

.2 Remove temporary spacers and install a section of asbestos-free calcium silicate insulation extending at least 150 mm (6") beyond each end of the bearing plate.

.3 Bond insulation to the bearing plate with Foster 85-20 or Bakor 230-39 or polymer waterproof adhesive and finish and seal the complete assembly with Foster 60-38 or Bakor 130-11 or polymer to form an unbroken vapour barrier.

.4 Reinstall or readjust any hanger or support which has been moved in any way to carry out the above work.

3.3 EQUIPMENT DRAIN LINES AND SAFETY VALVE VENTS

.1 Insulate flanges, valves, and fittings with segments of insulation of the same type and thickness as the insulation on the pipe, secured in place with soft annealed galvanized wire. Finish with Partek Hilcote insulating and finishing cement, and cotton wrapping applied while the cement is still wet.

3.4 HOT AND COLD WATER PIPING

.1 Apply 75 mm (3") wide butt strips of the same material as the factory applied jacket. Seal both longitudinal and butt joint strips with Foster 85-20 or Bakor 230-39 or polymer vapour barrier fire resistive lap sealer, or secure with self seal lap joints where provided.

.2 Insulate fittings, flanges and valves with fibrous glass insulation of same thickness as adjoining pipe insulation and finish with a pre-moulded PVC cover, securely fastened and sealed to adjoining pipe covering with Foster 85-75 or Bakor 230-39 or polymer to form a vapour proof joint.

.3 Do not insulate screwed unions and final connections to fixture.

.4 Terminate insulation at each end of unions with Partek Hilcote insulating and finishing cement, trowelled on bevel.

3.5 STORM AND SANITARY DRAIN PIPING

.1 Build up insulation at joints and fittings with two or more layers of insulation to form an unbroken surface over joint, coupling or fitting.

3.6 SURFACE FINISHES

.1 Cover exposed insulated piping, valves and fittings in Boiler Rooms, Mechanical Rooms, Equipment Rooms, and areas where vehicular traffic, etc. could damage the insulation, with 220 g/m^2 (6 oz.) canvas.

.2 Do not apply canvas to elastomeric closed cell foam or neoprene insulation, and piping which will be concealed or furred in.

.3 Securely paste canvas on with a two coat application of Foster 30-36 or Bakor 120-18 fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tight and smooth with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.

.4 Finish piping, valves and fittings indoors and outdoors insulated with elastomeric closed cell foam or neoprene with a full coating of white acrylic latex as recommended by insulation manufacturer.

.5 Finish all other insulated piping installed outdoors with a field or factory applied metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" or lapped joints and caulked and strapped butt joints secured with sheetmetal screws. Alternatively, finish pipe and fittings with glass fabric and Foster 65-07 or Bakor 110-26 or polymer fire resistive mastic as previously specified. Locate longitudinal joints in the bottom sector of horizontal lines and with laps positioned to shed any moisture.

.6 On single ply roofs extreme care must be taken when applying mastic sealers to piping to ensure that no surplus mastic material remains in contact with the roof membrane. Any accidental spills must be cleaned up immediately. Provide temporary plastic drop sheets to protect roof around work area. Remove drop sheets on completion and clean-up of insulation work.

.7 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.

.8 Finish exposed insulated piping within 2.4 m of finished floor level of clean process areas with an exterior metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" joints and strapped butt joints. Conceal longitudinal joints from view. The metal jacket may be field or factory applied.

END OF SECTION

1 GENERAL

1.1 SUMMARY

.1 Section Includes

.1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 SUBMITTALS

.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 21 05 01.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 21 05 01.

2 PRODUCTS

2.1 PUMPS - GENERAL REQUIREMENTS

.1 The following are minimum construction requirements, unless specified elsewhere.

.2 Pump Casings

.1 Close grained cast iron or cast bronze as specified.
.2 Fitted with casing or impeller wear rings, or both.

.3 Impellers

.1 Enclosed bronze or duralloy.
.2 Dynamically balanced.
.3 Mounted on carbon steel shaft fitted with stainless steel or bronze sleeves.

.4 Seals

.1 Suction pressures less than 640 kPa: fitted with mechanical seals.
.2 Stuffing box pressure in excess of 690 kPa: balanced type seals.
.3 Pumps with packing glands: fitted with stainless steel shaft sleeves for full length of stuffing box.

.5 Performance

.1 Characteristic curve to be continuously rising from run-out to shut-off.
.2 Select pump to operate within flow range from 30% below point of maximum efficiency to 10% above that point for impeller diameter chosen.
.3 Installed impeller diameter not to exceed 90% of maximum impeller diameter catalogued for pump casing.
.4 Motors to be sized for continuous operation without motor overload at runout condition for impeller size and rotational speed selected.

2.2 RECIRC PUMP

1. Provide one Astro (or approved equal) Model 225, 75 Watts, 120 V, recirc pump with H/O/A manual starter.

2.3 SEWAGE PUMP

.1 Provide in floor pit in basement, Zoeller Model M284, duplex with submersible pumps, prewired submersible power cables of length to suit. Pump shall be of capacity of 80 GPM @ 25 feet, 373 KW (1/2 HP) motor, level controller, slide rail, vented power cord and 63 mm discharge. Motor shall run at 208V, 1 phase.

.2 Provide separate high-water alarm for each pit supplied by Pump Manufacturer.

.3 Provide a control panel for pumps and level control. Control panel shall have a disconnect for each pump, electric alternator, intrinsically safe relays, integral circuit breakers, cycle counter, starters, HOA switches and pilot lights. Provide separate alarm units with bell, light and silencing switch for each pump with spare contact. Mount control panel on wall beside pit and install pumps and level switches in pit. Lead pump start switch shall be set 860 mm above pit bottom and lag pump start switch 1060 mm above floor. Pump off switch shall be 560 mm above pit floor. Set alarm to ring at 960 mm above pit floor. Provide additional alarm with bell and silencing switch to initiate alarm when water reaches 100 mm below inlet pipe.

.4 Provide 900 x 2000 deep sewage pit with anti-floating collar heavy duty gas tight cover. Provide vent line to Code.

3 EXECUTION

3.1 INSTALLATION

.1 General

.1 Set in place, and make piping and electrical connections to pumps in accordance with manufacturer's instructions.

.2 Check pump rotation.

.3 Set up and adjust controls.

.4 Pipe drain tapping to drain.

.5 Install gauges at suction and discharge.

.6 Install shutoff valve and pressure gauge above floor.

.7 Provide all wiring to complete the system and make operational.

.2 Recirc Pump

.1 Install with fluid flow direction as indicated by flow arrows on pump body.

.2 Support piping and pump at flanges or near unions on connections to unit.

.3 Install with bearing lubrication points accessible.

.4 Check pump rotation.

.5 Provide recirculation pumps on domestic hot water recirculation lines at H.W. tanks.

.6 Mount pump approximately 1 m above floor. Provide line size gate valve and brass strainer ahead of and gate valve after pump. Provide line size swing check valve on pump discharge between pump and gate valve.

3.2 SEWAGE PUMP

.1 Provide level control wiring from junction box to floats, control box and to each alarm unit. Seal end of conduit at junction box with "Duc-Seal" mastic plug or equivalent.

.2 Provide 63 mm copper discharge pipe from each pump complete with check gate valves and union above floor and connect to each pump with union for easy removal without disturbing other pump.

.3 Provide all wiring from outlet provided by Electrical Division.

END OF SECTION

1 GENERAL

1.1 REFERENCES

.1 ANSI B16.18-[1984], Cast Copper Alloy Lead Free Solder Joint Pressure Fittings.

.2 ASTM B88M-[89], Specification for Seamless Copper Water Tube (Metric).

.3 MSS-SP-80-[1987], Bronze Gate, Globe, Angle and Check Valves.

1.2 PRODUCT DATA

.1 Submit product data in accordance with Section 21 05 01

.2 Submit data for valves.

1.3 MAINTENANCE DATA

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

2 PRODUCTS

2.1 PIPING

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

.2 Above ground: copper tube, hard drawn, type L: to ASTM B88M.

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

2.2 FITTINGS

.1 Cast bronze threaded fittings, Class 125 and 250: to ANSI/ASME B16.15.

.2 Cast copper, solder type: to ANSI B16.18.

2.3 JOINTS

.1 Solder/brazing: lead free silver solder.

.2 Teflon tape: for threaded joints.

2.4 GATE VALVES

.1 NPS 2 and under, screwed:

.1 Rising stem: to MSS SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc.
.2 Acceptable material: Crane, Toyo, Red & White.

2.5 GLOBE VALVES

.1 NPS 2 and under, soldered:

.2 To MSS SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet.
.1 Lockshield handles: as indicated.
.2 Acceptable material: Crane, Toyo, Red & White.

2.6 SWING CHECK VALVES

.1 NPS 2 and under, soldered:

.2 To MSS SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap,regrindable seat.

.3 Acceptable material: Crane, Toyo, Red & White.

2.7 BALL VALVES

.1 NPS 2 and under, soldered:
.1 To ANSI B16.18, Class 150.
.2 Bronze body, chrome plated brass ball, PTFE Teflon adjustable packing, brass gland and [PTFE Teflon] seat, steel lever handle, with NPT to copper adaptors.
.3 Acceptable material: Crane, Toyo, Red & White.

3 EXECUTION

3.1 INSTALLATION

.1 Install in accordance with Building Code local authority having jurisdiction and Manufacturer's requirements.

.2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.

.3 Assemble all piping using fittings manufactured to ANSI standards. Connect water line to existing main serving existing building.

.4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.

.5 Connect to fixtures and equipment in accordance with manufacturer's 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.

.7 Electrically traced new and existing water lines subject to freeze and as noted on drawings.

3.2 VALVES

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

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

3.3 DISINFECTION

.1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction approval of Consultant and Local Plumbing Inspector. Provide laboratory test reports on water quality for Consultant approval.

END OF SECTION

1 General

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 Mechanical General Requirements.

1.2 SUMMARY

.1 Section Includes:

.1 The installation of drainage waste and vent piping.

.2 Sustainable requirements for construction and verification.

1.3 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA B67, Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.

.2 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.

.3 CAN/CSA-B125, Plumbing Fittings.

1.4 QUALITY ASSURANCE

.1 Health and Safety:

.1 In accordance with Section 01 70 12.

2 Products

2.1 MATERIAL

.1 Sustainable Requirements:

.1 Materials and resources in accordance with Section Sustainable Requirements.

2.2 PIPES

.1 Buried:

.1 Buried pipe: cast iron ferrule with inside caulked or spigot connection outlet, seal plug and nickel brass frame and cover suitable for type of floor in which it is to be installed, e.g. tile, terrazzo, carpet, concrete, etc. Provide membrane clamp if installed on membrane floors.

.2 Buried drains laid on approved solid bedding and shall be D.W.V. plastic P.V.C. solvent weld gravity sewer solvent weld pipe (CSA #B182.1) SDR-28 to 150 mm size and SDR-35 for larger sizes, including all interior drainage piping for wall hung urinals. Use same pipe for wall hung urinals.

.2 Above Ground Piping

.1 Cast iron piping in exposed location or in accessible pipe chases: cast iron body with straight threaded, coated plug having a tapered shoulder that seats against a lead seal.

.2 Copper stack piping in exposed locations or in accessible pipe chases: Bronze cleanout tee, bronze ferrule and cover, secured to ferrule by bronze cap screws.

.3 If approved by Authorities having jurisdiction Ipex System XFR-15-50 installed to manufacturer's direction is also acceptable.

.4 Access cover for cleanouts concealed in walls: type to suit wall surface and construction.

.5 Cover for cleanouts at base of vertical sanitary stacks or rainwater leaders: bolted type, neoprene gasket, and brass cap screws or bolt studs, unless shown otherwise on Drawings.

3 Execution

3.1 INSTALLATION

.1 Install in accordance with Ontario Plumbing Code and local authority having jurisdiction. Support all overhead pipes to approval. Provide vent line to each rap and pass thru roof.

.2 Provide vent line to each fixture and trap to Building Code requirement and pass-through roof.

.3 Vent line thru roof shall have very minimum penetrations and not less than 100 mm size. Terminate through roof at preapproved location.

.4 Provide all excavation and backfill required for buried pipes.

3.2 TESTING

.1 Pressure test buried systems before backfilling.

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

.3 Test the system in accordance with the Ontario Building - Plumbing Code and to local Authority requirements.

3.3 PERFORMANCE VERIFICATION

.1 Cleanouts:

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

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

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

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

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

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

END OF SECTION

1 GENERAL

1.1 SUMMARY

.1 Section Includes

.1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 CODES AND REGULATIONS

.1 Conform to the latest edition of the Codes and Standards referenced herein.

.2 Pressure Ratings

.1 Suitable for working pressure as scheduled

.3 Efficiency and Stand-by Loss Ratings

.1 To ASHRAE/IES 90.1

.4 Relief Valves

.1 Temperature, Pressure and Combination: to CAN1-4.4, or ANSI Z21.22

1.3 SUBMITTALS

.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 21 05 01.

.2 Provide certification for compliance to ASHRAE 90.1 for efficiency and stand-by loss ratings.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 00.

2 PRODUCTS

2.1 GENERAL REQUIREMENTS

.1 Water heaters to be factory pre-piped and pre-wired, except where devices are specified to be shipped loose to be installed by others.

2.2 CLOSEOUT SUBMITTALS

.1 Provide maintenance and engineering data for incorporation into manual.

2.3 DHW HEATER

.1 General: packaged unit stamped for 1100 kPa WP.

.2 Capacity: 1.5 KW, 120V/1 PH non simultaneous glass lined tank with 302 litres storage.

.3 T & P relief valve.

.4 Controls:

.1 Fully automatic.

.2 Thermopilot safety with 100% shut-off, adjustable electric high limit control.

.3 Minimum input valve, on-off.

.4 Provide Amtrol ST-12-C expansion tank.

.5 Acceptable material: A.O. Smith, Model DEN-80, Rheem, Bradford White.

2.4 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 EXECUTION

3.1 INSTALLATION

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

.2 Provide valved drain from tank to nearest funnel or hub drain.

.3 Pipe-up T&P relief valve down to floor.

.4 Connect up to cold water supply lines and domestic hot water distribution piping.

.5 Provide thermometer on outlet piping from hot water tank.

.6 Provide all required wiring from outlet provided by Another Section.

.7 Install pneumatic tank at high level on wall to approval.

.8 Provide electric wiring from outlet provided by electrical section.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION

1 GENERAL

1.1 SUMMARY

.1 Section Includes

.1 Labour, products, equipment and services necessary to complete the work of this Section.

1.2 SUBMITTALS

.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 21 05 01.

.2 Operation and Maintenance Data

.2 Submit printed operation instructions and maintenance data in accordance with Section 01 78 00.

1.3 REFERENCE STANDARDS

.1 Reduced pressure type backflow preventers: to CAN/CSA B64 standard series

2 Products

2.1 BACK FLOW PREVENTERS

.1 General

.1 Acceptable Manufacturers:

.1 Watts

.2 Honeywell/Braukmann

.3 Zurn Wilkins

.4 Conbraco

.2 Vacuum Breakers, Pressure Type

.1 To CSA B64.1.2 for back-siphonage, no back pressure.

.2 Working pressure: to 1000 kPa

.3 Working temperature: to 60oC

.4 NPS ½ to NPS 2: Anti-siphon pressure vacuum breaker complete with bronze body and spring loaded single float and disc with independent first check, shut off valves and bronze type test cocks for winterization draining. Springs should be of stainless steel construction.

.3 Reduced Pressure Principle Backflow Preventer Assembly

.1 To CSA B64.4.

.2 Two independent check valves with captured springs, access for maintaining internals, replaceable valve seats, intermediate relief valve, shut-off valves and ball type test cocks.

.3 Working pressure: to 1200 kPa

.4 NPS ½ to NPS 2: complete with quarter turn shut-off valves and bronze strainer.

.5 NPS 2½ to NPS 10: complete with non-rising stem, shut-off gate valves and strainer.

.6 Backflow preventer test kit: pressure gauge, colour coded needle valves and hose, adaptors, replaceable hose filters and valve stem seals, carrying case.

.4 Shock Absorbers

.1 Water hammer arrestor, sized in accordance with P.D.I.-WH201. Products from the following manufacturers are acceptable.

.1 Watts

.2 Zurn Shoktrol

.3 PPP Inc.

2.2 FLOOR DRAINS

.1 Floor Drains: to CSA B79.

.2 Cast iron body square, adjustable head, heavy nickel bronze strainer, integral seepage pan, and clamping collar. Zurn 415-B5-P-G or approved equal.

.3 Combination funnel floor drain; cast iron body with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel. Zurn 416-BF-G-P or approved equal.

.4 In seamless floors, provide suitable heavy duty floor drain with clamping collars. Zurn 415-R6.

.5 Trench Drain: Meadrain EN1500, slopped with F900 slotted heavy duty ductile iron Class F900 loading grate 216 mm deep, 210 mm wide with 150 mm wide grating. Length of trench as per Architectural Drawings.

2.3 CLEANOUTS

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

.2 Access Covers:

.1 Wall Access: face or wall type, 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:

.3 Plugs: bolted bronze with neoprene gasket.

.4 Cover for Unfinished Concrete Floors: nickel bronze square, gasket, vandal-proof screws.

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

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

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

.8 Seamless Floors: Similar to above fitted with surface clamping device.

2.4 PRESSURE REGULATORS

.1 NPS2 and over, semi-steel bodies, Class 125, flanged: to ASTM A126, Class B.

.2 Semi-steel spring chambers with bronze trim.

.3 Set regulator to supply maximum of 80 psi.

2.5 HOSE BIBBS AND SEDIMENT FAUCETS

.1 Exterior non freeze hose bibb shall be anti siphon, automatic draining, flush installation, copper casing, all bronze interior, nickel bronze box, Zurn Z1320 or approved equal.

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

2.6 WATER METERS

.1 Provide 25 mm size water meter with shutoff valves at inlet/outlet and valved bypass line.

2.7 TRAP SEAL PRIMERS

.1 Trap seal primer shall be electric trap seal primer as manufactured by P.P.I. Provide valved water line to each primer from nearest main.

2.8 STRAINERS

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

.2 Bronze body, screwed ends, with brass cap.

2.9 ELECTRIC PIPE TRACING

.1 Electric pipe tracings shall be two rows of Raychem 5XL trace with fluoro polymer c/w thermostat, splice kit seals, cables and other required accessories rated for 120V/1/60. Division 16 to provide outlet only.

.2 Provide 50 mm thick weatherproof insulation with two (2) coats of Flintkote C#29 applied over galvanized wired on and sealed to approval. Apply insulation after pipe tracing is tested.

2.10 SAND INTERCEPTOR PIT

.1 Provide a precast sand interceptor pit with heavy duty gas tight metal cover plate.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install in accordance with provincial codes, and local authority having jurisdiction.

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

3.3 CLEANOUTS

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

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

.3 Building drain cleanout and stack base cleanouts: line size to maximum NPS4.

3.4 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures and to hose bibs.

3.5 BACK FLOW PREVENTORS

.1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code at maximum 1500 mm AFF.

.2 Pipe discharge to terminate over nearest drain and or service sink.

.3 Submit test Certificates.

.4 Provide reduce pressure type backflow preventer at downstream of water meter.

.5 Install reduced pressure type backflow preventers where shown on drawings, in accordance with manufacturers recommendations, and as follows:

.1 Locate reduced pressure principle backflow prevention devices at 1200 mm above finished floor.

.2 Locate vacuum breaker devices exposed as close to fixture connection as possible.

.6 Testing:

.1 Test each unit on site and submit test certificates.

.2 Provide inspection tag on each such device.

.3 Submit test results to Building Plumbing Inspector and Consultant.

3.6 TRAP SEAL PRIMERS

.1 Install for each trap. Provide valved water line from nearest main to each primer.

.2 Trap seal primer install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval.

.3 Install soft copper tubing to floor drain.

3.7 STRAINERS

.1 Install with sufficient room to remove basket.

3.8 WATER METERS

.1 Install water with valved bypass line and a backflow preventer. Comply to local P.U.C. requirements.

3.9 MAKE-UP WATER VALVES

.1 Provide in domestic water lines to heating and cooling systems where shown c/w backflow preventer.

3.10 WATER PRESSURE REDUCING VALVES

.1 Locate in domestic water lines where pressure is more than 552 kPa.

.2 Provide pressure gauge on upstream and downstream side of PRV, complete with pet-cock.

.3 Provide pressure relief valve suitably sized and pipe to drain.

.4 Provide shutoff valves at inlet and outlet.

3.11 SHOCK ABSORBERS

.1 Locate shock absorbers in hot and cold water lines:

.1 At far ends of mains

.2 At branch lines to each flush valve and quick closing valve

.3 At dead ends of branch piping or to groups of plumbing fixtures

.4 At isolated individual plumbing fixtures

3.12 HOSE BIBBS

.1 Mount 1050 mm above finished floor.

.2 Provide a line mounted vacuum breaker selected for continuous pressure.

3.13 WASTE WATER HOLDING TANK

.1 Waste water holding tank is by Another Section. Provide all pipes as noted on drawing.

.2 Provide vent pipe and terminate at 3000 above grade with gooseneck and insect screen.

.3 Seal tight all pipe penetration at tank.

3.14 HIGH WATER ALARM

.1 Install high water alarm as per Manufacturer's direction. Locate float inside tank at level as directed on site.

.2 Provide all wiring from outlet provided by Electrical Section.

3.15 ELECTRIC PIPE TRACINGS

.1 Electrically traced all pipes subject to freeze.

.2 Provide labels stating "Electric Traced".

.3 Install to Manufacturer's direction. Submit confirmation letter from Manufacturer for performance and validity of guarantee.

3.16 SAND INTERCEPTOR PIT

.1 Locate pit at location directed on site.

.2 Provide pit, inlet/outlet pipe and vent pipe for pit.

.3 Provide heavy duty gas tight metal cover for pit.

3.17 START-UP

.1 General:

.1 In accordance with General Requirements.

.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.

3.18 TESTING AND ADJUSTING

.1 General:

.1 In accordance with 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 Adjustments:

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

.2 Make adjustments while flow rate.

.4 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 Provide prime line and vent line to each floor drain trap.

.5 Vacuum breakers, backflow preventers, backwater valves:

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

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

.3 Verify visibility of discharge from open ports.

.6 Access doors:

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

.7 Cleanouts:

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

.8 Water hammer arrestors:

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

.9 Wall, Ground hydrants:

.1 Verify complete drainage, freeze protection.

.2 Verify operation of vacuum breakers.

.10 Pressure regulators, PRV assemblies:

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

.11 Strainers:

.1 Clean out repeatedly until clear.

.2 Verify accessibility of cleanout plug and basket.

.3 Verify that cleanout plug does not leak.

.12 Training:

.1 Training of O&M Personnel, supplemented as specified.

.2 Demonstrate full compliance with Design Criteria.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes

.1 Labour, Products, equipment and services necessary to complete the work of this Section.

1.2 SUBMITTALS

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 21 05 01.

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 00.

2 Products

2.1 PLUMBING FIXTURES

.1 General Requirements

.1 CSA approved plumbing fixtures and fittings, of make, type and size specified herein.

.2 Comply with the current water saving ratings of the Ontario Building Code, and ASHRAE/IEEE 90.1.

.1 Lavatories

.2 Water closets

.3 Flow rates of fixtures as stated in each fixture description in paragraph.

.3 Plumbing supplies and fixture trim material to be of CSA approved plumbing brass with chrome plated finish, and of make and type specified.

.1 Each item to bear name of manufacturer or identifying trademark.

.4 Provide plumbing fixtures shown or noted complete with necessary fittings and escutcheons. Plastic escutcheons are not acceptable. Fixtures and fittings shall conform to C.S.A. B45.1, B45.4 and B125 amended to date.

.5 Verify each fixture with millwork provided by another Section. No extra will be allowed if revisions is required due to millwork provided by another Section. Provide floor support chair carrier for each wall mounted fixture.

.6 VERIFY mounting height of all fixtures with Architect BEFORE ROUGH-IN. Adjust flush valves to provide adequate flush with minimum water. Provide all wiring to electrically operated units from outlets provided by Electrical Division.

.7 Alternate Equipment:

Fixtures
1. Kohler
2. Zurn

Faucet
1. Moen
2. Zurn

Fixture Trim
1. Powers
2. Zurn
3. T&S Brass

Mop Sink
1. Stern Williams
2. Acorn

.8 Lavatory (L-1) – OBC Compliance Handicap
American Standard Murro 0954.000-005.020 with Delta 22C151, 0.5 gpm flow faucet 32 mm C.P. 'P' trap with C.P. 32 mm offset waste fitting with open grid strainer; 10 mm C.P. Teck 47T312 angle supplies with close to wall screwdriver stops and escutcheons. Provide Delta 3070LF mixing valve and supply tempered water to hot side of faucet.
Include matching ceramic shroud to protect drain line.

.9 Water Closet (W-1) – Flush Tank Handicap
American Standard 'Cadet' 2377.100, pressure assist, elongated W.C. bowl complete with brass and rubber floor flanges, bolts, nuts and china bolt caps; vitreous china flush tank with flush fittings, tank liner and float valve; 10 mm C.P. rigid angle supply with screwdriver stop; Centoco #82CC, Olsonite #96CC or Bemis #165 black open front seat with cover with check hinge.

.10 Mop Service Basin (MSB)
Fiat TSB-100 terrazzo mop basin, 610 x 610 x 305 mm deep, complete with stainless steel dome strainer and lint basket; brass drain outlet for 75 mm inside caulk; Watts 909 backflow preventer on each supply, C.P. Delta 28C2384 combination wall mounted faucet with hose outlet and integral vacuum breaker mounted 900 mm above floor; 75 mm 'P' trap under floor. Caulk and seal floor basin to rear wall and floor to approval. Supply 762 mm length of 13 mm rubber hose Model 832-AA on faucet outlet. Include E-77-AA rim guard.

.11 Eyewash-Shower (EW/SH)
Acorn Model S1320-ET71-2-BVS-OTG, eyewash shower, dust cover, mounting brackets.

.12 Sink (S-1)
Franke ALBD6405, 18 gauge, 38 mm P-Trap with cleanout, Delta 26C3222 faucet, stops on supply pipes. Provide Delta 3070LF mixing valve and supply tempered water to hot side of faucet.

3 Execution

3.1 INSTALLATION

.1 Water Flow Rate

.1 Adjust to provide specified water flow rate based on manufacturers calibration data for valve open vs. inlet water pressure.

.2 Install each fixture to Manufacturer's directions. Provide all accessories as required including electric wiring.

.3 Provide trap and vent line to each fixture.

.4 Run all services concealed in wall. Do not run any exposed pipes.

.5 Provide shut-off valves at each inlet and outlet of mixing valves.

.6 Provide drain vent, water to each fixture as per connection schedule.

1. Faucets and water closets.

	Trap	Vent	Cold	Hot
Lavatory	32	32	13	13
Eyewash / Shower	75	38	32	32
Water Closet	75	38	13	-
MSB	75	38	13	13
Floor Drains	50 - 100	38	10	-

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 Mechanical General Requirements.

1.2 RELATED SECTIONS

.1 Conform to Section 23 21 16 Hydronic Systems, Steel.

1.3 SUBMITTALS

.1 Shop Drawings: Prepare and submit Shop Drawings for equipment covered by this Section including upper, middle and pipe attachments, riser clamps, shields and saddles, and sway braces.

PART 2 - PRODUCTS

2.1 GENERAL

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

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

2.2 PIPE HANGERS

.1 Finishes:

- .1 Pipe hangers and supports: painted with zinc-rich paint after manufacture.
- .2 Use electro-plating galvanizing process.
- .3 Ensure steel hangers in contact with copper piping are epoxy coated.

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

- .1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.
  - .1 Rod: 9 mm UL listed.

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

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

.4 Hanger rods: threaded rod material to MSS SP58:

- .1 Ensure that hanger rods are subject to tensile loading only.
- .2 Provide linkages where lateral or axial movement of pipework is anticipated.

.5 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel black.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.6 Adjustable clevis: material to MSS SP69 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

2.3 MISCELLANEOUS STEEL

.1 General

.1 Supply and install miscellaneous structural supports, platforms and braces as may be required to hang or support piping unless Drawings or other Sections of Specifications state otherwise.

.2 Submit detailed Shop Drawings to Engineer for review before commencing fabrication.

.2 Materials and Fabrication

.1 Conform to CAN/CSA-S16 for materials, design of details and execution of work.

.2 Use welded construction wherever practicable, with bolted joints allowed for field assembly using high strength steel bolts. Chip welds to remove slag, and grind smooth.

.3 Conform to latest issue of following CSA Specifications.

CSA W47.1, for qualification of welders
CSA W48.1-M, for electrodes (only coated rods allowed)
CSA W59-M, for design of connections and workmanship
CSA W117.2, for safety

.3 Painting and Cleaning

.1 Touch up minor damage to finish on equipment with standard factory applied baked enamel finish. If, in Engineer's opinion, damage is too extensive to be remedied by touch up, replace damaged equipment.

.2 Clean steel by scraping, wire brushing or other effective means to remove base scale, rust, oil, dirt or other foreign matter.

.3 Apply 1 coat of zinc chromate iron oxide primer, conforming to CAN/CGSB-1.40-M to miscellaneous steel.

.4 In field, touch up bolt heads and nuts, previously unpainted connections and surfaces damaged during erection with primer as herein before specified.

.5 Give 2 coats of primer to surfaces which will be inaccessible after erection.

.6 Remove foreign matter from steelwork on completion of installation.

.7 With exception of prime painting of miscellaneous steel or any other specific requirements as specified under Section 21 05 01 – Mechanical General Requirements, or equipment otherwise factory painted, painting will be provided under Division 9, Finishes.

2.4 CONCRETE INSERTS

.1 Install inserts required for attachment of hangers, either for suspension of piping or equipment.

.2 For masonry or poured concrete construction use expansion type units. Insert into concrete after concrete has cured. Anchors or inserts installed by explosive means shall not be used.

2.5 ACCEPTABLE PRODUCTS

.1 Beam Clamps
Grinnell
Myatt
Hilti

.2 Pipe Hangers:

Grinnell
Myatt
Hilti

PART 3 - EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

.1 Attachment to Building Construction

.1 Use welding studs of size not larger than 10 mm (3/8") for attaching miscellaneous materials and equipment to building steel. If weight of materials or equipment require bolts or studs larger than 10 mm (3/8") dia, use steel clips or brackets, secured to building steel by welding or bolting method of attachment as approved by Engineer.

.2 Use self drilling expansion type concrete inserts for securing miscellaneous equipment and materials to masonry or concrete construction already in place, of sufficient number and size to prevent concrete from breaking away. Use of powder or power actuated fasteners will not be allowed unless prior written approval is obtained from Engineer.

.3 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.

.4 Provide beam clamps of 2-bolt design and of such type that rod load is transmitted only concentrically to beam web centreline. Use of "C" and "I" beam side clamps and other similar items will not be allowed without written consent of Engineer.

.5 Where roof or floor framing consists of open web or long span steel joists, ensure that hangers are located at or within 150 mm (6") of joist top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist spacing. Design suspension assembly such that hanger load is transmitted only concentrically to supporting joist. Do not use "C" and "I" beam side clamps, brackets and other similar, without written consent of Engineer.

3.2 PIPING CONSTRUCTION METHODS

.1 General

.1 Unless specified otherwise herein, construct and install piping in accordance with ANSI Sections B31.1 to B31.9 as applicable to service, except that soldered joints will not be permitted in compressed air piping.

.2 To avoid unnecessary cutting of masonry, provide inserts, sleeves and anchors to other trades for building in as Work proceeds. Arrange with other trades to leave openings, slots and chases to accommodate later installation of mechanical work.

3.3 PIPE HANGERS AND SUPPORTS

.1 General

.1 Support or suspend piping with necessary hangers, structural supports and/or brackets as indicated on Drawings and/or as required, to prevent sagging, warping and vibration and to allow for movement due to expansion and contraction. Place hangers and supports close to fittings, valves and/or other heavy parts.

.2 Do not allow loads of any nature to be transmitted through piping connections to equipment not specifically designed for such loads. Where flexible connections are not called for at connections to equipment, support pipe by stands attached to both pipe and supporting structure so that force in any direction is not transmitted to equipment.

.3 Provide suitably dampened spring hangers for first 3 supports from equipment connection on piping subject to excessive movement or shock from any source, thermal expansion and contraction, selected in accordance with ANSI B31.1. Where it is evident that no undue loads will be transmitted to equipment by system concerned, i.e. small bore connections to comparatively large equipment, cold service piping not subject to shock, etc., then spring hangers may be omitted and standard hangers used.

.4 Use trapeze type hangers where pipes are grouped together, unless specifically indicated otherwise on Drawings. Suspend horizontal member by adjustable rods with locking feature for maintaining level and slope. Space trapeze type hangers based on closest interval required by any pipe supported thereon. Provide any auxiliary steel required to support trapeze between building steel.

.5 Do not hang any pipe from another pipe unless specifically indicated on Drawings.

.2 Hangers

.1 For insulated piping up to NPS 4 carrying liquids at temperatures 10.5 deg C (51 deg F) and higher, use standard weight clevis steel hangers with level adjustment and locknut.

.2 For insulated lines of NPS 4 dia and larger carrying liquids at temperatures 10.5 deg C (51 deg F) or higher, use adjustable roller type hangers with locknuts, and rollers of sufficient width to clear outside diameter of insulation on piping. Support rollers at both ends, either by yoke, swivel type hanger or by 2 adjustable rods with locknuts.

.3 For insulated piping carrying liquids at temperature of 10 deg C (50 deg F) or less, use elongated clevis type steel hangers, with clevis of sufficient width to fit over insulation bearing plate.

.4 Provide insulation protection bearing plates at hangers and supports for piping carrying liquids at temperature of 10 deg C (50 deg F) or less. Install temporary spacers between plate and pipe equal to thickness of insulation specified.

.5 Bearing plates may be either shop fabricated, or manufactured plates of size required to properly fit outside diameter of pipe insulation.

.6 Fabricate bearing plates conforming to following table for various pipe sizes:

Pipe Size (NPS) P	Length of plate mm (in)	Thickness of Plate mm (ga)
13 mm thr. 138 mm	130 (5)	1.2 (18)
50 mm	150 (6)	.52 (16)
63 mm	200 (8)	1.52 (16)
75 mm	230 (9)	1.52 (16)
100 mm and up	250 (10)	1.52 (16)

.7 Form bearing plates to outside diameter of adjoining pipe insulation and extend plate up to horizontal centre line of pipe.

.8 For non-insulated piping use clevis type of wrought steel construction with adjustable rod, level locking feature and backnuts.

.9 For copper tubing provide copper coated hangers. Regulations of some municipalities require that copper tubing be taped with plastic tape at hanger location, or hanger be provided with plastic insert. Meet these requirements when required, in which case copper coating may be omitted on hanger.

.10 Attach hanger rods to building structure by means of malleable iron beam clamps, concrete inserts, and/or approved anchors as hereinbefore specified.

.3 Hanger Spacing

.1 For horizontal runs of plumbing and drainage piping comply with hanger spacing requirements of NBC.

.2 For horizontal runs of black or galvanized steel pipe, other than for plumbing service, do not exceed max distances between supports and with min dia rods as follows:

Pipe Size (NPS)	Distance m (ft)	Dia. of Rod mm (in)
Up thru 32 mm	1.8 (6)	10 (3/8)
38 mm 1.8 (6)	10 (3/8)	
50 mm 3.05 (10)	10 (3/8)	
63 mm & 75 mm	3.66 (12)	12 (1/2)
100 mm	4.27 (14)	16 (5/8)
150 mm	5.18 (17)	19 (3/4)
200 mm	5.79 (19)	22 (7/8)
250 mm & 300 mm	6.71 (22)	22 (7/8)

.3 Provide additional hangers in locations where there are concentrated loads such as valves, specialties and other such items.

.4 For horizontal runs of copper tubing for services other than plumbing, do not exceed 1.8 m (6 ft) between hangers for lines up to and including NPS 3/4 and 2.4 m (8 ft) for lines of NPS 1 and larger.

.5 For horizontal runs of piping fabricated of PVC, use hanger spacing as recommended by manufacturer.

.4 Vertical Piping Supports

.1 Support vertical plumbing and drainage piping as required by OBC, unless more stringent requirements are specified herein.

.2 Support cast iron soil pipe at every floor and other piping at every other floor unless otherwise required by expansion conditions or otherwise specified.

.3 Support bottom of riser with base fitting set on concrete pier or by hanger located at top of riser pipe as close to riser as possible.

.4 For supports at intermediate floors, use Grinnell Fig. 261 or Myatt or Crane steel extension pipe clamp, bolted securely to pipe. Rest ends of clamp on pipe sleeve or on floor.

.5 Provide lateral stability of vertical piping by fabricated brackets or malleable iron, extension type split hangers. Run vertical piping at columns in column webs, on either or both sides of column, unless otherwise directed by Engineer.

.5 Anchors and Guides

.1 Supply and install anchors where indicated on Drawings and/or as required to maintain permanent location of pipe lines. Construct anchors for steel or galvanized pipe of approved steel straps and/or rods and for anchoring copper lines use copper plated anchors or provide insulation bands between tubing and clamps if steel straps or rods are used. Install anchors and guides in approved manner.

.2 Acceptable Materials:

.1 Crinnell
.2 Myatt
.3 Crane
.4 Adsco
.5 Hunt

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General mechanical Requirements.

1.2 RELATED SECTIONS

.1 Heat Pumps Section 23 81 40

.2 Heat Recovery Ventilator Section 23 72 13

1.3 SUBMITTALS

.1 **Shop Drawings**: Prepare and submit shop drawings for all equipment and systems covered in this Section.

.2 Data on vibration isolation devices including physical dimensions, spring data, isolation efficiency based on rigid support points.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

.1 Acceptable manufacturers of noise and vibration control hardware:

1. Vibron
2. Vibro-Acoustics
3. Korfund-Sampson
4. Approved Alternate

2.2 MATERIALS

.1 **General**

1. Furnish all noise and vibration control hardware supplied by a single supplier.

2. Carry out the work in this section in accordance with manufacturer's instructions (and supervision where required) and only by workmen experienced in the installation of such systems.

.2 **Vibration Control**

1. Furnish vibration isolation hardware of the types referred to below, each with detailed specification as outlined separately:

.3 **Isolator Requirements**

1. Ensure that the vibration isolation supplier examines and conforms to the overall requirements for the project in accordance with the requirements specified herein.

2. Take into consideration the RPM of equipment in determining the disturbing frequency on all fans, pumps, compressors, etc.

3. Establish vibration isolation requirements from equipment manufacturers certified shop drawings and performance data.

4. Select spring isolators from the manufacturer's catalogue inventory wherever possible.

5. Should deflection requirements warrant the use of special springs, provide complete design data to the Consultant with the review drawings.

6. Supply hanger type spring isolators with neoprene or composition pads at both ends of the spring.

.4 **Isolating Base**

.1 Provide for evaporative water cooler, Vibro-Acoustic continuous isolation base consisting of galvanized section rails formed to fit equipment with flexible air joining upper and lower rail sections.

.2 Rails shall have cadmium plated stable springs selected to provide 50 mm minimum deflection with 50% additional travel to solid.

.3 Each isolating assembly shall have neoprene cushioned wind restraints which allow 6.4 mm movement before engaging in resisting wind loads in any lateral direction.

.4 Isolation rail assembly shall be shipped assembled.

PART 3 - EXECUTION

3.1 GENERAL

.1 Install all equipment, piping and ductwork in accordance with good noise and vibration control engineering practice and Manufacturer’s installation instructions in order to meet the following requirements:

.2 Noise created by mechanical equipment must not exceed the levels listed below:

<u>Room N.C. Levels</u>

Offices 35
Classroom 35
Labs 35

.3 Vibration created by mechanical equipment must be below the level of perception in all occupied areas of the building.

3.2 NOISE CONTROL

.1 In the selection and installation of equipment, ensure that the equipment does not produce undue amounts of noise and vibration induced noise.

.2 Sleeve all pipes passing through walls or floor within the first 100 times diameter length from a noise/vibration source, with sleeves at least 50 mm (2") larger than the pipe diameter. After installation of the pipe, pack the periphery with Firestop, ULC listed fireproof, or high density mineral wool (greater than 5 lb/cu.ft.) at not more than 50% compression.

.3 Caulk the ends of the packing and seal with non-hardening caulk (with colourpak if weatherproof quality is required).

.4 Similarly, pack and seal all spaces and cracks around ducts passing through Mechanical Room walls or floor, as described above for pipes.

.5 Provide flexible connection between ducts and equipment (HRV Units, Heat Pumps and Exhaust Fans).

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General mechanical Requirements.

1.2 RELATED WORK

.1 Electric Duct Coil: 23 55 01.

.2 Heat Recovery Ventilator: 23 72 13

.3 Heat Pumps: 23 81 40

.4 Hydronic Pumps: 23 21 23

.5 Hydronic Systems Steel: 23 21 16

.6 Thermal Insulation for Piping: 23 07 14

.7 Variable Frequency Drive: 23 53 00

1.3 SUBMITTALS

.1 Shop Drawings

.1 Submit samples and lists of proposed wording for approval before ordering materials or engraving nameplates.

.2 Submit a full list of all services to be labeled and the colour and legend proposed for each service.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MATERIALS

.1 Pipe Labels, Identification Tapes and Tags

Brady
Safety Supply Co.
S.M.S.
Revere-Seton
Approved Alternate

2.2 MANUFACTURERS NAMEPLATES

.1 Provide metal nameplate on each piece of equipment, mechanically fastened complete with raised or recessed letters.

.2 Indicate equipment tag number as indicated on Drawings and equipment size, model, manufacturer's name, serial number, performance rating, voltage, cycle, phase and power of motors.

2.3 EQUIPMENT NAMEPLATES

.1 Provide nameplates for all mechanical and electrical equipment installed under this Division, adequately describing the function or use of the particular equipment involved and including equipment number and equipment name generally as listed on the Drawing Schedules. Submit list of name plates to the Consultant for review. Do not commence fabrication of nameplates until after receipt of Consultant review.

.2 Fit nameplates to electrical equipment, including, but not limited to: motor starters, pushbutton stations, control panels, time switches, disconnect switches, and contactors or relays in separate enclosures.

.3 Furnish nameplates of laminated phenolic plastic with white finish and minimum 10 mm (3/8") high black letters.

2.4 VALVE TAGS & INDEXES

.1 Upon completion of the work, furnish and install a 25 mm (1") dia. brass tag at each valve bearing an Index Number designating the valve. Review valve designation with the Consultant before ordering.

.2 Provide in duplicate, a typewritten directory mounted in a glazed hardwood frame for each system, giving the valve index number, size, make and Cat. No. and the "service" of each valve and the location of the valve.

2.5 PIPE IDENTIFICATION

.1 Label all piping installed under this Division to indicate the content and direction of flow. Include the operating pressure or vacuum, as applicable for piping carrying steam, compressed air or vacuum.

.2 Conform with CGSB 24.3 for primary label colour, and with legend and direction arrows in black. Print legend in full wherever feasible, or a recognized abbreviation of the service involved.

.3 Where outside diameter of pipe (or insulation) exceeds 75 mm (3"). Provide labels with a minimum width of 64 mm (2-1/2") and 50 mm (2") high letters. Where outside diameter of pipe (or insulation) is 75 mm (3") or less, provide labels of 29 mm (1-1/8") width and 25 mm (1") high lettering. Length of labels as dictated by legend.

.4 Provide labels of plastic coated tape with self-adhesive backing surface. For installation on insulated pipe, provide adhesive suitable for this application.

2.6 CONTROLS IDENTIFICATION

.1 Identify all systems, equipment, components, controls and sensors with nameplates of laminated phenolic plastic with white finish and minimum 10 mm (3/8") high black letters.

2.7 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.2 Construction:

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

PART 3 - EXECUTION

3.1 GENERAL

.1 Clean all surfaces before painting or attaching adhesive labels.

.2 Treat any surface which is "dusty" or "chalky" with a sodium silicate solution before application of the labels. After application of labels, apply a clear lacquer, as approved by the Consultant, over the labels, and at least 25 mm (1") beyond perimeter of labels.

.3 Locate nameplates and identification in conspicuous location to facilitate easy reading from operating floor.

.4 Do not insulate or paint over nameplates.

3.2 EQUIPMENT NAMEPLATES

.1 Securely fasten nameplates to the equipment with round-head cadmium plated steel self-tapping screws.

3.3 VALVE TAGS & INDEXES

.1 Attach tags to valve handwheels or operators with a non-ferrous key chain.

.2 Locate framed indexes where instructed by Consultant.

3.4 PIPE IDENTIFICATION

.1 Locate labels as follows:

.1 At every end of every pipe run, adjacent to the valve or item of equipment serviced.

.2 At all valves, tees and changes of direction.

.3 On each exposed pipe passing through a wall, partition or floor (one on each side of such wall, partition or floor).

.4 At intervals of 15 m (50'-0") along every exposed pipe run exceeding 15 m (50'-0") in length.

.5 At every access point on concealed piping.

.2 Locate labels so they are visible from 1.5 m (5'-0") above the adjacent floor or platform.

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.

.3 The work under this Section will be provided and paid for by the Mechanical Contractor.

1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Engineer within 30 days of award of Contract.

.2 Qualifications: personnel performing TAB current member in good standing of AABC and NEBB.

.3 Quality assurance: perform TAB under direction of supervisor qualified to standards of NEBB.

.4 Provide documentation confirming qualifications, successful experience.

.5 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

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

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

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

.9 TAB Standard quality assurance provisions such as performance guarantees form part of this Contract.

.1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.

.2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 PURPOSE OF TAB

.1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

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

1.5 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into Project construction and completion schedule to ensure completion before acceptance of Project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 PRE-TAB REVIEW

.1 Review Contract documents before Project construction is started and confirm in writing to Engineer adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.

.2 Review specified standards and report to Engineer in writing proposed procedures which vary from standard.

.3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

.1 Notify Engineer 7 days prior to start of TAB.

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

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

.4 Application of weatherstripping, sealing, and caulking.

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

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Fire, smoke, volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus 5%, minus 5%.

1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 5% of actual values.

1.12 INSTRUMENTS

.1 Prior to TAB, submit to Engineer a list of instruments to be 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 Engineer.

1.13 SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Engineer, 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 one PDF copy of TAB Report to Engineer for verification and approval, complete with index tabs.

1.16 VERIFICATION

.1 Reported results subject to verification by Engineer.

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

.3 Number and location of verified results as directed by Engineer.

.4 Pay costs to repeat TAB as required to satisfaction of Engineer.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Engineer, 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 Engineer.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of TAB standards of AABC, NEBB and SMACNA.

.2 Do TAB of following systems, equipment, components, controls:

.1 Energy Recovery Unit
.2 Exhaust Fans
.3 Controls

.3 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.

.4 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.

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

.6 Provide systems leakage tests to SMACNA Class 12 requirements.

1.20 HYDRONIC SYSTEMS

.1 Standard: TAB to most string of TAB standards of AABC, NEBB & SMACNA.

.2 Do TAB of following systems, equipment, components, controls

.1 Wallfin Convectors

.3 Measurements to include as appropriate for systems, equipment, components control: water flow rate, pressure drop and temperature, RPM, electrical power, voltage, noise, vibration.

.4 Location of equipment measurement to include as appropriate:

.1 Balancing Valves
.2 Controllers Controlled Devices

.5 Locations of system measurements to include as appropriate:

.1 Main supply pipes
.2 Branch pipes
.3 CBV at each heat pump.
.4 Triple daily value at pumps

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 210501 General Mechanical Requirements.

1.2 RELATED SECTIONS

.1 Ductwork – Low pressure metallic to 500 PA. Section 233114.

1.3 SUBMITTALS

.1 Shop Drawings: Before ordering any insulating materials, submit to the Engineer a list of proposed insulation materials, exterior jackets and adhesive for the various services and equipment on the project. Deviation from the approved list will not be allowed.

.2 Samples: Before ordering any insulation materials, prepare a sample board with a cross-section sample of all types of insulation, including exterior jacket, properly identified for the various services and equipment on the project and state types of adhesives used. Submit the sample board to the Engineer for his review and, after review and acceptance, the sample board will be kept in the Engineer's site office for the duration of the project for reference. Deviation from the accepted samples will not be allowed.

PART 2 - PRODUCTS

2.1 INSULATION ON SHEETMETAL

.1 Apply insulation to the following ductwork systems and components:

.2 Insulate 1800 mm from outlet (louvre, roof cap or roof exhauster) of exhaust ductwork and all fan coil units supply air ducts with organic fiberglass flexible duct insulation of 12 kg/m^3 (3/4 lb/cu.ft.) density, 25 mm (1") thickness, with reinforced foil flame resistant kraft facing. Insulate all ERV supply air duct between unit and electric duct coil similarly.

.3 Insulate ERV unit fresh air duct and exhaust air duct between unit and louvres with two (2) layers of 25 mm thick organic glass fiber 72 kg/m3 density rigid insulating board with reinforced foil faced flame resistant kraft vapour barrier. Insulation shall have 0.03 perm rating minimum.

2.2 FIRE AND SMOKE RATING

.1 In accordance with CAN/ULC-S102:

.1 Maximum flame spread rating: 25.
.2 Maximum smoke developed rating: 50.

2.3 JACKETS

.1 Aluminum:

.1 To ASTM B209 without moisture barrier as scheduled in PART 3 of this section.
.2 Thickness: 0.50 mm sheet.
.3 Finish: Smooth.
.4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.

2.4 ACCEPTABLE PRODUCTS

Manson	Alley Wrap FSK
Fibrex Insulations Inc.	Fibrex IF Flex 1230 FSK
Knauf Fibre Glass	Blanket Insulation with FSK Facing
Johns Manville	Duct Wrap Type 150 Micolite

PART 3 - EXECUTION

3.1 GENERAL

.1 Perform insulation work using qualified insulation applicators, in accordance with latest trade application methods and to the Engineer's approval.

.2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean dry surfaces.

.3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.

.4 Do not apply insulation until ductwork has been tested, inspected, verified, and accepted by the Engineer.

.5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Extend insulation through sleeves in walls (except fire walls) or other openings in building to make insulation and vapour barrier continuous and of uniform diameter.

.6 Terminate insulation at each side of fire walls and pack the space between wall sleeve and duct or pipe as specified in Section 21 05 01.

3.2 SHEETMETAL

.1 Secure insulation on exposed rectangular ductwork with welded impaling pins and speed washer type fasteners at 300 mm (12") centres. Provide a minimum of two rows of fasteners on each side of duct.

.2 In addition to mechanical fasteners, adhere insulation to the duct with Foster 85-20 or Bakor 230-38 fire resistive adhesive applied to the duct in 150 mm (6") wide strips at 450 mm (18") centres. Tightly butt all joints and breaks in insulation and seal with Foster 30-35 or Bakor 130-11 fire resistive mastic and 75 mm (3") wide scrim foil pressure sensitive tape. Cut off protruding ends of welded pins and cover speed washers with same tape to ensure a smooth application of exterior jacket.

.3 Fasten insulation to concealed rectangular ductwork and to both concealed and exposed round ductwork with Foster 85-20 or Bakor 230-38 adhesive, applied in 150 mm (6") wide strips at 300 mm (12") centres. Tightly butt all edges and joints and seal with Foster 30-35 or Bakor 130-11 fire resistive mastic and 75 mm (3") wide pressure sensitive scrim foil tape. Use tying cord only to temporarily secure insulation until adhesive has set. Remove prior to application of exterior jacket.

.4 Insulate access doors or removable panels in ductwork as separate units to permit opening or removal without damage to adjoining insulation.

.5 All fan coil units supply and return ducts will be soundlined.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Section 01 45 00: Quality Requirement.

.2 Section 01 61 00: Product Requirement.

.3 Conform to Mechanical General Requirements Section 210501as applicable.

1.2 RELATED SECTIONS

.1 Hydronic Systems - Steel: Section 23 21 16.

1.3 SUBMITTALS

.1 Shop Drawings: Before ordering any insulating materials, submit to the Consultant a list of proposed insulation materials, exterior jackets and adhesive for the various services and equipment on the project. Deviation from the approved list will not be allowed.

.2 Samples: Before ordering any insulation materials, prepare a sample board with a cross-section sample of all types of insulation, including exterior jacket, properly identified for the various services and equipment on the project and state types of adhesives used. Submit the sample board to the for his review and, after review and acceptance, the sample board will be kept in the 's site office for the duration of the project for reference. Deviation from the accepted samples will not be allowed.

PART 2 - PRODUCTS

2.1 DOMESTIC COLD WATER & NON-POTABLE WATER PIPING

.1 Fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

<u>Acceptable Products</u>

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K with all purpose APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

.2 Fire retardant elastomeric closed cell foam or neoprene tubing of 10 mm (3/8") nom. thickness may be used instead of fibrous glass insulation on cold water runouts to plumbing fixtures, not exceeding 1.5 m (5'-0") in length, applied in accordance with the manufacturer's printed instructions using the recommended adhesive.

Acceptable Products
Armstrong AP/Armaflex Nomaco
Therma-Cel Rubatex R-1800

2.2 DOMESTIC HOT WATER, DOMESTIC HOT WATER RECIRC, BUILDING HEATING SYSTEM AND UNBURIED 40 HEAT PUMP LOOP

.1 Fibrous glass split sectional pipe insulation of the thickness hereinafter specified with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products
Owens Corning Canada Inc. High Temp 1200
Manson Alley K with APT jacket
Fibrex Insulations Inc. Fibrex Coreplus 1200

HOT WATER GLYCOL PIPING – Pipe Insulation Thickness							
Fluid Design Operating	Insulation Conductivity		Pipe Size (mm) and Insulation Thickness (mm)				
Temperature ^{0}C	Conductivity W/m-K	Mean Rating Temp. ^{0}C	<25	25 to <40	40 to <100	100 to <200	>20
>177	0.046-0.049	121	64	76	76	102	102
122-177	0.042-0.046	93	38	64	76	76	76
94-121	0.039-0.043	66	38	38	51	51	51
61-93	0.036-0.042	52	25	25	25	38	38
41-60	0.032-0.040	38	13	13	13	25	25

.2 Fire retardant elastomeric closed cell foam or neoprene tubing of 10 mm (3/8") nom. thickness may be used instead of fibrous glass insulation on hot water runouts to plumbing fixtures, not exceeding 1.5 m (5'-0") in length, applied in accordance with the manufacturer's printed instructions using the recommended adhesive.

Acceptable Products
Armstrong AP/Armaflex
Nomaco Therma-Cel

2.3 SANITARY, STORM DRAIN PIPING & CONDENSATE DRAIN FROM HEAT PUMPS

.1 Insulate above floor storm and sanitary drain piping within the building, with fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

.2 Insulate vertical sections of rainwater conductors between the body of the roof drain and the horizontal section of the pipe in the same way, also any exposed vertical piping in high humidity areas such as locker and shower rooms.

.3 Insulate exposed waste pipe of all handicapped lavatories with fibrous glass split sectional pipe insulation of 25 mm (1") thickness with factory applied vapour barrier jacket and self-seal lap joint.

Acceptable Products

Owens Corning Canada Inc.	High Temp 1200
Manson	Alley K all purpose with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200

2.4 EQUIPMENT DRAIN LINES, SAFETY VALVE VENTS, ETC.

.1 Insulate equipment drains carrying liquids at 38 C (100 F) or higher temperature, and safety valve vent piping to a height of 2.4 m (8 ft.) above any floor, step, catwalk, or platform from which personnel would be within reach of such piping with 25 mm (1") thick insulation. Insulate heat pumps condensate drain lines with 25 mm thick pipe insulation.

Acceptable Products

Owens Corning Canada Inc.	850 with ASJ
Manson	Alley K with APT jacket
Fibrex Insulations Inc.	Fibrex Coreplus 1200
Knauf	

Acceptable Products

Mineral Wool	
Owens Corning Canada Inc.	SSL II pipe Insulation
Fibrex Insulations Inc.	Fibrex Coreplus 1200 (metal jacket

PART 3 - GENERAL

3.1 GENERAL

.1 Perform insulation work using qualified insulation applicators, in accordance with latest trade application methods and to the Consultant approval.

.2 Clean all surfaces to be insulated to remove grime, grease, oil, moisture or other matter to ensure that insulation is applied to clean dry surfaces.

.3 Apply insulation under ambient temperature conditions in accordance with insulation or adhesive manufacturer's recommendations.

.4 Do not apply insulation until piping and heat tracing, has been tested, inspected, verified, and accepted.

.5 Apply insulation neatly and tightly in unbroken lengths and with ends of sections firmly and squarely butted or engaged together. Lap canvas or other specified wrapping over all joints and thoroughly cement down with adhesive. Extend insulation through sleeves in walls (except fire walls) or other openings in building to make insulation and vapour barrier continuous and of uniform diameter.

.6 Terminate insulation at each side of fire walls and pack the space between wall sleeve and duct or pipe as specified in Section 21 05 01.

.7 Where asbestos-containing insulation has been removed from existing piping, reinsulate (to same extent as removal work) or (to extent as indicated on Drawings). Maintain same thermal value as existing.

.8 Replace insulation removed from existing piping to make tie-in connections with new insulation. Cut back existing insulation a sufficient distance to make a neat and firm butt joint between old and new insulation.

.9 At expansion joints in piping, apply insulation over a sleeve of 1.6 mm (16 gauge) metal, fabricated to fit around expansion joint without restricting its movement. Fabricate sleeve so it can be removed to allow for the repacking and lubrication of expansion joint without damaging the adjoining insulation. Extend sleeves a minimum of 75 mm (3") longer than expansion joint, fit with insulation retaining flanges and with a means of maintaining the position of sleeve over expansion joint.

.10 Where piping is specified to be heat traced, provide oversized insulation to accommodate tracing cable specified in Electrical Specifications.

3.2 INSULATION PROTECTION BEARING PLATES

.1 Each mechanical trade will supply and install bearing plates and temporary spacers at each hanger and support on insulated cold piping or tubing as specified in Section 230529 – Hangers Supports for Piping and Equipment.

.2 Remove temporary spacers and install a section of asbestos-free calcium silicate insulation extending at least 150 mm (6") beyond each end of the bearing plate.

.3 Bond insulation to the bearing plate with Foster 85-20 or Bakor 230-39 or polymer waterproof adhesive and finish and seal the complete assembly with Foster 60-38 or Bakor 130-11 or polymer to form an unbroken vapour barrier.

.4 Reinstall or readjust any hanger or support which has been moved in any way to carry out the above work.

3.3 EQUIPMENT DRAIN LINES & SAFETY VALVE VENTS

.1 Insulate flanges, valves, and fittings with segments of insulation of the same type and thickness as the insulation on the pipe, secured in place with soft annealed galvanized wire. Finish with Partek Hilcote insulating and finishing cement, and cotton wrapping applied while the cement is still wet.

3.4 HOT & COLD WATER PIPING

.1 Apply 75 mm (3") wide butt strips of the same material as the factory applied jacket. Seal both longitudinal and butt joint strips with Foster 85-20 or Bakor 230-39 or polymer vapour barrier fire resistive lap sealer, or secure with self seal lap joints where provided.

.2 Insulate fittings, flanges and valves with fibrous glass insulation of same thickness as adjoining pipe insulation and finish with a pre-moulded PVC cover, securely fastened and sealed to adjoining pipe covering with Foster 85-75 or Bakor 230-39 or polymer to form a vapour proof joint.

.3 Do not insulate screwed unions and final connections to fixture.

.4 Terminate insulation at each end of unions with Partek Hilcote insulating and finishing cement, trowelled on bevel.

3.5 STORM & SANITARY DRAIN PIPING

.1 Build up insulation at joints and fittings with two or more layers of insulation to form an unbroken surface over joint, coupling or fitting.

3.6 SURFACE FINISHES

.1 Cover exposed insulated piping, valves and fittings in Boiler Rooms, Mechanical Rooms, Equipment Rooms, and areas where vehicular traffic, etc. could damage the insulation, with 220 g/m^2 (6 oz.) canvas.

.2 Do not apply canvas to elastomeric closed cell foam or neoprene insulation, and piping which will be concealed or furred in.

.3 Securely paste canvas on with a two coat application of Foster 30-36 or Bakor 120-18 fire resistive lagging adhesive over the entire surface. Apply canvas between coats of adhesive, while first coat is still wet. Stretch canvas tight and smooth with overlapping seams located where least visible. Apply second coat of adhesive immediately following application of canvas. Do not use metal bands.

.4 Finish piping, valves and fittings indoors and outdoors insulated with elastomeric closed cell foam or neoprene with a full coating of white acrylic latex as recommended by insulation manufacturer.

.5 Finish all other insulated piping installed outdoors with a field or factory applied metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" or lapped joints and caulked and strapped butt joints secured with sheetmetal screws. Alternatively, finish pipe and fittings with glass fabric and Foster 65-07 or Bakor 110-26 or polymer fire resistive mastic as previously specified. Locate longitudinal joints in the bottom sector of horizontal lines and with laps positioned to shed any moisture.

.6 On single ply roofs extreme care must be taken when applying mastic sealers to piping to ensure that no surplus mastic material remains in contact with the roof membrane. Any accidental spills must be cleaned up immediately. Provide temporary plastic drop sheets to protect roof around work area. Remove drop sheets on completion and clean-up of insulation work.

.7 Seal canvas with off-white sizing to leave a smooth non-porous surface ready to receive paint application.

.8 Finish exposed insulated piping within 2.4 m of finished floor level of clean process areas with an exterior metal jacket of 0.4 mm (26 ga.) aluminum, with longitudinal "snap-lock" joints and strapped butt joints. Conceal longitudinal joints from view. The metal jacket may be field or factory applied.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to General Mechanical Requirements Section 21 05 01 as applicable.

.3 All components shall be compatible with ethylene glycol.

1.2 RELATED SECTIONS

.1 Piping insulation: Section 21 05 01, Thermal Insulation for Piping.

.2 Testing, Adjusting, Balancing and Recording - Section 23 05 93.

1.3 SUBMITTALS

.1 Shop Drawings: Prepare and submit shop drawings for all equipment and systems covered by this Section in accordance with Section 01 33 00 Administrative Requirements.

.2 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

PART 2 - PRODUCTS

2.1 PIPE, FITTINGS & VALVES

.1 For types of pipe, fittings and valves for services in this Section refer to the following Piping Standards attached to Section 21 05 01.

Standard No. 006 Service Water Piping.

2.2 STRAINERS

.1 "Y" type, Class 125 cast iron body strainer with removable monel screen and bolted cleanout plug on flanged strainers and screwed cleanout on screwed strainers. Provide screwed strainers for sizes NPS 2 and smaller and flanged strainers for sizes NPS 2-1/2 and larger.

.2 "Y" type, Class 250 semi-steel body strainer with removable monel screen and bolted cleanout plug on flanged strainers and screwed cleanout on screwed strainers. Provide screwed strainers for sizes NPS 2 and smaller and flanged strainers for sizes NPS 2-1/2 and larger.

.3 Provide strainers in equipment rooms and where shown in other locations, complete with NPS 3/4 blow-off globe valves.

.4 Furnish screen with perforations as follows:

Type of ServiceScreen Perforation (dia)
H.W. Heating1.6 mm (1/16")

.5 Acceptable Products

Spirax Sarco
Armstrong
Streamflo
Colton

2.3 THERMOMETERS & GAUGES

.1 Thermometers shall be Trerice #BX93403-1/2 red reading mercury, 228 mm stem type with cast aluminum case and forged brass separable socket, adjustable angle with brass separable well and plexiglass window, range 0 to 115°C with combined C/F scale. Thermometers shall be compatible with Loopanol-2 and ethylene glycol.

.2 Pressure gauges shall be Trerice #600/C, 114 mm dial with cast aluminum case, phosphor bronze bushed rotary type movement and bourdon tube, black finish case and figures, white face with dampening insert and plexiglass window, range 0 to twice working pressure complete with 6.4 mm brass cock, snubber fitting and combined Metric/Imperial scale. Gauges shall be compatible with Loopanol-2 and propylene glycol.

.3 Alternate Equipment:
1. Baker Instrument Ltd.
2. Winters Thermogauges Ltd
3. Weksler Instruments Corp.
4. Taylor Instruments Ltd.
5. Ashcroft

2.4 AIR VENTS

.1 Approved Manufacturers

Maid-O-Mist No.7
Taco Hy-Vent
Braukmann EA122
Spirax Saveo 13WS
Approved Alternate

2.5 DRAIN VALVES

.1 Provide (13 mm) (1/2") brass sediment faucets with hose thread outlets.

.2 Approved Manufacturers

Crane
Emco
Cambridge Brass
Approved Alternate

2.6 FLEXIBLE PIPING CONNECTIONS

.1 Furnish flexible metal hoses on the piping connections to heating and cooling coils, on the suction and discharge connections to pumps, and in piping systems where shown on the Drawings.

.2 At coils provide Flexonics RW-81 or RW-91 hoses suitable for a minimum working pressure of (1034 kPa) (150 psig).

.3 Furnish flexible hoses up to NPS 2 of braided bronze construction with screwed ends and union nut and nipple. Hoses NPS 2-1/2 and over to be braided stainless steel construction with Class 150 flanges. Furnish the standard hose length for normal industrial vibration.

.4 At pumps provide Flexonics Model BBN hoses up to NPS 2 and BSF on piping NPS 2-1/2 and larger.

.5 Approved Manufacturers

.1 Flexonics
.2 Piping Accessories of Canada
.3 Goodridge
.4 Approved Alternate

2.7 DIAPHRAGM TYPE EXPANSION TANK

.1 Horizontal galvanized steel pressurized diaphragm type expansion tank.

.2 Capacity 38 L.

.3 Size as indicated.

.4 Diaphragm sealed in elastomer suitable for 115 degrees C operating temperature.

.5 Working pressure 860 kPa with ASME stamp and certification.

.6 Air precharged to 84 kPa (initial fill pressure of system).

.7 Saddles for horizontal installation.

.8 Alternate Equipment: Amtrol, Expanflex, Bell & Gossett.

2.8 AIR SEPATOR – IN-LINE

.1 Working pressure 860 kPa.

.2 Size NPS 1 ½.

.3 Alternate Equipment: Armstrong, ITT, Taco.

2.9 COMBINATION LOW PRESSURE RELIEF & REDUCING VALVE

.1 Adjustable pressure setting 206 kPa relief, 55 kP.

.2 Low inlet pressure check valve.

.3 Removable strainer.

.4 Alternate Equipment: Danfoss, Armstrong, Tyco.

2.10 FLOW MEASURING EQUIPMENT

.1 Fittings up to 50 mm size shall be screwed end circuit balancing fitting with shutoff/balancing valve, drain connection and meter connections. Fittings over 50 mm size shall be flanged end circuit balancing fitting with valved meter connection and shutoff/balancing valve. Fittings shall be rated for 862 kPa working pressure.

.2 Provide one (1) portable flow measuring device c/w carrying case, fittings, connections and pre-calibrated.

.3 Alternate Equipment:

.1 Taco
.2 Delta `P' (Air Power Equipment)
.3 Armstrong

PART 3 - EXECUTION

3.1 GENERAL

.1 Applicable requirements specified in Section 210501 form a part of this Section to the same extent as if stated herein in full.

.2 Supply and install all miscellaneous structural supports, platforms, braces and tie-rods as may be required to hang or support all equipment, piping, etc., installed under this Section, in accordance with the drawings and/or as directed by the Consultant.

3.2 GAUGES, THERMOMETERS & TEMPERATURE IMMERSION WELLS

.1 Install pressure gauges and thermometers in all locations shown on drawings or specified. Mount gauges not higher than (2.5 m) (8'-0") from the floor or operating platform.

.2 Install gauges and thermometers as recommended by the manufacturer. Provide isolating petcocks on all pressure gauges.

.3 Fill immersion wells with a high temperature mineral grease prior to insertion of thermal bulb.

.4 Install immersion wells so they do not restrict the flow of liquids in piping. Increase size of piping as required to prevent restriction.

3.3 DRAIN VALVES

.1 Install drain valves at low points of water systems in order to completely drain each system, and also in any other location noted on Drawings.

3.4 FLEXIBLE PIPE CONNECTIONS

.1 Install flexible metal hoses in piping systems where indicated on Drawings.

.2 Firmly supply or guide piping adjacent to flexible connection to prevent pipes from swaying.

3.5 AIR VENTS

.1 Install automatic air vents at high points of glycol piping systems and also in any other location noted on Drawings.

.2 Install automatic air vents with 150 mm (6”) high, line size or NPS 4 size air pocket, whichever is smaller, and NPS ¾ isolating gate valve and piping to inlet connection of air vent.

.3 Connect discharge to nearest funnel or hub drain or as shown on Drawings.

.4 Provide manual air vent in locations noted on Drawings.

3.6 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above nearest drain.

3.7 EXPANSION TANK

.1 Adjust expansion tank pressure to suit design criteria.

.2 Install lock shield type valve at inlet to tank.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General Mechanical Requirements.

1.2 RELATED SECTIONS

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

.2 Section 23 05 29 "Hangers Support for Piping and Equipment".

.3 Section 23 21 14 "Hydronic Specialties".

.4 Section 23 05 54 "Mechanical Identification".

1.3 SUBMITTALS

.1 Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

.2 Welding Certificates: Copies of certificates for welding procedures and personnel.

.3 Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

.1 Test procedures used.
.2 Test results that comply with requirements.
.3 Failed test results and corrective action taken to achieve requirements.

1.4 QUALITY ASSURANCE

.1 Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

.2 ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

1.5 COORDINATION

.1 Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, fire-suppression-system components, and partition assemblies.
.2 Coordinate pipe sleeve installations for foundation wall penetrations.

.3 Coordinate pipe fitting pressure classes with products specified in related Sections.

.4 Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

.5 Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

.1 Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

.2 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

.1 Grooved Mechanical-Joint Fittings and Couplings:

1. Central Sprinkler Company; Central Grooved Piping Products.
2. Grinnell Corporation.
3. Victaulic Company of Canada.
4. Approved Alternate.

.2 Calibrated Balancing Valves:

1. Armstrong Pumps, Inc.
2. ITT Bell & Gossett; ITT Fluid Technology Corp.
3. Taco, Inc.
4. Approved Alternate.

2.2 PIPING MATERIALS

.1 General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 STEEL PIPE & FITTINGS

.1 Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless) or Type F (furnace-butt welded), Grade B, Schedule 40, black steel, plain ends.

.2 Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.

.3 Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

.4 Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

.5 Grooved Mechanical-Joint Fittings (sprinklers only): ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47, Grade 32510 malleable iron; ASTM A 53, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings.

.6 Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

.7 Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

.8 Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

.9 Victaulic fittings may be used.

2.4 VALVES

.1 Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."

.2 Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

2.5 REFRIGERANT PIPING

.1 ACR hard copper with wrought copper fittings.

.2 Joints shall be made with lead-free solder 95/5.

.3 Vibration isolator on each pipe to DX coil and condensing unit.

.4 R410A refrigerant or latest approved type.

.5 All welded joints to be completed using continuous nitrogen flush.

.6 Thermal expansion valve and solenoid valve for each circuit.

.7 Pressure gauge connection on inlet to each compressor, condenser and evaporative coil.

.8 Drain pipe of Type ‘M’ hard copper with solder fittings for each fan coil unit.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

.1 Hot Water, NPS 2 and Smaller: Aboveground, use Schedule 40 steel pipe with threaded joints.

.2 Condensate Drain Lines: Schedule 40.

3.2 VALVE APPLICATIONS

.1 General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

.1 Shutoff Duty: Ball, and butterfly valves.
.2 Throttling Duty: Globe, ball, and butterfly valves.

.2 Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

.3 Install calibrated balancing valves in the return water line of each heating element and elsewhere as required to facilitate system balancing.

3.3 PIPING INSTALLATIONS

.1 Refer to Division 210501 Section "General Mechanical Requirements" for basic piping installation requirements.

.2 Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

.3 Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

.4 Install piping at a uniform grade of 0.2 percent upward in direction of flow.

.5 Reduce pipe sizes using eccentric reducer fitting installed with level side up.

.6 Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

3.4 FIELD QUALITY CONTROL

.1 Prepare hydronic piping according to ASME B31.9 and as follows:

.1 Leave joints, including welds, uninsulated and exposed for examination during test.

.2 Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

.3 Flush system with clean water. Clean strainers. Clean system prior to filling.

.4 Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

.2 Perform the following tests on hydronic piping:

.1 Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

.2 While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.

.3 Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."

.4 After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

.5 Prepare written report of testing.

3.5 CLEANING

.1 On completion, clean complete heating using Dearborn #11 or equal cleaner for at least 48 hours at 20oF. Flush out each system, opening and cleaning each scale pocket and strainer. System must be flushed out before filling with clean water and Dearborn #545 molybdate corrosion inhibitor at 90 ppm.

.2 Provide written report to Consultant when cleaning is completed. Advise Consultant at least 48 hours prior to cleanout so same can be witnessed.

.3 The supplier of the chemical treatment equipment and chemicals will supervise the entire cleaning and flushing operation of all the systems.

.4 The supplier shall ensure the following:

.1 All systems are flushed of all sand, gravel and fillings before cleaner is added.

.2 The proper strength of cleaner is added and circulated for the prescribed time.

.3 Each system is thoroughly flushed again before chemicals are added.

.4 The proper dosage of chemicals is added.

.5 Cartridge filters are replaced at the proper intervals.

.5 Provide written report to Consultant when cleaning is completed. Advise Consultant at least 48 hours prior to cleanout so same can be witnessed.

.6 Acceptable Products:

.1 Drew Chemical Co.
.2 Finnan Eng. Products Ltd.

3.6 REFRIGERANT PIPING

.1 After completion of refrigeration piping installation, test each piping system under nitrogen for leaks. Repair any leaks detected. Evacuate each system three times by vacuum pump to 508 mm Hg. Each system shall hold same for 24 hours without decrease in vacuum. Upon completion of testing and dehydration process, each system shall be charged with refrigerant. Halo Carbon inventor forms shall be completed.

.2 Provide all wiring necessary to complete each system including controls and inter-wiring to condenser units and DX coil solenoid valves and hot gas bypass controls.

.3 Provide complete start-up service and instruct Building Operators in care and maintenance of DX type Air Conditioning System. See 210501 – General Mechanical Requirements – Instructions to Operator.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to General Mechanical Requirements Section 21 05 01 as applicable.

1.2 RELATED SECTIONS

.1 Noise and Vibration Control: Section 23 05 48

.2 Temperature Controls: Section 25 90 00

.3 Mechanical Identification: Section 23 05 54

1.3 SUBMITTALS

.1 Shop Drawings
- .1 Prepare and submit complete shop drawings in accordance with Section 01 78 00 Administrative Requirements.
- .2 Indicate equipment including connections, fittings, control assemblies and ancillaries, and identify factory and field assemblies.

.2 Maintenance Data
- .1 Provide maintenance data for incorporation into manual specified in Section 013000 Administrative Requirements.

PART 2 - PRODUCTS

2.1 VERTICAL INLINE PUMPS

.1 Furnish hot water heating pumps of capacity, size, and electrical characteristics indicated on Drawings.

.2 Furnish "in-line" type circulators with oval or round flanges matching threaded companion flanges and direct connected through a flexible connection to motor.

.3 Furnish all-bronze construction circulators, with alloy steel shaft, oil-lubricated bronze sleeve bearings, and mechanical seal.

.4 Each vertical inline pump shall be Armstrong Series 4300, Split Coupled Type Vertical In-Line Centrifugal pumping unit. The pumps shall be radially split, single stage centrifugal type with BF (Bronze Fitted) casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections, Bronze dynamically balanced impeller, stainless steel shaft, lower carbon throttle bushing, Outside balanced type mechanical seal with Carbon rotating face, Ceramic stationary seat and Viton secondary seal.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner. The squirrel cage induction type, P-base, with ODP enclosure and shall be connected to the pump through a high tensile aluminum, split type spacer coupling to permit Servicing of the mechanical seal without disturbing pump, motor or electrical wiring. Coupling shall be protected by a guard.

.5 Acceptable Manufacturers
- .1 S.A. Armstrong
- .2 Taco
- .3 Patterson

PART 3 - EXECUTION

3.1 GENERAL

.1 Install work of this Section to applicable requirements of Section 21 05 01.

3.2 PUMP INSTALLATION

.1 Set pumps in place, align, connect and place in operation with:

Controls set for efficient, stable operation.

Connections and required safety devices installed.

.2 Protect pumps from damage during and after installation, and on completion of work ensure that equipment is free from cracks, scratches, discolorations, tool marks, and other defects. Thoroughly clean finished surfaces before acceptance of work.

.3 Support pumps independent of piping such that no loads are transmitted to pumps.

.4 Install suction guides and strainer at the inlet and triple duty valve at the outlet of each pump.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to General Mechanical Requirements: Section 21 05 01 as applicable.

.3 All components shall be compatible with ethylene glycol.

1.2 RELATED SECTIONS

.1 Thermal Insulation for Piping: Section 23 07 14

.2 Testing, Adjusting, Balancing and Recording - Section 23 05 93.

1.3 SUBMITTALS

.1 Shop Drawings

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

.2 Operation and Maintenance Data

.1 Submit printed operation instructions and maintenance data in accordance with Section 01 78 00.

.2 Submit information for incorporation in operating manual for each internal water treatment system. Include schematic drawings, data sheets for equipment, and step by step instructions for testing procedures.

PART 2 - PRODUCTS

2.1 OUTLINE DESCRIPTION

.1 General

.1 Provide packaged chemical control systems as described herein.

.2 Systems to be complete with chemical drums, pre-mixed chemical solutions.

.3 Acceptable Manufacturers:

.1 Rochester Midland Corp. (RMC)
.2 WMC
.3 Guardian Chemicals
.4 Glengarry Chemicals
.5 General Filtration Chemicals Co.
.6 Approved Alternate

2.2 HEAT PUMP SYSTEMS

.1 Heat Pump Loop Water Treatment

.1 Corrosion control equipment and chemicals are required for each of following closed circuit cooling systems:

.2 System Data:

Type of System:	Closed / Recirculating
Recirculation Rate, L/s	18.9
Temperature Range:	12°C to 35°C
Estimated System Volume, Litres	2000
Chemical System Type	Pot Feeder

.3 Provide equipment for *EACH* of above noted systems.

.2 Chemical System Type

.1 Pot feeders:

.1 45 litre capacity, cast steel.

.2 Working pressure: 550 kPa.

.3 Working temperature: 55°C.

.4 Fitted with cartridge type filter for filtrate quality of 20 microns.

Sized to handle 5% of pump capacity.

.3 Supply following chemicals in addition to those used for cleaning systems:

.1 Cleaner - for each Recirculating System, two 23 Litre Pails of CSW.

.2 Chemical for Closed Systems

- Five 20 litre pails of nitrite corrosion control chemicals.
- Drew Type `S' Test Cabinet with light and lock.
- Nitrite Test Kit (#2508).

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 HVAC water treatment systems in accordance with ASME Boiler Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.

.2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.3 CHEMICAL FEED PIPING

.1 Install crosses at changes in direction. Install plugs in unused connections.

3.4 CLEANING & FLUSHING OF MECHANICAL SYSTEM

.1 On completion, clean complete H.T and heat pump system using Ferroquest 345 or equal cleaner for at least eight hours at 37.8ºC. Flush out each system, opening and cleaning each scale pocket and strainer. System must be flushed out before filling with clean water.

.2 If in-line circulators are used during cleaning and flushing, provide new seals on same afterwards. Ensure flushing line on base mounted pump seals are operating during cleaning flushing, when pumps are on. Division 23 shall replace all pump seals which become defective during the one year guarantee period, at NO COST to Owner.

.3 During cleaning operation, heat pump units shall be disconnected and their hose connections used to bypass water around each unit. Operate heating boilers to maintain 30ºC system water temperature in systems. DO NOT EXCEED 43 C. See heat pump manufacturers printed instructions for further information and guidance.

.4 Install evaporative water cooler treatment system as described providing piping, valves, supports and accessories not supplied by manufacturer. Arrange for start-up, instruction period and put system in proper, safe, efficient operating condition.

.5 The supplier of the chemical treatment equipment and chemicals will supervise the entire cleaning and flushing operation of all the systems.

.6 The supplier shall ensure the following:

.1 All systems are flushed of all sand, gravel and filings before cleaner is added.
.2 The proper strength of cleaner is added and circulated for the prescribed time.
.3 Each system is thoroughly flushed again before chemicals are added.
.4 The proper dosage of chemicals is added.
.5 Cartridge filters are replaced at the proper intervals.

.7 Provide written report to Consultant when cleaning is completed. Advise Consultant and Owner at least 48 hours prior to cleanout so same can be witnessed.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Mechanical General Requirements - Section 21 05 01 as applicable.

1.2 RELATED SECTIONS

.1 Ductwork Insulation: Section 23 07 13.

.2 Ductwork accessories: Section 23 33 00.

1.3 SUBMITTALS

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Indicate design, construction and relevant details of sealant, tape and propriety joints.

PART 2 - PRODUCTS

2.1 SHEET METAL WORK - GENERAL

.1 Furnish sheet metal work in accordance with material Specifications and construction details specified herein, and conforming to standard and recommended practices as defined by SMACNA Duct Construction Standards.

.2 Furnish all ductwork constructed to SMACNA 2" w.g. pressure classification, unless noted otherwise on Drawings.

.3 Furnish ductwork of galvanized steel sheet with Z-275 (G90) or ZF075 (A25) designation zinc coating to ASTM A653/A653M.

.4 Furnish ducts of sizes shown on Drawings. For acoustically lined ducts, adjust duct size to accommodate liner thickness, with clear inside dimensions as shown on Drawings.

.5 Fabricate ductwork free from vibration, rattle or drumming under operating conditions. Furnish necessary reinforcements, bracing, framing, gasketing, etc. to comply with performance criteria.

.6 Continuously solder or seal joints in exterior air intake duct to prevent dripping of moisture through joints. Furnish 38 mm (1-1/2") drain flange in low point of such ductwork.

.7 Furnish sleeves at duct penetrations through walls and floors, fabricated from same material and thickness sheet material as for ductwork. Furnish closure plates each side of wall to cover sleeve.

.8 Furnish flanged joints and gaskets of neoprene or other resilient non-flammable for duct connections to AC units, coils, etc. Fabricate flanges from mild steel angles to match equipment flanges.

.9 Furnish screens of 13 mm (1/2") mesh x 2.7 mm (0.105") diameter galvanized wire for air intakes, exhausts and open ends of ductwork.

.10 Rectangular Ductwork Type I - Low Pressure - Medium Pressure

.1 Fabricate rectangular ductwork to metal thickness and construction methods as specified herein for various size ranges of ducts. Given dimensions represent widest side of duct.

Galvanized Steel Gauges and Equivalent Thicknesses

Gauge (gsg)	mm	Low Pressure	Medium Pressure	Slip
26	0.49 mm	Up to 300 mm		
24	0.64 mm	330 - 762 mm	Up to 457 mm	Up to 762 mm
22	0.84 mm	787 - 1372 mm	483-1219 mm	787-1524 mm
20	0.94 mm	1397-2134 mm	1245-1829 mm	1549 mm and over
18	1.24 mm	2134 mm and over	1854 mm and over	

.11 Supports and Hangers - Rectangular Ductwork

.1 Except where shown otherwise on Drawings, Furnish strap hangers of 3 mm x 25 mm (1/8" x 1") mild steel bar stock for ducts up through 760 mm (30") width. Bend strap hanger around bottom of duct for a minimum of 38 mm (1-1/2") and attach to sides and bottom of duct. Furnish mild steel rod hangers of 10 mm (3/8") dia. minimum size for ducts over 760 mm (30") in width and furnish 38 mm x 38 mm x 3 mm (1-1/2" x 1-1/2" x 1/8") steel angle across bottom of duct and attach hanger to angle (not the duct).

.12 Kitchen Hood exhaust ducts shall be 16 gauge welded steel in compliance with NFPA #96.

.13 Pool supply and return ducts and change rooms exhaust ducts shall be made of aluminum of the following thickness:

Longest Side	Aluminum mm – Gau.
Up to 300 mm	0.51 – 24
301 to 750 mm	0.65 – 22
751 to 1375 mm	0.81 – 20

.14 Provide where shown, flexible air duct hoses. Secure hose to metal ducts with attachment screws and band clamps and tape seal with Permascreen fiberglass duct tape. Minimum length 25% longer than measured distance. Maximum length 50% more than measured length (max. 2 m). Provide manual balancing damper in trunk duct at connection to each flexible duct. Balancing dampers shall be opposed blades TAMCO 1000, Ruskin or E.H. Price c/w access door. Provide TAMCO 1000 dampers on all fresh air branch ducts connected to heat pumps or supplied to Classrooms.

.15 Sound jacketing: Provide Barymat BM-1C noise control composite around supply and return ducts from the equipment and all the way to the point the duct leaves or enters the Mechanical Room.

2.2 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
500	C
250	C
125	C

.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.
.3 Class C: transverse joints and connections made air tight with sealant.
.4 Unsealed seams and joints.

2.3 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.

2.4 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.5 DUCT LEAKAGE

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

2.6 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.
.1 Rectangular: standard radius short radius with single thickness turning vanes Centreline radius: 1.5 times width of duct.
.2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm: with single double thickness turning vanes.
.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with radius on branch 1.5 times width of duct 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: 30 degrees maximum included angle.

.6 Offsets:

.1 Full short radiused elbows as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07840 - Firestopping.

.2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA proprietary manufactured duct joint. Proprietary manufactured flanged duct joint to be considered to be a class A seal.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

.1 Refer to and comply with applicable requirements specified in Section 21 05 01.

.2 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support ductwork as specified herein, and as shown on Drawings.

.3 Install ductwork in arrangement shown on Drawings in accordance with standards and recommended practices off ASHRAE and SMACNA. Provide required offsets and transitions, whether specifically indicated or not, to facilitate duct arrangement and to avoid interference with building structure, piping, equipment and services.

.4 Install ductwork in locations and at elevations appropriate to ceiling height shown on Drawings. Where required to be concealed, install ductwork in furred spaces provided in walls and ceilings. Where there is no provision for concealed ductwork, install as close as possible to walls, partitions and overhead structures to attain maximum headroom and clearance.

.5 Install sleeves where ducts pass through walls or floors. Pack space between duct and sleeve with mineral wool and seal both ends with non-inflammable fire resistant sealing compound. Install sheet metal closure plates on each side of wall to cover sleeve.

.6 At air intakes, exhausts and open ends in ductwork install removable galvanized screens securely fastened in place.

.7 Install gasketted flanged joints at duct connections to air conditioning units, coils, etc.

.8 Install beam clamps or supplementary steel to secure hanger rods, angles and straps to structural steel framing.

.9 Where shape of duct changes, install transition piece so that angle of side of transition piece does not exceed 15 degrees from straight run of duct being connected, unless shown otherwise on Drawings.

.10 In office areas paint interior of ductwork for at least 600 mm (24") behind supply and exhaust grilles with matte black paint so as to render ductwork invisible from occupied space.

.11 In areas having high humidity, slope exhaust ductwork up away from register and without seams in bottom of duct for at least 3 m (10'-0") of duct run behind register.

.12 Slope fresh air intake ducts down at 1:100 to permit moisture induced by air intake to be drained. Install 38 mm (1-1/2") drain flange in bottom of duct at low point and run drain line to nearest floor drain or as noted on Drawings.

3.2 SUPPORTS AND HANGERS – RECTANGULAR DUCTWORK

.1 Install supports and hangers at intervals not over 2400mm (8'-0") centres for ducts up to 1500 mm (5'-0") in width and at 1200 mm (4'-0") centres for ducts 1500 mm (5'-0") in width and over.

.2 Install miscellaneous steel angles or channels as required between joists or building steel for structural support of duct where building framing spacing does not coincide with the required hanger spacing.

3.3 CLEANING AND TESTING OF DUCTWORK

.1 Inspect and test ductwork for air leakage at joints and connections to equipment, under normal operating conditions. Provide systems leakage tests to SMACNA Class 12 requirements.

.2 Test ductwork before ducts are insulated, painted or concealed.

.3 Immediately correct defects discovered during tests and retest systems to complete satisfaction of Engineer.

.4 Prior to start-up of fans, blow out complete systems of ductwork with high velocity air for not less than two hours using where possible the installed air handling equipment to full capacity and by blanking off duct sections to achieve required velocity. Do not install air filters prior to blow- out of ductwork systems. Use auxiliary portable blowers for cleaning where installed fan systems are not adequate to blow out complete system free from dust and dirt.

.5 After duct systems have been blown out, clean register, grille or diffuser outlet collars with industrial type vacuum cleaner. On completion of cleaning process, install filters before placing systems in final operation.

3.4 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.

3.5 LEAKAGE TESTS

.1 In accordance with SMACNA HVAC Duct Leakage Test Manual and SMACNA Class 12.

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.6 Complete test before performance insulation or concealment Work.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Mechanical General Requirements Section 21 05 01 as applicable.

1.2 RELATED SECTIONS

.1 Noise and Vibration Control: Section 23 05 48.

.2 Ductwork Insulation: Section 23 07 13.

1.3 SUBMITTALS

.1 Shop Drawings: Prepare and submit Shop Drawings for all equipment and systems covered by this section.

.2 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

.3 See Sections 01 33 00 and 01 78 00.

PART 2 - PRODUCTS

2.1 FLEXIBLE DUCT CONNECTIONS

.1 Furnish flexible duct connections between fans and/or air handling units and connecting ductwork, between unit components, in ducts at building expansion joints, and in other locations shown on Drawings.

.2 Furnish flexible connectors of heavy glass fabric double coated with neoprene and attached to 0.6 mm (24 ga) metal strips 75 mm (3") wide. Furnish flexible connectors with length of fabric between metal strips of minimum 75 mm (3") for ducts of maximum size in either dimension or diameter of 750 mm (30") or less, and 150 mm (6") for ducts of 775 mm (31") size and larger.

Acceptable Manufacturers

Duro-Dyne	"Grip-Loc Type SMFN"
Ventfabrics	"Ventglas"
Hardcast	

2.2 BALANCING DAMPERS

.1 Furnish balancing dampers, manually operated opposed blade type, splitter type, or butterfly blade type, fabricated from galvanized steel sheet of thicknesses specified herein and complete with standoffs and extensions to permit for installation of insulation on the damper.

.2 Furnish factory built opposed blade type balancing dampers, with galvanized channel type frames, non-binding pre- lubricated type linkage, and blades fabricated of minimum 1.6 mm (16 ga) core thickness material. Furnish damper blades of 200 mm (8") maximum width, and of length coinciding with frame opening on horizontal plane to maximum length of 1200 mm (48").

.3 Furnish opposed blade balancing dampers complete with inter-connecting linkage, manual operator and locking type quadrant as required for synchronous operation and setting of blades.

.4 Except where shown otherwise on Drawings, furnish splitter dampers in supply and return ductwork where main ducts are split into two more trunks, and at branch duct connections to main or trunk ducts. Fabricate splitter dampers from same material and thickness as ducts in which they are to be installed, down to minimum of 0.8 mm (22 ga). Furnish splitters formed of double thickness of metal and with rounded surface at air entering edges. Furnish length of splitter at least 1-1/2 times width of smaller branch duct, but in no case less than 300 mm (12"). Provide splitter dampers with locking type quadrant.

.5 Furnish butterfly blade balancing dampers for round ducts (other than fume exhaust system) fabricated of 1.6 mm (16 ga) metal and with locking type quadrant.

2.3 VOLUME EXTRACTORS

.1 Acceptable Manufacturers: Titus, Nailor Hart, Kruger.

.2 Furnish extractors with #3 manual operator and mounting bracket, where noted on Drawings.

2.4 FIRE DAMPERS

.1 Acceptable Manufacturers: Controlled Air, Ruskin, Advanced Air.

.2 Furnish fire dampers of hinged, fusible link type with channel frames, blades and housing, ULC labeled and conforming to NFPA 90A requirements. Furnish "Type B" fire dampers for rectangular or square ductwork and "Type C" fire dampers for round ductwork.

.3 Furnish fire dampers and frame constructed of same material as duct in which they are installed.

2.5 ACCESS DOORS IN DUCTWORK

.1 Furnish access doors in ductwork and for plenums to allow servicing, maintenance, and inspection of control dampers, fire detectors, both sides of fire dampers, control elements, bearings and as shown on Drawings. Furnish access doors at least 300 mm x 150 mm (12" x 6") unless duct dimensions prevent, or as required. Where motors are installed within unit or duct, furnish access door large enough to permit removal of same.

.2 For installation in insulated ductwork and plenums, furnish access doors of 0.8 mm (22 ga) thick galvanized steel sheet double panel construction with approved 25 mm (1") thick insulating filler, in flanged collar flush with face of finished insulation.

.3 Furnish access doors for installation in uninsulated ductwork and plenums from 18 gauge (1.2 mm) galvanized steel sheet, with door frames welded in place.

.4 Furnish access doors in air conditioning and ventilation systems with heavy continuous hinges, three heavy sash fasteners and sponge neoprene gaskets to ensure air-tight fit at operating pressure.

2.6 PROBE INLETS

.1 Furnish probe inlets with Ventlok No. 699 or Duro-Dyne IP-1 or IP-2 or Ductmate Test Opening Enclosures complete with locking cap, chain, gaskets, insulating plug, and extensions for insulated ductwork.

.2 Furnish probe inlets in main supply and return ducts, inlet and outlet side of fans, and other locations as required by Testing and Balancing Trade, to permit testing, balancing and measurement of air quantities and static pressure in air handling systems.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.

.2 Flexible Duct Connections

.1 Install flexible connectors with fabric in folds, not drawn tight.

.2 Install guides to prevent flexible connection from collapsing on suction side of fans.

.3 For installation between sections of air handling units, install flexible connectors suitable for connecting to flanges of casings where so provided.

.3 Balancing Dampers

.1 Install dampers at locations in supply and return ductwork where main ducts are split into two more trunks, and at branch duct connections to main or trunk ducts.

.4 Fire Dampers

.1 Install fire dampers in accordance with suppliers instructions, complete with retaining angles on both sides of wall or floor and fastened to damper collars.

.2 Install fire dampers complete with adjacent access door as required to permit re-opening of damper and replacement of fusible link.

.5 Relief Dampers: Install steel angle or channel frames at wall openings as required to mount relief damper (complete with fire damper) as shown on Drawings.

.6 Access Doors in Ductwork

.1 Install access doors in ductwork and in plenums to allow servicing, maintenance, and inspection of control dampers, fire dampers, fire detectors, control elements, bearings and as shown on Drawings.

.7 Probe Inlets

.1 Install probe inlets in ductwork at locations as specified under Part 2 - Products.

.2 Locate probe inlets sufficient distance from elbows or transition sections to ensure stable readings of non-turbulent air and install 75 mm (3") from corners and at 150 mm (6") centres across long side of duct.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Section 21 05 01 Mechanical General Requirements.

1.2 SUMMARY

.1 Section Includes:

.1 Metallic insulated.

.2 Materials and installation of flexible ductwork, joints and accessories.

1.3 RELATED SECTIONS

.1 Section 23 33 00 – Ductwork Accessories.

.2 Section 23 37 13 – Diffusers, Registers and Grilles

1.4 SUBMITTALS

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

.1 Product Data: submit WHMIS MSDS for the following:

.1 Thermal properties.

.2 Friction loss.

.3 Acoustical loss.

.4 Leakage.

.5 Fire rating.

.2 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01330 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 METALLIC - SOUNDLINED

.1 Spiral wound flexible aluminum with factory applied, 37 mm thick soundlined glass fibre with vapour barrier and vinyl 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 DUCT INSTALLATION

.1 Install in accordance with: SMACNA.

.2 Maximum length of flexible duct shall be 4 m.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 Mechanical General Requirements.

1.2 RELATED SECTIONS

.1 Section 23 31 14 – Ductwork – Low Pressure Metallic to 500 Pa.

1.3 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittals.

PART 2 - PRODUCTS

2.1 DUCT LINER

.1 General

.1 Mineral Fibre duct liner: air surface coated.

.2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102, NFPA 90A and NFPA 90B.

.3 Fungi resistance: to ASTM C1338.

.2 Flexible

.1 Use on round or oval surfaces surfaces indicated.

.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 with ASTM C177, at 24 degrees C mean temperature.

.5 Maximum velocity on coated airside: 25.4 m/sec.

.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.

.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. Polymer 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 GENERAL

.1 Do work in accordance with SMACNA HVAC DCS and as indicated except as specified otherwise.

.2 Line inside of ducts where indicated.

.3 Duct dimensions, as indicated, are clear inside duct lining.

.4 Provide duct liner for 6m of HVAC supply and return duct and 6 m of Soundline 1800 mm of exhaust fans ducts starting at the fan.

3.2 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.

.2 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 impact driven mechanical fasteners to compress duct liner sufficiently to hold it firmly in place.

.3 Spacing of mechanical fasteners in accordance with SMAC HVAC DCS. In systems, where air velocities exceeds 20.3 m/sec, install galvanized sheet metal noising to leading edges of duct liner.

3.3 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 two coats of sealer over tape.

.2 Replace damaged areas of liner.

.3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 Mechanical General Requirements.

1.2 RELATED SECTIONS

.1 Painting: Section 09 91 23, Painting and Finishing.

.2 Ductwork: Section 23 31 14, Ductwork-Low Pressure Metallic to 500PA

1.3 SUBMITTALS

.1 Shop Drawings: Prepare and submit Shop Drawings for all equipment and systems covered by this section.

.2 Record Drawings

.1 Record, as work progresses, on one set of white prints provided, all changes or deviations in location of ductwork, dampers, terminal equipment, and equipment and such other approved changes that occur during the progress of the Work.

.2 Provide at completion of work, one final set of Drawings with all changes correctly marked in red ink.

.3 Operational and Maintenance Data: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

PART 2 - PRODUCTS

2.1 DIFFUSERS, REGISTERS AND GRILLES

.1 General

.1 Refer to Drawings for neck size, dimensions, capacity, etc. of grilles, registers and diffusers.

.2 Catalogue numbers of first named supplier are listed in schedules on Drawings to show required type and style.

.3 Furnish supply diffusers and registers to deliver indicated air quantities shown with throw to reach intended space limits without increasing sound level of room. Furnish blank-off baffles where required. Furnish equalizing deflectors on diffusers and in other locations as shown or required.

.4 Coordinate placing of diffusers, registers and grilles in ceilings with electrical and ceiling installation trades and exact location to final approval of Engineer.

.2 Diffusers

Diffusers shall have equalizing grid.

.1 Linear diffusers shall be Model SDA with plenum extruded aluminum, number of slots and length are shown on drawings continuous slot diffusers each complete with adjustable pattern control elements, end caps on both ends; hangers and blank-off strips as detailed and described herein. Finishes shall be baked enamel; off white on face, and black on interior parts. Provide end clip support and special frame. Diffuser shall be compatible.

.2 Type A diffusers shall be #SCD-31, of steel construction and fit 610 mm O.C. T-bar suspended lay-in ceilings. Inner assembly shall be easily removable. Diffuser face shall be 610 x 610 mm size unless otherwise noted. Diffusers shall be of adjustable air pattern type.

.3 Grilles, Registers

.1 Grilles and registers shall be of aluminum construction (except where noted) with baked white enamel finish, except in walls where prime coat finish shall be supplied. Aluminum frames and bars shall be extruded from hard stock, free from pits and spots. Joints shall be ‘hairline’. Attachment shall be with stainless steel or C.P. screws with 6 mm thick urethane foam gasket set under flange.

.2 Exhaust air grilles, except where otherwise noted, shall be #530D/F/S/A/B12, with removable key operated volume damper.

.3 Supply air registers shall be double deflection and complete with volume dampers.

.4 Acceptable Equipment

.1 E.H. Price
.2 Carnes
.3 Titus
.4 AirVector
.5 Krueger

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Refer to and comply with applicable requirements specified in Section 21 05 01.

.2 Install miscellaneous steel framing, supports, braces, etc. as may be required to hang or support equipment and ductwork as specified herein, and as shown on Drawings.

.3 Install beam clamps or supplementary steel to secure hanger rods, angles and straps to structural steel framing.

.4 In suspended ceiling areas, adjust final location of grilles and diffusers to suit reflected ceiling plan.

.5 Set and secure roof penthouse on roof curb and seal weatherproof.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to General Mechanical Requirements Section 21 05 01 as applicable.

1.2 RELATED SECTIONS

.1 Temperature Controls: Section 25 90 00

.2 Hydronic Pumps: Section 23 21 23

1.3 SUBMITTALS

.1 Shop Drawings
- .1 Prepare and submit complete shop drawings in accordance with Section 01 33 00 Administrative Requirements.
- .2 Indicate equipment including connections, fittings, control assemblies and ancillaries, and identify factory and field assemblies.

.2 Maintenance Data
- .1 Provide maintenance data for incorporation into manual specified in Section 01 33 00 Administrative Requirements.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVE

.1 Provide variable frequency drives for two (2) L.T. pumps. One pump is standby for the other pumps. Verify horsepower of existing equipment prior to order VFD's.

.2 Furnish complete ABB ACH580 BACnet variable frequency drives as specified herein for supply air unit fan. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure.

.3 The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to negate the need for motor derating.

.4 An advanced sine wave approximation and voltage vector control shall be used to allow operation at rated motor shaft output at nominal speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life.

.5 The VFD shall include a full-wave diode bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

.6 The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Local representative panel shop assembly for option panels is not acceptable. The appropriate UL stickers shall be applied to both the drive and option panel, in the case where these are not contained in one panel. When these drives are to be located in Canada, the CSA or C-UL certifications shall apply.

.7 The VFD shall have a DC link reactor to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.

.8 The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

.9 The VFD shall be able to provide full torque at any selected speed up to base speed to allow driving direct drive fans without derating.

.10 An automatic energy optimization selection feature shall be provided standard in the drive. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide a 3% to 10% additional energy savings.

.11 Input and output power circuit switching can be done without interlocks or damage to the VFD.

.12 An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.

.13 <u>Protective Features</u>

1. Class 20 I2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications.
2. Protection against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, drive overtemperature and motor overtemperature. The VFD shall display all faults in plain English. Codes are not acceptable.
3. Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 150 volts for 208/230 volt units, and 285 volts for 460 volt units.
4. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.

5. Drive shall have semi-conductor rated input fuses to protect power components.
6. Drive shall include a "signal loss detection" circuit to sense the loss of the control signal, and shall be programmable to react as desired in such instance.
7. Drive shall be designed and constructed so that input or outputs can be disconnected with the drive running without the need for interlocks.
8. Drive shall catch a rotating motor operating forward or reverse up to full speed.
9. VFD shall be rated for 100,000 amp interrupting capacity (AIC).
10. Drive shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.
11. Drive shall continue to operate without faulting until input voltage exceeds 300 volts on 208/230 volt drives, and 604 volts on 460 volt drives.

.14 Interface Features

1. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the drive and determine the speed reference.
2. Provide a 24 V DC output signal to indicate that the drive is in Auto/Remote mode.
3. Digital manual speed control. Potentiometers are not acceptable.
4. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using standard 9-pin cable.
5. All keypads shall be identical and interchangeable.
6. Drive may be operated with keypad removed.
7. All drives shall use the same control keypad.
8. To setup multiple drives, it shall be possible to upload all setup parameters to the drive’s keypad, place that keypad on all other drives in turn and download the setup to each drive.
9. Display shall be programmable to display in 9 languages including English, Spanish and French.
10. The display shall have four lines, with 20 characters on three lines and eight large characters on one line.
11. Two lines of the display shall allow free programming so that the exact unit controlled by the drive can be identified.
12. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the drive when the keypad is removed.
13. A quick setup menu with factory preset typical HVAC parameters shall be provided on the drive eliminating the need for macros.
14. The drive shall be fitted with an RS 485 serial communications port and be supplied with Windows® compatible software to display all monitoring, fault, alarm and status signals. The software shall allow parameter changes to be made to the drive settings, as well as storage of each controller’s operating and setup parameters, and remote operation of the drive.
15. Two set-point control interface (PID control) shall be standard in the unit. Drive shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
16. Floating point control interface shall be provided to increase/decrease speed in response to switch closures.

17. Sleep mode shall be provided to automatically stop the drive when speed drops below set "sleep" level for a specified time. Drive automatically restarts when speed command exceeds set "wake" level.
18. Run permissive circuit shall be provided to accept a "system ready" signal to assure that the drive does not start until dampers or other auxiliary equipment are in the proper state for drive operation.
19. An elapsed time meter and kWh meter shall be provided.
20. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, No Load Warning, DC Bus Voltage, Drive Temperature in degrees, and Motor Speed in engineering units per application (in percent speed, GPM, CFM). Drive will read out the selected engineering unit either in a linear, square or cubed relationship to output frequency as appropriate to the unit chosen.
21. Up to four meter displays can be shown at once on the display. This allows the actual value of the follower signal to be shown simultaneously with the drive's response to that signal for ease in commissioning.
22. Drive will sense the loss of load and signal a no load/broken belt warning or fault.
23. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
24. The VFD shall store in memory the last 20 faults and record all operational data.
25. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
26. Two programmable relay outputs, one Form C 240 V AC, one Form A 50 V AC, shall be provided for remote indication of drive status.
27. Two programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include 0-10 V dc, 0-20 mA and 4-20 mA.
28. Two programmable analog outputs shall be provided for indication of drive status. These outputs shall be programmable for output speed, voltage, frequency, amps and input kW.
29. Under fire mode conditions the VFD shall automatically default to a preset speed.

.15 Adjustments

1. VFD shall have an adjustable carrier frequency.
2. Sixteen preset speeds shall be provided.
3. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves may be automatically contoured to prevent tripping.
4. Four current limit settings shall be provided.
5. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit, inverter overload and motor overload.
6. The number of restart attempts shall be selectable from 0 through 20 and the time between attempts shall be adjustable from 0 through 600 seconds.
7. An automatic "on delay" may be selected from 0 to 120 seconds.

.16 Bypass

1. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position DRIVE/OFF/LINE/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the drive. In the OFF position, the motor and drive are disconnected. In the LINE position, the motor is operated at full speed from the AC power line and power is disconnected from the drive so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power. This allows the drive to be given an operational test while continuing to run the motor at full speed in bypass. Customer supplied normally closed dry contact shall be interlocked with the drives safety trip circuitry to stop the motor whether in DRIVE or BYPASS mode in case of an external safety fault.

.17 Service Conditions

1. Ambient temperature, -10 to 40°C (14 to 104°F).
   0 to 95% relative humidity, non-condensing.
2. Elevation to 3,300 feet without derating.
3. AC line voltage variation, -10 to +10% of nominal with full output.
4. No side clearance shall be required for cooling of any NEMA 1 units, or of any NEMA 12 units of less than 75 HP at 460 volts. All power and control wiring shall be done from the bottom.

PART 3 - EXECUTION

3.1 GENERAL

.1 Wire between VFD and pumps.

.2 Start / Stop, Speed, Status to be hardwired.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General Mechanical Requirements.

1.2 RELATED SECTIONS

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

.2 Section 25 90 00 Temperature Controls.

1.3 SUBMITTALS

.1 **Shop Drawings**

.1 Submit all shop drawings and product data for equipment covered by this Section.

.2 See Sections 013300 and 017800.

.2 **Operational and Maintenance Data**

.1 Provide equipment literature, operating instructions, maintenance instructions, part lists, and other pertinent data for all equipment covered by this Section.

PART 2 - PRODUCTS

2.1 ELECTRIC DUCT COILS

.1 Provide P.M. Wright Electric Co. Ltd. forced air electric duct coils of size and performances noted in drawings. They are referred to as D.H. on the Drawings. Each coil shall be built to comply with C.S.A and Hydro Standards and rated for operation on voltage shown on drawings volt supply and have balanced three phase circuitry. Wiring shall be in high temperature wire to suit. Verify with Electrical Drawings before ordering coils.

.2 Coil shall have galvanized steel frame, nickel-chrominum resistance elements rated at 46.5 KW per square metre supported on zircon bushings held in aluminum coated steel supporting brackets; have primary overheat protection provided by built-in thermal primary cut-out of fail-safe type automatically reset; built-in secondary cut-out of fail-safe type as before with manual reset feature; integral air motion proving switch to de-energize coil on "No Air Flow" condition.

.3 Coil shall be complete with all necessary controls, relays, control transformers and fused power on/off switch, all built into gasketted external terminal box prewired to terminal blocks, suitably identified for easy connection of power and control circuits. Control box shall not exceed coil in height. Supply coil to suit controls specified.

.4 Where contactors or relays are required to handle power load or to conform to C.S.A. Code, provide approved contactors or relays on such coils. Contactors or relays shall be "silent" either sealed mercury type (Durakool BF) contactors or Honeywell R8229A relays or equal.

.5 Coil shall be complete with SCR controller.

.6 Alternate Equipment:
1. Canadian Chromalox
2. Westcan Electrical Mfg. Inc.
3. Thermolex Mfg. Ltd.

PART 3 - EXECUTION

3.1 ELECTRIC DUCT COIL

.1 Provide contactors, transformers, controls, etc. to complete system controls. Coil will be controlled by 24 volt duct sensor in steps to suit coil.

.2 Coil shall have air pressure drop 25 Pa (2.5 mm) maximum and be suitable for duct mounting with bolted flanges for easy removal. Coil internal height shall match connecting duct & shall fit space allotted. Each coil shall have inlet protection screen.

.3 Electrical Division will provide power wiring to line side of coil terminal only.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General Mechanical Requirements.

1.2 RELATED SECTIONS

.1 Section 23 05 48: Noise Vibration Control.

.2 Section 23 05 93: Testing, Adjusting & Balancing.

.3 Section 25 90 00: Temperature Controls.

1.3 SUBMITTALS

.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01 33 00.

.2 Submit the following product specific information:

.1 Manufacturers certified data sheets for unit capacity and rating method.

.2 Manufacturer's piping and wiring diagrams.

.3 Written verification confirming internal pore diameter distribution in desiccant limits absorption to materials with critical diameters less than or equal to that of water molecule (2.8 angstroms).

.2 Operation and Maintenance Data.

.1 Submit printed operating instructions and maintenance data in accordance with Section 01 33 00.

PART 2 - PRODUCTS

2.1 ENERGY RECOVERY VENTILATOR

.1 Units shall have the following components:

- Rotary Heat recovery wheel
- Outdoor air Fan, exhaust air fan and Motors
- Filters
- Frost control
- Integral unit controls
- Dampers and Operators
- Access on both Sides of the Heat Recovery Wheel
- Timer for delay start on resumption of power. Coordinate with Electrical Division regarding the adjustment of time delay.
- Weatherproof fused disconnect and magnetic starter of type to conform to Power Authority requirements.

.2 Unit Construction

The installed weight shall be as per the equipment schedule. Unit casing shall be minimum 18 gauge satin coat steel with weather resistant baked enamel finish. All seams shall be weather sealed with weather resistant caulking. All interior surfaces including the center partition to be lined with minimum 25 mm thick, 1.5 lbs/cu ft. insulation with adequately spaced clip pins. The floor shall be double skinned to protect the insulation. The perimeter shall be fully welded, hinged access doors with full length piano hinge, two latches per door and a full perimeter gasket. Motorized fresh air and exhaust air dampers shall be of low leakage parallel blade construction open when fan is running. Unit shall be provided with a non fused disconnect switch accessible from the outside.

.3 Energy Recovery Wheel Assembly

The wheel assembly shall be designed to slide in and out of the unit for inspection and maintenance purposes. The assembly shall contain an energy wheel assembly made up of eight pie shaped segments removable without the use of tools and shall be constructed of light weight polymer material with a permanently bonded desiccant coating. The energy wheel assembly shall have an integral wheel drive motor with automatic thermal overload protection and drive belts. Wheel bearing shall be self-aligning and permanently sealed.

.4 Air Distribution

Supply and exhaust fans shall be forward curve double inlet. Fan motors shall be rated continuous duty, ball bearing construction and class B insulation. Variable pitch V belt drive and adjustable motor mounts to be provided. ERV shall be complete with factory mounted VFD's.

.5 Warranty

The recovery wheel shall have a limited warranty for a full two years from date of installation. All other components have a limited warranty for a full one year.

.6 Frost Control

When the control system, senses frost buildup on the energy wheel, it will modulate the operation of the recovery wheel and activate the electric preheat as part of the defrost cycle.

.7 Motorized Intake Damper and Hood

Furnish and field install low leakage parallel blade dampers. Damper shall open by a linkage driven two position motor. Intake shall include a 2" thick MERV 13 filter. Unit shall be selected to account for additional pressure drop of these filters.

.8 Motorized Exhaust Damper and Hood

Furnish and field install low leakage parallel blade dampers. Damper shall open by a linkage driven two position motor. Provide a MERV 13 - 2" thick filter upstream of the heat recovery coil. Unit shall be selected to account for additional pressure drop of these filters.

.9 Roof curb

Prefabricated with clip lock construction with nailer strip

.10 Unit Performance
Refer to the equipment schedule.

.11 Units shall be complete with integral control including 7-day programmable timer.

.12 Acceptable Manufacturers:
1. Greenheck
2. Spinnaker
3. Loren Cook
4. Carnes

PART 3 - EXECUTION

3.1 ENERGY RECOVERY VENTILATOR

.1 Mounting:
.1 Mount unit on roof curb.

.2 Start Up:
.1 Start-up of unit, checking of controls, setting of switches, balancing of drives, and balancing of all air flow shall be performed by service personnel who are trained in servicing this equipment and whose only function is service work.
.2 Two subsequent service calls at 3 months and 6 months shall be performed to check operation of unit and switches, and to check all filters.

.3 Training
.1 Provide training for the Owner's personnel on the operation and maintenance of the Energy Recovery Ventilators.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General Mechanical Requirements.

1.2 RELATED SECTIONS

.1 Section 23 05 29: Hangers & Support for HVAC Piping & Equipment.

.2 Section 23 05 54: Mechanical Identification

.3 Section 23 05 93: Testing, Adjusting & Balancing

.4 Section 25 90 00: Temperature Controls

1.3 SUBMITTALS

.1 Shop Drawings

.1 Submit shop drawings in accordance with Division 1.
Shop drawings shall include performance data, physical dimension weight, fan data, power requirements, heating & cooling capacity, accessories & controls.

.2 Operation and Maintenance Data

PART 2 - PRODUCTS

2.1 HEAT PUMPS

.1 Heat Pump Units shall be Climate Master reverse cycle package heating/air conditioners of models shown on the drawings suitable for ground source application using Loopanol-2 as a thermal fluid. Types, sizes and performances are shown in Heat Pump Unit Schedule. Each H.P.U. shall be U.L. and C.S.A. listed and performance certified by A.R.I. CSA certification shall not be invalidated by inclusion of options noted in this Specification. Heat pumps shall meet or exceed A.S.H.R.A.E 90.1 requirements.

.2 Units shall be supplied completely factory built and capable of operation with an entering water temperature range from 20° to 120°F (-6.7° to 49°C) as standard. All equipment listed in this section must be rated and certified in accordance with ARI/ISO, NRTL or CSA. The units shall have ARI/ISO, NRTL or CSA labels. All units shall be factory run tested under normal operating conditions at nominal water flow rates. This testing shall generate a report card to be shipped with each unit stating performance in both heating and cooling modes. Serial numbers will be recorded by factory and furnished to contractor for ease of unit warranty status. Units tested without water flow ARE NOT acceptable.

.3 Each H.P. Unit shall contain sealed refrigerant circuit (HFC 410A refrigerant) consisting of field replaceable hermetic motor-compressor, air-to-refrigerant finned tube heat exchanger (for water to air type and water to refrigerant for water to water type), capillary expansion tube, pilot operated refrigerant reversing valve, solenoid valve, water-to- refrigerant coaxial tube heat exchanger, high pressure and low temperature safety cut-outs, motor and filter section with filters. Integral control section shall include all operating and safety controls.

.4 Each H.P. unit shall be complete with factory mounted automatic flow regulator and water solenoid valve.

.5 Ceiling mounted models shall be horizontal configuration with horizontal air discharge and return complete with rubber-in-shear isolators. Units shall be built for filter removal in any of three directions.

.6 Horizontal Units shall have one of the following air flow arrangements: Right-Discharge/Left-Inlet; Left-Discharge/Right-Inlet; Back-Discharge/Left-Inlet; or Back-Discharge/Right-Inlet as shown on the plans. Units must have the ability to be field convertible from side to back or back to side discharge with no additional parts or unit structure modification. Units will have factory installed hanger brackets and isolation grommets. Units will also have factory installed 1” duct collars.

.7 All units must have a minimum of three access panels for serviceability of compressor compartment. If other arrangements make servicing difficult, the contractor must provide access panels and clear routes to ease service. Architect must approve any changes in layout.

.8 The horizontal heat pumps shall be fabricated from heavy gauge galvanized sheet metal. All interior surfaces shall be lined with 13 mm thick, 0.67 kgs. acoustic type glass fiber insulation. All fiberglass shall be coated and have exposed edges tucked under flanges to prevent the introduction of glass fibers into the air stream. All insulation must meet NFPA 90A.

.9 UltraQuiet package shall consist of high technology sound attenuating materials that are strategically applied to the cabinet, in addition to the standard ClimaQuiet system, to further dampen sound.

.10 Each unit shall be supplied with two flexible metallic hose assemblies for supply and return piping. Each unit shall be supplied with 900 mm long flexible metallic condensate hose assembly of adequate size to accommodate any condensate generated.

.11 All units must have an insulated panel separating the fan compartment from the compressor compartment. Units with the compressor in the air stream ARE NOT acceptable. Units shall have a factory installed 1 inch wide filter bracket for filter removal from either side. Units shall have a 1 inch thick pleated filter. The contractor shall purchase one spare set of filters and replace factory shipped filters on completion of start-up. Filters shall be standard sizes. If units utilize non-standard filter sizes then the contractor shall provide 4 spare filters for each unit.

.12 Cabinets shall have separate openings and knockouts for entrance of line voltage and low voltage control wiring. Supply and return water connections shall be copper FPT fittings and shall be securely mounted flush to the cabinet corner post allowing for connection to a flexible hose without the use of a back-up wrench. Water connections that protrude through the cabinet or require the use of a backup wrench SHALL NOT be allowed. All water connections and electrical knockouts must be in the compressor compartment corner post as to not interfere with the serviceability of unit. Contractor shall be responsible for any extra costs involved in the installation of units that do not have this feature. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.

.13 Units rated 5 ton and under shall have a direct-drive centrifugal fan. The fan motor shall be 3-speed, permanently lubricated, PSC type with internal thermal overload protection. Blower shall have inlet rings to allow removal of wheel and motor from one side without removing housing. Units supplied without permanently lubricated motors must provide external oilers for easy service. The fan motor shall be isolated from the fan housing by torsionally flexible isolation grommets. The fan and motor assembly must be capable of overcoming the external static pressures as shown on the schedule. CFM/Static pressure rating of the unit shall be based on a wet coil and a clean filter in place. Ratings based on a dry coil and/or no filter SHALL NOT be acceptable.

.14 Units shall have a sealed refrigerant circuit including a high efficient scroll, rotary or reciprocating compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, an enhanced aluminum lanced fin and rifled copper tube refrigerant to air heat exchanger, a reversing valve, a coaxial (tube in tube) refrigerant to water heat exchanger, and safety controls including a high pressure switch, a low pressure sensor, and a low water and low air temperature sensor. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a lockout device. The lockout shall be reset at the thermostat or at the contractor supplied disconnect switch. Units which may be reset only at the disconnect switch only SHALL NOT be acceptable.

.15 The compressor will be mounted on external computer selected isolating springs. The external springs will be secured to rails that are isolated from the cabinet base. Compressor shall have thermal overload protection and be located in an insulated compartment away from air stream to minimize sound transmission. Refrigerant to air heat exchangers shall utilize enhanced lanced aluminum fins and rifled copper tube construction rated to withstand 450 PSIG refrigerant working pressure. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 450 PSIG working refrigerant pressure and 450 PSIG working water pressure. Plate to plate heat exchangers ARE NOT acceptable.

.16 Refrigerant metering shall be accomplished by thermostatic expansion valve only. Units intended for use in factory standard built operating range with entering water temperatures from 20° to 120°F (-6.7° to 49°C). Reversing valves shall be four-way solenoid activated refrigerant valves which shall fail to heating operation should the solenoid fail to function. If the reversing valve solenoid fails to cooling, a low temperature thermostat must be provided to prevent over-cooling an already cold room.

.17 Automatic reset freeze protection shall be provided within each unit to directly protect water coil from freezing using device that will not cause nuisance shut-down because of cold ambient air temperature. Freezestat shall be set at 4ºC to provide safe margin against damaging freeze and be in direct contact with circulating water. Indirect sensor is not acceptable and must be modified to ensure direct sensing of leaving water temperature.

.18 The drain pan shall be constructed to inhibit corrosion and fully insulated. Drain outlet shall be located on pan as to allow complete and unobstructed drainage of condensate. Vertical units will be supplied with factory installed trap inside of cabinet. The unit as standard will be supplied with solid-state electronic condensate overflow protection. Mechanical float switches WILL NOT be accepted.

.19 Each unit water-to-refrigerant heat exchanger shall incorporate serpentine water coil which will not trap air and be suitable for 200 kpa water circuit design pressure.

.20 Where units supplied exceed electrical load requirements indicated, supplier shall ensure that all electrical devices such as disconnects, circuit breakers, and wiring are adequately sized to accommodate these loads. Advise Consultant of such changes for their review as part of Shop Drawing processing.

.21 Where units supplied exceed water pressure drops indicated, supplier shall ensure that all piping, circulating pumps, and other associated equipment is adequately sized to accommodate these pressure drops, as well as any changes to pump motors and associated electrical hardware. Advise Consultant of such changes for their review as part of Shop Drawing processing.

.22 Each unit shall have extended 4 year Parts and Labour Warranty on complete heremetic refrigeration circuit, F.O.B. suppliers local service centre. This warranty shall include compressor, refrigerant tubing, reversing valve, air coil, and water-to-refrigerant heat exchanger.

.23 Coefficients of performance (C.O.P.) and energy efficiency ratios (E.E.R.) shown in Schedule are minimum acceptable.

.24 Controls and safety devices will be factory wired and mounted within the unit. Controls shall include compressor contactor, 24V transformer, reversing valve coil, lock-out relay and low pressure bypass timer (or a solid-state device incorporating the functions of these two components) to prevent nuisance low pressure lock-outs during operation with low fluid temperatures. A terminal block with screw terminals shall be provided for control wiring. When the safety controls are activated the lock-out circuit must be reset at the aquastat or main circuit breaker to prevent compressor operation during fault conditions. A lock-out indicating terminal shall be provided in the low voltage circuit. Safety devices include a low pressure cutout set at 20 PSIG (140 kPa) for loss of charge protection (freezestat and/or high discharge gas temperature sensor is not acceptable) and a high pressure cutout control set at 380 PSIG (2800 kPa). An optional energy management relay to allow unit control by an external source shall be factory installed.

.25 Water piping connections shall be female pipe thread with a single set of source and load connections flush mounted to the unit cabinet.

.26 Each H.P. Unit shall be complete with a microprocessor based standalone DDC controller to monitor all functions of the heat pump operation including low water temperature, high refrigerant pressure, low refrigeration pressure (loss of charge) and condensate overflow protection. When unit is in lockout, microprocessor will attempt to restart unit after a 10 minute period if fault condition is cleared. If fault condition still exists, unit will not restart until manually reset. Microprocessor controller will also provide the following features:

1. High/Low voltage protection
2. Random Start
3. Anti short cycle time delay
4. LED status light for visual diagnostics

Each heat pump shall be complete with wall mounted intelligent electronic thermostat with a limited adjustment of 2 degrees up and down.

.27 Alternate Equipment:
(Include for all electrical revisions necessary to suit equipment including wire sizes, breakers, etc. to suit power supply).

1. Florida
2. Daiken
3. Water Furnace
4. Johnson Controls
5. Approved Alternate
6. Trane

PART 3 - EXECUTION

3.1 HEAT PUMPS

.1 Division 26 will provide power wiring to each heat pump unit. Division 25 to provide all controls wiring for heat pump units and tie Bacnet interface cards on units to BMS. Startup and configuration of heat pump units and Bacnet interface

.2 Supply services of factory trained installation representative for at least two site visits during construction period for supervision of system installation, checking and testing of each individual heat pump unit, and start-up and commissioning of entire system complete with operating controls to Owner or his representatives.

.3 After connection of heat pumps into low temperature (L.T.) water loop, water flow balance shall be conducted to assure proper flow rate to each heat pump. This procedure must be supervised by heat pump manufacturer's factory trained personnel.

.4 Install each suspended unit in place with steel rods from building structure using inserts provided in place by this Section. Installation shall comply with manufacturers directions and be approved by Consultant. Supply spring type anti-vibration mount at each support point. Hangers and isolators shall not extend below bottom of unit when ceiling mounted. Mount vertical units on 100 mm concrete housekeeping pads. In addition, mount counter flow units on steel stands.

.5 Co-operate with Sheet Metal Trade to install ductwork for each unit as shown via flexible connectors.

.6 Pipe each unit into L.T. loop complete with unions at connection. Install ball valves and hoses to approval. Piping shall conform to manufacturers printed directions. Note requirements for flushing piping system.

.7 Each unit condensate hose shall be coiled by installer to provide minimum 75 mm trap and be connected to condensate disposal system so that all condensate piping is pitched downward from unit.

.8 Start-up each unit, test and adjust controls and components and put each unit and each entire system in safe efficient operating condition to meet design criteria and manufacturer's directions.

.9 Training

1. Provide training for the Owner’s personnel on the operation and maintenance of the Heat Pumps.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Labour, Products, equipment and services necessary for firestopping and smoke seals Work in accordance with the Contract Documents.

1.2 RELATED SECTIONS

.1 Section 21 05 01 "General Mechanical Requirements”

.2 Section 23 21 14 "Hydronic Specialties"

.5 Section 23 05 54 "Mechanical Identification"

1.3 SUBMITTALS

.1 Product data:
- .1 Submit copies of manufacturer's Product data in accordance with Section 01 33 00 indicating:
  - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
  - .2 Product transportation, storage, handling and installation requirements.
  - .3 Submit firestop and smoke seal manufacturer's Product data for materials and prefabricated devices, including manufacturer's printed installation instructions.

.2 Shop drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 indicating:
  - .1 Fire rated and smoke sealed systems for each typical application.
  - .2 Construction details, accurately reflecting actual job conditions.
  - .3 ULC or Intertek Testing assembly listing.

.3 Certification:
- .1 Submit certified documentation from manufacturer for each worker performing Work of this Section.
- .2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

1.4 QUALITY ASSURANCE

.1 Perform Work of this Section by manufacturer-approved, skilled, qualified, and experienced workers trained in installation of Work of this Section.

1.5 SITE CONDITIONS

.1 Conform to manufacturer's requirements and maintain a minimum temperature of 5^0 C for a minimum period of 24 h before application, during, and until application is fully cured.

.2 Maintain sealant at a minimum 18 C for best workability.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

.1 Acceptable manufacturers of rated systems include:
- .1 AD Fire Protection Systems Inc.
- .2 Hilti Canada Corporation.
- .3 3M Canada Inc.
- .4 Tremco Ltd.
- .5 Approved Alternate

2.2 MATERIALS

.1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.

.2 Firestop sealant: single component, low modulus, silicone rubber, moisture curing, ULC labelled to CAN/CGSB 19.13-M and CAN/ULC S115.

.3 Firestop insulation: to CAN/ULC-S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
- .1 Density: Minimum 64 kg/m^3 when tested to ASTM C303.
- .2 Combustibility: Noncombustible to CAN/ULC S114.
- .3 Melt temperature: >1175 degrees C.
- .4 Surface burning characteristics: to CAN/ULC S102, maximum flame spread of 0, smoke developed of 0.
- .5 Moisture Absorption: 0.04 percent when tested to ASTM C1104.
- .6 Smoulder Resistance: 0.01 percent when tested to CAN/ULC S129.

.4 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.

.5 Primer: As recommended by firestopping sealant manufacturer.

2.4 BURIED EARTHLOOP PIPING

.1 Equipment and installation shall be by an approved specialty sub-contractor having at least 3 years experience in this type and size of work and having at least 2 similar projects in service at time of bidding.

.2 The earthloop system contractor shall bid to the mechanical contractor and NOT to the Heat Pump manufacturer. Work of this sub-contractor shall include all related site work and piping up to the steel pipes connection beside the mechanical room.

.3 The earthloop contractor must have a contractor's license and technician license issued by the Ministry of the Environment (MOE). The earthloop contractor shall be licensed by the Canadian Earth Association (CEEA). He shall be able to perform the requirements of drilling the holes, installing the loops and grouting to both MOE and CEEA specs. He shall have modern equipment capable of performing these functions in a reasonable period of time. He shall have gas detection equipment on site connected and operating.

.4 System shall include buried earthloop system where shown consisting of reverse supply and reverse return headers and multiple heat exchanger loops drilled into ground.

.5 Earthloop contractor must ensure that noise level from his operations does not exceed 55 decibels at the property line.

.6 Earthloop contractor shall provide all earthloop piping exterior to building and up into the building as shown where steel pipe starts. Exterior work includes all horizontal and vertical piping, excavating, backfilling, drilling etc. for this piping.

.7 Earthloop piping materials shall be in compliance with CSA Standard #B123.1 regarding piping materials for ground source heat pumps. Earthloop pipe shall be Series (160#WWP) #8406 or #3406 resin polyethylene extruded to Schedule 40 I.P.S.

.8 Vertical earthloops of diameter shown shall be installed in boreholes drilled to depths as shown on Drawings. Earthloop boreholes shall be drilled where shown unless site conditions (slabs, foundations services) change and dictate otherwise. Provide metal sleeves where required to suit ground conditions.

.9 Each vertical pipe loop shall be ready to install and be inserted into borehole as soon as drill stems are removed so as to minimize time for cave-ins and to maximize opportunity for even heat exchanger lengths.

.10 Space between any two boreholes shall be no closer than 45 meters (150 feet). All boreholes shall be no closer than 3 m to any building, service, waterline or sewer area. See Drawings for details.

.11 Remove drilled out material from site unless otherwise directed. Excavate and backfill trenches as noted in 21 05 01. Provide written report confirming that all vertical piping has been backfilled as specified and that all buried horizontal earth loop piping has been backfilled with sand and rigid insulation installed as specified and shown on Drawings.

.12 All heat pump holes must be completely sealed with impermeable materials to prevent downward migration of contaminants and intermixing of aquifer complexes. Drilling contractors shall provide a bentonite clay/cement mixture to the full depth of each hole. The grouting shall be tremmied or pressure grouted from the bottom of each hole and upward. This must be repeated as required until grouting is cured and settlement is completed.

.13 For anticipated drilling conditions see test bore hole information which is part of the architectural specifications. Closed Loop Ground Source Sub-Contractors should check local conditions before submitting drilling price. See also soil test report prepared by Geotechnical Consultants and included as part of the architectural specification.

.14 Vertical earth loop heat exchangers shall be connected together in reverse return fashion where shown 1.5 meters below final grade level. Any breaking of rocks to achieve 1.5 meters deep trenches is the responsibility of the Ground Source Sub-contractor.

.15 Building entry shall be through 75 mm steel pipe sleeves. Seal gap between PVC pipes and sleeves with Link Seal modular seal.

.16 Closed loop ground source Sub-Contractor shall have current C.E.E.A. Certified Technician in both butt fusing and socket fusing procedures and techniques. Document must be on site at all times while working is in progress.

.17 All outside connections shall be fused in field at 254ºC to 265ºC (490ºF to 510ºF). No non-fused joints in field will be permitted. U-bends for vertical boreholes shall be butt fused.

.18 Use minimum of plastic elbows and fittings etc. and maximize flexibility of earth loop pipe material so as to minimize pressure drop throughout system.

.19 Excavation and backfilling for earthloop system shall be by this section. Refer to Soils Report and Drilling Report. Make due allowance for these conditions in tender price. Include all necessary costs in tender price to accommodate and include all conditions shown in both reports. Both reports are included in the Architectural specifications.

2.5 EARTHLOOP THERMAL FLUID

.1 Heat pump system shall have antifreeze solution as heating/cooling medium consisting of special de-natured ethanol 96% solution with strength capable of withstanding freezing to –20ºC (-4ºF). Solution shall have a stable rust inhibitor and an algicide. The solution is marketed under the name Loopanal-2 by Quatic Industries in Guelph, Ontario (Tel.: 1-800-265-8392).

.2 The solution shall be premixed off site and trucked to site for pumping into the ground loop system using purging unit. Completely fill entire system venting off all air except in expansion tank leaving 275 kPa residual pressure in system.

.3 Provide Loopanal-2 solution make-up for ground source loop as shown. Provide 25 mm pipe from pump located in 205 litre drum to top of 250 dia. supply header with shutoff valve and low flow sensor as shown. Install control pressure switch in return header and wire to heat pump central control panel.

.4 All components on Loopanal-2 system shall be suitable for solution used. Pump seals, gaskets, expansion tanks, valves and other materials must not be affected and have normal life span. Where solution will affect normal life span, provide alternate materials to meet this requirement.

2.6 TEST WELL

.1 Drill the first well as a pilot test.

.2 During drilling, record the different soils encountered to provide a summary of the stratigraphy along with its respective accurate depths for an independent hydro geologist to review later.

.3 Follow materials and procedures, CSA 448.1-02 and CSA 448.2-02 standards and procedures shall apply.

.4 After the well has been drilled, insert a (2 tubes 1.25” dia each , with “U” bend) geothermal closed loop down to 138 meter level.

.5 Immediately after insertion, tremie grout (pressure grout from the bottom up) with either a 20 % solid bentonite blend, or a 5% bentonite with 95% cement.

.6 Pressure test the well to a 100 PSI level to hold for 12 hours.

.7 Flow test the well to assure that there is no restriction that occurred during installation.

2.7 THERMAL RESPONSE TEST

.1 Supply and Install a Thermal Response Test Machine.

.2 Assure you have continuous power for a minimum of 48 hours.

.3 Record the Conductivity of the borehole.

.4 Record the Diffusivity of the borehole.

.5 Produce a complete and graphed report for the above tests and drilling.

PART 3 - EXECUTION

3.1 EARTH LOOP THERMAL FLUID

.1 System MUST be cleaned BEFORE filling, by circulating a 1/4% solution by weight of tripotassium phosphate or trisodium phosphate for at least 4 hours at 5°C (40°F) and then drained and flushed with clean water meeting above criteria. Consult with quatic regarding method of cleaning.

.2 Install two (2) 19 mm valved capped hose end connection in this system for charging system across system pumps and clearly identify both connections as to use.

.3 Circulate solution in system for at least 48 hours and verify solution characteristics before starting system. Report actual characteristics and lowest safe operating temperature and guarantee same in writing to Architect.

.4 On completion of work, supply at least one (1) 45 Imperial Gallon (205 litre) drums of premixed solution for topping up system complete with instructions. Drums shall be suitably labeled to show contents. Supply similar empty drum, also labeled for containing solution taken from system complete with bung plugs, etc.

.5 System shall be purged of all air during and after filling with solution. After one (1) week of operation, repurge system and verify system is 100% full, no air is present and system pressure remains constant at approximately 30 psig (208 kPa) at pumps under no flow condition.

3.2 BURIED EARTHLOOP PIPING

.1 Clean and flush each earthloop after pressure testing to hold 700 kPa (100 psig) for 24 hours without decrease in pressure. Each pipe loop shall be pressure tested before being layed into trench. Repeat cleaning, flushing and pressure testing after pipe circuit is connected to pipe headers. All earth loop piping circuits shall be left clean and filled with clean water before charging with solution.

.2 Flush and purge system of debris and air as outlined in CEEA Engineering Manual, Chapter 7. Also see CAN/CSA #C445-M89 and comply thereto. Fill system including interior piping, circulate and reflush and repurge to ensure complete system is clean and free of air.

.3 Provide written report confirming that all system piping has been cleaned, flushed and pressure tested as per plans and specifications. Co-ordinate with interior piping installer.

.4 Excavating Subcontractor shall dispose of waters used in excavating or recovered from trenches in safe manner to local and MOE requirements. Such water shall NOT be permitted to flow onto adjacent or municipal properties.

.5 Supply summary of final pressure readings for all loops and systems at completion of work, AND 12 months into guaranty period.

.6 Provide glass framed chart showing borehole field with each hole numbered, each supply and return pipe circuit numbered and tagged. Indicate the number of each bore hole connected to each circuit.

.7 Provide minimum two trace circuits wires to assist in future identification of horizontal pipes in the field. Wires shall be 14 gauge solid copper insulated with TW or equivalent material. Each circuit must be wired from Pump Room out to field in trenches and back in Pump Room. Divide field into two equal areas. Wires shall be CSA approved. Each circuit shall be clearly labelled identified and marked on as built drawings.

.8 Refer also to report on soil conditions by Geotechnical Consultant. Include all necessary costs in tender price to accommodate and include all conditions shown in reports.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 Conform to Sections of Division 1 as applicable.

.2 Conform to Section 21 05 01 General Mechanical Requirements.

.3 Provide Johnson Controls temperature controls complete in all details, substantially as shown or described together with minor details not specifically mentioned, or shown, but as may be reasonably inferred and necessary to complete each system and place in successful operating service.

.34 Temperature control systems shall be electrically operated except where otherwise noted. Systems shall be installed by competent mechanics and electricians employed by Controls Manufacturer.

.5 All thermostatic controls shall read in Celsius or have dual C/F scale. Wall mounted manually operated controls in Service Rooms shall be mounted not more than 1500 mm above floor.

.6 Provide engraved black and white lamacoid plastic nameplates, 25 mm x 63 mm minimum at all duct mounted instruments, reset controls, thermometers and panels so as to clearly indicate service of particular device. All manual switches unless they come with a standard nameplate shall be similarly labeled.

1.2 RELATED SECTIONS

.1 Variable Frequency Drives: 23 53 00

.2 Heat Recovery Ventilators: 23 72 13

.3 Heat Pumps: 23 81 40

1.3 SUBMITTALS

.1 **Shop Drawings**: Prepare and submit shop drawings for all equipment and systems covered by this section.

.2 **Operational and Maintenance Data**: Provide equipment literature, operating instructions, maintenance instructions, parts lists, and other pertinent data for all equipment and systems covered by this Section.

1.4 QUALITY ASSURANCE

.1 **Regulatory Requirements**: Conform to the requirements of local by-laws, Ministry of Labour Regulations, and authorities having jurisdiction.

1.5 ELECTRICAL WIRING

.1 All electrical wiring required for temperature controls (except where otherwise noted) shall be supplied and installed by Control Supplier. All controls wiring installed by Control Supplier shall be run in EMT conduit and shall otherwise conform with requirements of Electrical Division.

.2 Coordinate location of power outlets for controls with Electrical Division. Provide on/off switch on each circuit for service.

.3 Exterior wiring shall be in rigid conduit with waterproof connections and junction boxes.

1.6 INSTALLATION

.1 Supply control valves, piping, wells an pipe mounted devices to piping trade for installation complete with necessary instructions.

.2 Mount control panels to 1200 mm floor to centre unless otherwise noted secured to wall to approval.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

.1 Provide for installation by the Mechanical Contractor for the control valves reqiured for the systems as shown on the drawings.

.2 Control valves shall be brass body globe style electronic/electrically operated, modulating control, built for 862 kPa working pressure, two way 0.25 L/s and three-way for larger flows. Pressure drop not to exceed 6 kPa up to 0.63 L/s and 18 kPa for larger flows.

.3 Ensure that valves have a tight shut-off against the full differential pressure imposed b the system.

.4 Motorized valves shall be 120 volt.

2.2 FLOW SWITCHES

.1 Flow switches shall be installed in a horizontal pipe with a minimum of five pipe diameters on each side.

.2 Flow switches shall be McDonnel #FS4-3.

.3 The paddle size and length is to be as per the Manufacturer's recommendation for the pipeline size and flow.

.4 Flow switches shall be adjustable to the required flow.

.5 Wetted parts shall be brass unless the application requires stainless steel.

2.3 PUMPS CONTROL

.1 Alternate pumps to owners schedule.

.2 Record status of pumps from flow switches.

.3 On loss of flow provide alarm signal and start standby pump.

.4 Pressure sensor 2/3 away from pumps shall control VFD's maintain required flow.

2.4 HEAT PUMPS

.1 Room thermostat shall control heat pumps to maintain room temperature.

.2 In Labs, room thermostats shall control heat pumps and electric duct coil to maintain room temperature. Humidistats shall control heat pumps to maintain RH levels.

2.5 DOMESTIC WATER HEATING

.1 Temperature sensor in tank shall modulate 3-way valve to maintain 140°F.

2.6 ENERGY RECOVERY VENTILATOR

.1 Energy recover ventilator (ERV) shall run during occupied hours only.

.2 ERV shall be controlled from integral controls.

2.7 ALTERNATE MANUFACTURERS

.1 Honeywell

.2 Siemens

PART 3 - EXECUTION

3.1 OPERATING INSTRUCTIONS

.1 Supply operating instruction to Building Operators for temperature control system. Include description of sequence of operation, and drawings of system schematics. Provide three copies of control drawings and sequence of operations with maintenance instructions.

3.2 SERVICE & GUARANTEE

.1 Upon completion, adjust all thermostats, controllers, switches, and other control equipment as required to place each system in complete operating condition subject to Contract Administrator's approval to give required performance. Cooperate with Other Trades and Sections during testing and balancing of each mechanical system to ensure each total system operates to approval.

.2 Temperature control system shown and specified herein shall be warranted free from defects in materials and workmanship and shall be serviced without charge (except for damage from lack of maintenance of other causes) for one year, after date of start of lien period. If, within this period, any equipment herein described is proved to be defective in workmanship or materials, it shall be replaced or repaired without charge.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCE SECTIONS

.1 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical general requirements. Conform to Division 1, General Requirements and all documents referred to therein. Supplement with the following requirements.

.2 Conform to the conditions stated in the Contract Form and Supplementary Conditions.

.3 This section of the specification is an integral part of the Contract Documents and shall be read accordingly. This Section applies to and is a part of all Sections of Electrical Division.

1.2 INTENT

.1 Mention herein or indication on drawings of articles, materials, operations or methods requires: supply of each item mentioned or indicated, of quality, or subject to qualifications noted; installation according to conditions stated and; performance of each operation prescribed with furnishing of necessary labour, equipment, tools, instruments, services and incidentals for Electrical Work Division.

.2 Sections of these Electrical Specifications are not intended to delegate functions nor to delegate work and supply to any specific trade and the work shall include all labour, materials, equipment, tools and inspection required for a complete and working installation as described.

.3 The Specifications are integral with the Drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one, but included in the other is properly specified.

.4 Wherever differences occur in the Contract Documents, the maximum conditions will govern and be allowed for in the Tender price. The item to be incorporated will be at the option of the Consultant.

1.3 DEFINITIONS

.1 Where used, words "Section" and "Division" shall also include other Subcontractors engaged on site to perform work to make building and site complete in all respects.

.2 Where used, the word “products” shall mean the material, equipment, component, machinery, or fixtures forming the completed work.

.3 Where used, word “connect” shall mean to supply and install all wiring and raceways and make all power connections to products.

.4 Where used, word "supply" shall mean to include all labour, materials and services to furnish to site in location required or directed complete with accessory parts, but is not intended to include installation.

.5 Where used, word "install" shall mean to include all labour, materials and services to secure in place products, including receiving, unloading, transporting, storage, uncrating, installing, connecting and performance of such testing and finish work as is compatible with degree of installation specified complete ready for use.

.6 Where used, word "provide" shall mean to supply and install as each is described above.

.7 Where used, word "commission" shall mean to startup and initial operation of products as required to demonstrate satisfactory operation of products and entire system including calibration of any instrumentation.

.8 Where used, word "work" shall mean the total construction required by the Contract Documents and includes all labour, products and services.

.9 Where used, wordings such as "approved, to approval, as directed, permitted, permission, accepted, acceptance, report to", shall mean "approved, directed, permitted, accepted, report to", by Consultant.

1.4 BY-LAWS AND REGULATIONS

.1 Conform to latest Government, Provincial and Municipal By-laws, regulations, Codes and Standards and requirements of other authorities having jurisdiction in the area where work is to be performed. Minor changes required by an authority having jurisdiction shall be carried out without change to the Contract amount. Standards established by drawings and specifications shall not be reduced by applicable codes or regulations.

.2 Conform to the following applicable standards and regulations as minimum, but not limited to:

Canadian Standards Association (CSA) Standards
Underwriter's Laboratories of Canada (ULC) Standards
Ontario Electrical Safety Code (OESC) and Bulletins
Electrical Safety Authority (ESA) Requirements
Canadian Underwriters Association (CUA) Standards
Ontario Building Code (OBC)
National Fire Protection Association (NFPA) Standards
National Electrical Manufacturers Association (NEMA) Standards
Electrical and Electronic Manufacturers Association of Canada (EEMAC) Standards

1.5 TENDERS AND FORMS

.1 State separate prices in the tender form for work indicated. Prices shall include the complete cost of the work, i.e. all equipment, wiring, material, labour, incidentals, profit, overhead, etc, excluding taxes. It shall be the Owner's option to delete from the Contract any of the work indicated at the prices stated.

1.6 PERMITS AND FEES

.1 Apply for, obtain, and pay for permits, licences, certificates, connection charges and inspections required by authorities having jurisdiction. Include any premiums applicable due to requirements for after office hours inspections.

.2 The first submission of plans and specifications to ESA will be made by the Consultant. From then on, this contractor shall be responsible for obtaining and complying with all the requirements of ESA.

.3 Submit all required documentation to the Authorities for their approval and comments before starting any Work. Provide all additional drawings, details or information as may be required. Comply with any changes requested by authorities as part of the contract, but notify the consultant immediately of such changes.

1.7 EXAMINATION OF SITE AND CONDITIONS

.1 Examine the site and local conditions. Examine carefully all Drawings and complete Specifications to ensure that work and equipment will satisfy conditions and performance requirements as shown. Examine the work of other Contractors and report at once any defect or interference affecting the work, its completion or warranty. No allowance will be made later for any expense incurred through failure to make these examinations or to report any such discrepancies and omissions in writing, five working days prior to Tender closing.

.2 Submission of a Tender confirms that the Contract Documents and site conditions are completely understood and accepted without qualifications unless exceptions are specifically noted in the Tender.

1.8 CONTRACT DOCUMENTS

.1 The Contract Drawings of this Division are performance drawings and indicate the scope and general arrangement of the Work. They are diagrammatic except where specific details are given. They shall be read in conjunction with Architectural, Structural, Mechanical and all other Division Drawings of the Contract.

.2 Obtain accurate dimensions from the architectural and structural drawings, or by site measurement. Locations and elevations of services are approximate and must be verified before construction is undertaken.

.3 Make changes required to accommodate structural conditions, (beams, columns caps, etc.). Obtain Consultant's approval before proceeding.

.4 Adjust the location of materials and/or equipment up to 3 meters in any direction as instructed without adjustment to contract price, provided that the instructions are given before installation and rough-in.

.5 The drawings do not show all conduit and/or wiring or all structural, mechanical and architectural details. Plan and install conduit runs respecting all applicable conditions including structural, mechanical and architectural details.

1.9 SHOP DRAWINGS

.1 Prepare and submit shop drawings of all Products in accordance with Division 1-General requirements as specified herein and in each section of Electrical Division.

.2 Submit pdf of shop drawings electronically. Shop drawings shall have a minimum 210 mm x 285 mm (8-1/2” x 11”) clear space on the front sheet, suitable for stamping. The cover sheet shall include the project name, Electrical Division name and product description. Where multiple equipment is submitted under one binding, include an index of all equipment as the front sheet.

.3 Assume full responsibility for submission of shop drawings. Allow minimum two (2) weeks for Consultant's review.

.4 The Consultant will only review shop drawings bearing the Electrical Division and Contractor's stamps of approval.

.5 Submit shop drawings showing the following:

.1 Submit shop drawings showing the following:
.2 Project name.
.3 Project tag number.
.4 Manufacturer's name and model number.
.5 Supplier's name.
.6 Approval agencies.
.7 Shipping and working weight.
.8 Performance characteristics.
.9 Dimensions, including required clearances.
.10 Electrical characteristics.
.11 Bill of materials and finishes.
.12 Time required to fabricate and deliver.
.13 All variations from Tender Documents.
.14 Construction and field connection details.
.15 Installation requirements.

.6 The Consultant's review shall not relieve this Division of responsibility to provide Products in accordance with the design intent and Contract Documents.

.7 Manufacturer's printed data sheets for standard items are acceptable providing pertinent characteristics are identified and relate to specified items.

.8 Each shop drawing shall be checked and stamped as being correct, by trade purchasing item, and by Contractor, before drawing is submitted. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.

.9 Where applicable, provide wiring details, schematics, single line drawings, and wiring diagrams showing interconnection with work of other Trades.

.10 Verify and check dimensions to ensure proper installation of equipment in available space and without interference to work of other Trades. Ensure that electrical and all other coordination is complete prior to submission of shop drawings.

.11 Provide data sheets and samples for all wiring devices and wall plates prior to installation. Device and plate colours/finishes to be confirmed prior to ordering.

.12 Where requested, submit samples of Products for review and approval.

.13 Do not have equipment delivered to site until a shop drawing for the item has been reviewed.

1.10 INTERFERENCE AND DETAIL DRAWINGS

.1 Prepare Interference Drawings in conjunction with all parties and trades concerned showing sleeves and openings and passage of piping and conduits through building structure. Drawings shall also show inserts, curbs, equipment bases, anchors, special hangers and weights on all load points.

.2 Prepare fully dimensioned detail drawings of products and services in electrical rooms, service and ceiling spaces, and all other critical locations. Co-ordinate the Work with all other Divisions. Base drawings on reviewed shop drawings and indicate all details pertaining to access, clearances, sleeves, electrical connections, and elevations of pipes, ducts and conduits. Include location of access doors provided under this Division.

.3 Ensure that clearances required by jurisdictional authorities are indicated on the Interference Drawings. The Owner will not consider any extra cost as a result of the Contractor's failure to prepare proper interference drawings.

1.11 AS-BUILT DRAWINGS

.1 Conform to General Requirements. Maintain at least 2 sets of documents and clearly mark on same as job progresses, changes and deviations from work shown so that on completion Owner will have records of exact location of ducts and equipment and record of material and equipment changes.

.2 Contractor shall obtain clean set of prints from Consultant at start of Contract Work and shall keep these prints up-to-date at jobsite, accurately recording all changes made on project and locating all services, equipment, etc. which may have been shown only diagrammatically on Contract Documents.

.3 Contractor shall ensure that as-built information is accurately recorded and shall check same. As-Built drawings shall be reviewed with Consultant at each jobsite meeting.

.4 Prepare record drawings showing the following:

.1 Inverts of all services entering and leaving the building and at property lines.
.2 Dimensions of underground services in relation to property lines at key points of every run.
.3 Elevations of underground services in relation to ground floor level of the building.
.4 Location of all services embedding in the structure, utilizing grid line references.
.5 Dimensioned locations of all services left for future work.
.6 All changes to the Work due to Change Orders and Site Instructions.
.7 All changes to the Work during construction.
.8 All changes to structural and architectural elements that affect the backgrounds of this record set.
.9 Location and designation of all electrically supervised valves, flow switches and pressure switches.
.10 Location and designation of all items requiring access or service in a hidden location.
.11 Location of all access doors provided under Electrical Division.
.12 All changes and revisions to Specifications, details and equipment schedules.
.13 All homerun conduits, junction boxes for complete electrical systems.

.5 Upon completion of Contract Work, prior to Substantial Performance inspection and after final review with Consultants, Contractor shall issue to the Consultant for review the actual on site As-Built Drawings. Upon acceptance Contractor shall neatly transfer recorded information and make final As-Built submission to Consultant electronically for review.

.6 After Record Drawings have been reviewed, revised if necessary until acceptable to the consultant. Submit electronic pdf copy.

1.12 OPERATION AND MAINTENANCE MANUAL

.1 Contractor will be responsible for collecting and organizing all data, operating instructions, maintenance and trouble-shooting instructions, parts lists, parts diagrams, evidence of all tests and certifications, complete reviewed shop drawings, etc. and assembling them in neat manuals. Identify cover “Operation and Maintenance Manual for NAME OF THE PROJECT”. Manuals shall be submitted in pdf electronically and also one hardcopy to be provided.

.2 Contractor shall also collect from Sub-trades and Suppliers all Guarantees/Warranties specified. Check that starting date (date of Substantial Performance of entire project) and extent of each guarantee/warranty are clearly indicated. Check also that all guarantees/warranties indicate Supplier’s Name or Subcontractor’s Name as appropriate together with contact phone number. Assemble neatly in labeled section of each manual.

.3 Prior to requesting Substantial Performing inspection, submit pdf copy to Consultant for review. Make all corrections requested by Consultant and forward the corrected pdf of Manual to the Owner.

1.13 SCHEDULING

.1 Comply with the construction schedule. Conform to phasing of work if applicable. Conform to interim and final completion dates.

.2 Co-ordinate electrical schedule with general construction schedule.

.3 Submit a bar chart schedule showing the start and completion dates for each activity based on a critical path analysis of the work.

.4 Include in schedule for electrical work done by others, e.g. Power Supply Authority connection.

1.14 ALTERNATES AND SUBSTITUTIONS

.1 Substitute Products will only be considered when tendered Products become unobtainable. State in tender the proposed substitute and amount added or deducted.

.2 It is the responsibility of this Division to ensure "Substitute Products" fits space allotted and gives performance specified.

.3 If Products manufactured and/or specified by a manufacturer named as equivalent are used in lieu of the manufacturer specified, be responsible for ensuring that the substituted Product is equivalent in performance and operating characteristics to the specified Product, and, it shall be understood that all costs for additional space, larger power feeders and changes to associated or adjacent work will be borne by the contractor offering the substitution. In addition, in Equipment Rooms where Products named as equivalent is used in lieu of specified Products and the dimensions of such Products differs from the specified Products, prepare and submit for approval, accurately dimensioned layouts of rooms affected.

.4 Contractor shall pay the Consultant on a per diem basis (hourly) for the review of the alternate Products for cost saving purpose.

1.15 VALUATION OF CHANGES

.1 For each change submit a complete itemized breakdown of labour and material.

.2 Only the net difference between an extra and a credit will be subject to overhead and profit mark-up.

.3 Material shall be valued at current trade prices incorporating all discounts and labour rates. Overhead and profit shall be as shown in the Tender Form.

1.16 WORKMANSHIP

.1 Workmanship and method of installation shall conform to best standards and practice and be performed to approval. Work shall be done by tradesmen skilled in work to be performed. Where required by local or other By-Laws and Regulations, tradesmen shall be licensed in their trade. Install all work and equipment to manufacturer's printed directions.

1.17 INSTALLATION REQUIREMENTS

.1 Coordinate the Work with all Divisions. Inform other Divisions of the locations of openings, chases, sleeves, supports, services, connections, etc., to be incorporated into the Work.

.2 Check the locations of all expansion/building joints and ensure that all electrical installations are at or crossing these locations are as detailed and as required to compensate for the possible movement at the joint.

.3 Confirm the exact location of outlets, fixtures and connections. Check architectural details and elevations for more requirements. Confirm location of connection points for equipment supplied under other Divisions or by the Owner.

.4 Install neatly all equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.

.5 Install metering and/or sensing devices to provide accurate and reliable sampling of quantities being measured. Install instruments to permit easy observation.

.6 Provide suitable shielding and physical protection for devices.

.7 Install all Products and services in accordance with the manufacturer's requirements and/or recommendations.

.8 Provide all supports, hangers and fasteners. Secure all Products and services so as not to impose undue stresses on the structure and systems.

.9 Ensure that the load onto structures does not exceed the maximum loading per square meter (foot) as shown on structural drawings or as directed by the Consultant.

.10 Do not use explosive activated tools.

1.18 FIELD REVIEW

.1 The Owner and Consultant shall have access to the site at all times for review of the work during construction.

.2 Arrange for review of Products during manufacturing.

.3 Provide all gauges, instruments and other necessary measuring equipment required for review of the Work.

.4 Maintain a complete set of Contract Documents at all times for field reference by the Consultant.

.5 Correct any deficiencies as they are reported during the performance of the Work.

1.19 TEMPORARY SERVICES

.1 Provide temporary office, workshop and tools and material storage space for the Work and assume responsibility for any loss or damage thereto. Buildings erected for this purpose shall conform in appearance to those erected for similar purposes under other Divisions of Specification.

.2 Provide temporary lighting for whole construction area. Coordinate with General Contractor for requirements.

.3 Provide scaffolding and shoring necessary for work of this Division. Scaffolding and shoring shall be adequate to protect the workmen according to Provincial and Local Regulations.

.4 Provide rigging and millwrighting, labour and equipment necessary for the work of this Division. Employ only workmen well experienced and skilled in such trades for this portion of the work.

.5 Provide hoisting machinery, operators, labour and materials necessary to lift and place equipment supplied under this Division.

.6 The permanent systems or any part thereof shall not be used during construction for construction purposes, unless so permitted by the Owner, in writing.

1.20 PROTECTION AND CLEANING

.1 Securely plug or cap open ends of electrical raceways or equipment to prevent entry of dirt, dust, debris, water, snow or ice.

.2 Equipment stored on site shall be protected from weather and kept dry and clean at all times. Take care to avoid corrosion of metal parts.

.3 Protect all finished and unfinished Work of this and other Divisions from damage due to carrying out of this Work.

.4 Make good any damage caused directly or indirectly to walls, floors, ceilings, woodwork, brickwork, finishes, etc.

.5 Before energizing any systems, inspect and clean the inside of all panelboards, switchgear and cabinets to ensure that they are completely free from dust and debris.

.6 Clean all polished, painted and plated work. Clean all lighting fixtures. Remove all debris, surplus material and tools.

.7 Carry out additional cleaning operations of systems as specified in other Sections of this Division and as Division 1 requirements.

1.21 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials.

.2 Divert unused wiring and metal materials to metal recycling facility, or place in appropriate on-site bins for recycling in accordance with General Contractor's requirements.

1.22 MOCK-UPS AND TRIAL USAGE

.1 Provide mock-ups in accordance with the conditions stated in the Contract Form and Division 1 of the Specifications.

.2 Trial usage of any equipment or materials shall not be construed as evidence of acceptance of same and no claim for damage shall be made for injury to or breaking of any part of such work which may be so used.

1.23 COMMISSIONING

.1 Be responsible for commissioning of all work provided under this Division. The total commissioning requirements of this Division involve:

.1 Complete activation of all systems.
.2 Re-torquing of all bolted connections in all distribution equipment.
.3 Calibration, testing and verification of all systems.

.2 Commissioning shall commence with activation and verification of all systems in accordance with requirements of the Specifications. This will include but not be limited to the following items to be tested, adjusted and verified:

.1 Secondary switchgear.
.2 Generator.
.3 Transformers.
.4 Lighting and power distribution.
.5 Fire alarm systems.
.6 Emergency lighting system.
.7 Electric heating equipment/system.

1.24 TESTING, VERIFCATION & INTEGRATION OF LIFE SAFETY SYSTEMS

.1 All life safety systems integrated with the fire alarm system must be verified and documented in accordance with O.B.C. 3.2.10.1 and the latest edition of CAN/ULC-S1001-11, "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" The following is to be prepared and submitted by the Electrical Contractor and signed by a P.Eng. to the Consultant for review at the start of the project:

.1 Integrated Testing Plan – A written specific document prepared by the Integrated Testing Coordinator, outlining the required tests and necessary functional results to conduct integrated fire protection and life safety systems testing.

.2 Integrated Testing Report – A written project specific document, prepared by the Integrated Testing Coordinator, documenting the implementation of the integrated testing plan.

.3 The following systems (where applicable) are to be integrated into the Testing Plan and Testing Report:

.1 Fire Alarm System (including Sequence of Operation)
.2 Mass Notification System
.3 Elevators
.4 Emergency Generators
.5 Audio/Visual System
.6 Lighting Control System
.7 Notification Systems
.8 Fire Protection System including Sprinkler System, Standpipe, etc.
.9 Freeze Protection Systems
.10 Fire Suppression Systems
.11 Smoke Control Pressurization Systems
.12 Smoke Control Smoke Exhaust Systems
.13 Hazardous Protection Monitoring
.14 Smoke Alarms
.15 Nurse Call System
.16 Other System (where applicable)

1.25 TESTING

.1 Carry out all tests specified and tests required by authorities having jurisdiction. The testing and adjusting is the responsibility of this Division.

.2 Provide all equipment, labour, instruments, expenses of the manufacturer's representative, and incidentals, and pay for all power and fuel required to carry out the tests.

.3 Submit the record of all tests and have these tests signed by Contractor's Superintendent and, where applicable the manufacturer's representative. Show in schedule form a record of the systems or parts of systems tested, the date of the test, the circumstances such as current, temperatures, etc., the duration of the test and any special remarks pertaining to events during the test. Note which tests have been witnessed by authorities having jurisdiction.

.4 Submit certification letters from the manufacturers of all equipment certifying that their technical representatives have inspected and tested their equipment and are satisfied with the methods of installation and operation. Where existing systems are extended, provide letters covering both new and existing equipment and connections. These letters shall state the names of persons present at testing, methods used and a list of functions performed with location and room numbers where applicable.

1.26 INSPECTION

.1 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work furnish final unconditional certificates of approval by the inspection authorities.

.2 Application for final review will be considered when the Work has been completed and written declarations submitted that all commissioning, testing adjustment, set up and documentation is complete. Final review shall be done when:

.1 All reported deficiencies have been corrected.
.2 All systems have been balanced, tested, commissioned and are operational.
.3 The Owner has been instructed in the operation and maintenance of all equipment.
.4 All reports have been submitted and reviewed.
.5 All maintenance manuals have been submitted and reviewed.
.6 All tags and nameplates are in place and all data submitted and reviewed.
.7 Cleaning up is finished in all respects.
.8 All certificates are furnished.
.9 All spare parts and replacement parts specified have been provided.
.10 All record drawings have been submitted and reviewed.

1.27 DEMONSTRATION AND INSTRUCTION

.1 Provide personnel, equipment and tools to demonstrate and instruct Owner's designated personnel in operation, controlling, adjusting, trouble-shooting and servicing of all systems and equipment to satisfaction of the Owner. This work shall take place during Owner's regular business hours prior to acceptance.

.2 Where specified elsewhere in this Division, manufacturers shall provide demonstration and instructions.

.3 Where deemed necessary, the Consultant or Owner's agent may record these demonstrations via video tape or other means for future reference.

1.28 WARRANTY

.1 Provide a written guarantee stating that systems, equipment, components, etc. have been installed to manufacturer's instructions, that systems meet the contract requirements and that all deficiencies in material and labour occurring within one year after substantial completion, will be corrected at no charge.

.2 Obtain Product warranties in excess of one (1) year from the manufacturer on behalf of the Owner. These Product warranties shall be issued by the manufacturer to the benefit of the Owner.

.3 Instruct all manufacturers and suppliers that warranties on Products will commence at the date of Substantial Performance and not from the date the Products are put into operation.

.4 All corrections to deficiencies listed in field review reports and other correspondence, as well as but not limited to those indicated in testing, adjusting, balancing and commissioning shall be completed prior to turn over.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical general requirements.

.3 Work to be done under this Section shall include furnishings of labour, materials, and equipment required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.

1.2 SUBMITTALS

.1 Submit shop drawings and product data for products specified in this section in accordance with Section 260100 – Electrical General Requirements.

1.3 PRODUCTS

.1 Products shall be new, of Canadian manufacture where available, first quality and uniform throughout. Submit tender based on the use of products and equipment specified, or on the listed acceptable alternate equipment as further detailed.

.2 Electrical products s shall be C.S.A. approved and be so labeled. Products not C.S.A. approved shall receive acceptance for installation by Ontario Hydro Special Inspections Branch before delivery, and modifications and charges required for such acceptance shall be included in work of this Section. Products shall not be installed or connected to the source of electrical power until approval is obtained.

.3 Where manufacturer is not specified provide products of high commercial standard and quality consistent with the standards of these specifications. Provide products of same manufacture for like applications unless noted otherwise.

.4 Products shall be designed and manufactured in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment. Confirm capacity, ratings and characteristics of products being provided to supply power to equipment provided under other Sections of the work. Resolve discrepancies before such items are purchased.

.5 Acceptance of products installed presumes that products have not been damaged or exposed to conditions that would adversely affect performance and life expectancy. If in the opinion of the Consultant, products have sustained damage, or have been exposed to abnormal conditions it shall be the responsibility of the Contractor to have such tests performed as deemed necessary by the Consultant to establish condition and therefore, acceptability of installed products.

PART 2 - PRODUCTS

2.1 ELECTRICAL IDENTIFICATION

.1 Outlet boxes

.1 Identify outlet boxes on the box cover with: circuits contained in the box, the panels from which they are fed, the voltage and purpose of the outlet.

.2 Cable and conduit

.1 Identify conduits and cables for the various systems by the use of the following distinctive coloured labels. The Labels shall comprise pressure sensitive plastic tape with printing labels indicating the system. Apply a small area of paint to the outside and inside of each outlet box, pull box and panel as it is being installed. Identify junction boxes in suspended ceiling areas with colour on both inside and outside.

.1 120/208 volt system – yellow
.2 347/600 volt system – white
.3 Emergency power - orange
.4 Fire alarm systems – red
.5 Data cabling system – blue
.6 P.A./Telephone systems – grey
.7 Security/Intercom/CATV systems – black
.8 Other telecommunication systems - green

.2 Locate identification labels at follows:

.1 Behind each access.
.2 At each change of direction, at junction boxes, and at both ends of each run.
.3 At not more than 15m apart in straight runs.
.4 Where passing through a wall, partition, and floor. One on each side of wall, partition, and floor.

.3 Cable and conduit labels

.1 For power and lighting system feeders, install labels at either end of the conductors where terminated inside of equipment to match wiring diagram conductor identification or panelboard circuit numbers. Typical identification Panel AA circuit - 21; use "AA-21". For a three phase circuit provide identification on phase A conductor only. For a single phase circuit provide identification on the phase conductor.

.2 For lighting branch circuits identify circuit at panel and in outlet box connection to lighting fixture. Install label on phase conductor tap-off. Typical identification if fixture connected to Panel A, circuit 5; marker identification A-5.

.3 For branch circuits supplying single phase and three phase devices such as receptacles and connections to equipment identify conductors at panel and in device outlet box. Install label on phase conductor inside outlet box. Typical identification if device is connected to Panel B - circuit 14, marker identification "B-14".

.4 For switchboards identify all control conductors at terminal strips inside equipment and where terminated at all remote devices. Identification shall match numbering system on Drawings and "Reviewed" shop drawings.

.5 For fire alarm systems, identify all conductors at terminal strips located in:

.1 Control panels.
.2 Annunciators.
.3 Printers.
.4 Local terminal cabinets.
.5 All remote devices.
.6 All connections in the system.
.7 Provide identification in accordance with the numbering system on the "Reviewed" shop drawings.

.6 For miscellaneous systems identify all conductors at terminal strips located in:

.1 Control and/or monitoring panels.
.2 Control and/or monitoring stations.
.3 Local terminal cabinets.
.4 All remote devices.
.5 All connections in the system.
.6 Provide identification in accordance with the numbering system on the "Reviewed" shop drawings.

.4 Equipment nameplates

.1 Provide shop drawings of the lamacoid label designs to be reviewed and approved by Queen's Facilities Engineering prior to manufacture.

.2 Provide lamacoid name plates, white background with black engraved letters high for normal power and red background with white engraved letters for emergency power 0.4" (10 mm), for electrical equipment but not limited to panels, switchboards, transformers, disconnect switches, breakers, contactors, relay panels, starters, TVSS, FACP and miscellaneous panels.

.3 Nameplates shall be in accordance with Queen's Building Standards Division 26 00 00 Section 4. Contractor to obtain the referenced Standards before proceeding and comply accordingly.

.4 Install plates after all painting has been completed. Secure with mechanical fastening devices except on the inside of panel doors where gluing will be acceptable.

.5 Power system colour code

.1 Power system phase colour code:

.1 Red - Phase A
.2 Black - Phase B
.3 Blue - Phase C
.4 Neutral - White
.5 Ground - Green.

.2 Identify incoming utility service lines with enamel paint to above colour code.

.3 Band buses in switch board and panels to above colour code.

.4 Provide branch conductor to above colour code.

.6 Manufacturer's nameplates

.1 Have the manufacturer's nameplates affixed to each item of all equipment showing the size, name of equipment, serial number and all information usually provided, including voltage, cycle, phase, horsepower, etc., and the name of the manufacturer and his address. Ensure that all stamped, etched or engraved lettering on plates is perfectly legible. Ensure that nameplates are not painted over. Where apparatus is to be concealed, attach the nameplate in an approved location on the equipment support or frame.

.2 Ensure that panels and other apparatus which have exposed faces in finished areas do not have any visible trade marks or other identifying symbols. Mount nameplates behind doors.

.7 Signage and marking

.1 Provide signage to local inspection authority on all equipment and electrical rooms.

.2 The suitable warning signs must be installed as per Electrical Safety Code.

.3 Where applicable, provide warning signs for ground fault protection circuit as required by OESC section 68-068.

.4 Where applicable, provide warning signs and marking for the power disconnect switches for fire pumps as per NFPA-20, section 9.3.

.8 Single line distribution drawings

.1 Provide clear acrylic covered framed as-built single line distribution system drawing of the entire project in the main electrical room. Distribution system shall be CAD generated. Size shall be minimum 305 x 460 mm with all text legible. Provide interim drawings until such time that permanent as-built drawings are available for permanent installation.

2.2 WIRES AND CABLES

.1 Comply with the requirements of the latest editions of the followings:

.1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.
.2 CAN/CSA-C22.2 No.131 – Type TECK 90 Cable.
.3 CSA C22.2 No. 38, Thermoset Insulated Wires and Cables.
.4 CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables
.5 CSA C22.2 No. 65, Wire Connectors.

.2 All cables shall be copper.

.3 Use copper conductors TWH, 600V, 90°C rated insulation unless otherwise noted.

.4 Use RW90 X-Link, 1000V, minus 40 degree, 90°C rated insulation for 250MCM and larger.

.5 Joints in feeder cables are not permitted.

.6 Except as indicated hereinafter, wire for branch circuits to be #12 AWG except that #10 minimum to be used where the home run exceeds 27m (90').

.7 Wires for power circuits to be #12 AWG minimum, and for control circuits to be #14 AWG minimum.

.8 Solid conductors of #12AWG and smaller. Stranded conductors for #10 AWG and larger.

.9 For wiring through or in lighting fixtures use type 'GTF' fixture wire, rated 600 volts to meet code requirements for recessed fixtures.

.10 Wire to ceiling outlet boxes on which a lighting fixture is or may be mounted, with conductors having insulation suitable for 90°C.

.11 Cables located in plenum, ceiling or floor spaces shall be totally enclosed in non-combustible conduit or raceway or be armoured cable where permitted by the Ontario Building Code.

.12 Wires and cables for outdoor locations shall be minus 40°C rated.

.13 Armoured cables shall be complete with interlocked aluminum armour, approved fastening and connectors and meet the requirements of Vertical Flame Test-Cables in Cable Tray of CSA C22.2 No. 0.3. The PVC jacket cables (TECK 90 and ACWU90) shall be FT6 rated.

.14 Install all wiring in conduit, unless indicated as armoured. Route wire and cable to meet Project conditions. Use suitable cable fittings and connectors.

.15 Use an approved lubricant to assist in pulling conductors through conduit. Neatly train and lace wiring inside boxes, equipment and panelboards.

.16 Balance the loading on feeders so that unbalanced load is less than 10%.

.17 Limit the voltage drop at the end of feeders and branch circuits to 2% at the rated load of the circuit.

.18 For single conductor armoured cables, where required to conform to the Electrical Safety Code, Rule 12-108, Bulletin 12-7-11.

.19 Lighting fixture wiring in accessible ceiling spaces shall be run in conduit from the lighting panel to ceiling outlet boxes with armoured cable drops no longer than 3.0m (10 ft.) permissible from the boxes to fixtures.

.20 Protect all exposed non-armoured cables in manholes, pull pits and trenches with an approved fire protective fibreglass tape of '3M' manufacture or approved equal. Extend the protective wrapping on the cables where they leave pull pits or trenches below switchgear to the circuit breaker or fused switch terminals. Rack cables in manholes and pull pits to provide clear access for maintenance and servicing.

.21 BX may be used in hollow partitions for receptacles.

2.3 RACEWAYS AND FITTING

.1 Drawings do not show all raceways. Those shown are generally in diagrammatic form only.

.2 Conform with the requirements of the latest editions of the following:

.1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.

.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. 62, Surface Raceways and Lighting Fixture Raceways and Fittings.
.5 CSA C22.2 No. 83, Electrical Metallic Tubing.
.6 CSA C22.2 No. 126, Cable Tray System.
.7 CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
.8 CAN/CSA C22.2 No. 227.3, Flexible Non-metallic Tubing.
.9 CSA C22 No. 18, Outlet Boxes, Conduits Boxes, Fittings and Associated Hardware.

.3 Conduits

.1 Rigid steel conduit hot dip galvanized inside and outside installed:

.1 On the exterior of building;
.2 Where exposed to mechanical damage;
.3 Where conduits turn up or turn down out of concrete slab;
.4 Damp and wet locations.

.2 Steel galvanized electrical metallic tubing (EMT) installed:

.1 In partitions;
.2 In ceiling spaces;
.3 In service spaces.
.4 In masonry walls.

.3 Rigid PVC (unplasticized) conduit except for exit light, emergency lighting, and fire alarm system installed:

.1 In slabs with rigid steel galvanized turn-up;
.2 Underground with rigid steel galvanized turn-up;
.3 In concrete walls;

.4 Flexible armoured conduit:

.1 In partitions;
.2 For lighting fixture drops;
.3 From ceiling junction boxes into wall outlets;
.4 Flexible armoured conduits shall be limited to 10'-0" lengths where run horizontally from take-off junction boxes.

.5 Liquid tight flexible conduit

.1 Final connection to motors.
.2 Any equipment which vibrates or generates noise.

.6 For EMT use steel concrete tight set screw fittings as manufactured by T & B or equal. Die cast or pressure cast fittings are not acceptable. For rigid steel conduit use only steel or malleable iron threaded fittings. Threadless, die cast or pressure cast fittings are not acceptable.

.7 ENT might be used where permitted by OESC, provided with mechanical protection as required by OESC.

.8 Provide bushings on the ends of all conduits in enclosure, boxes, panels and cabinets, to protect the conductor installation. Except where grounding bushings are specified use all plastic insulated bushings temperature rating 150ϟC with double locknuts.

.9 Use PVC conduit for all landscaping locations where conduit comes in contact with soil. Refer to Landscape Drawings for final elevation of planting soil. Co-ordinate and adjust electrical devices accordingly.

.10 Conceal all conduits except in service spaces, mechanical rooms, electrical rooms and areas with ceilings.

.11 Install all locknuts and bushings to ensure a secure mechanical and electrical bond. Use Erickson couplings in lieu of running threads.

.12 Where conduit joints occur in concrete, use silicone sealing compound to make water tight.

.13 Lay out conduit to drain free of all moisture.

.14 Securely hold conduits in place in concrete or masonry during pouring and construction operations; provide templates, forms and spacers as necessary.

.15 Support multiple runs of conduit on channel or angle iron with rod hangers.

.16 Secure all conduits in place with conduit clamps T & B or equal. Perforated pipe straps, wire lashings, wood screws or nails are not acceptable.

.17 Provide conduit expansion joints where conduits cross building expansion joints, also in straight runs of conduit 30 m (100') or longer. Conduit expansion joints shall be telescoping sleeve type, with insulated bushings and ground jumper.

.18 Make field bends and offsets uniform and symmetrical without flattening conduit. Minimum bending radius shall be ten (10) times the conduit diameter.

.19 Ream conduit ends to remove burrs and sharp edges. Fit conduit stubs with waterproof plastic caps during installation to protect threads and to prevent entrance of moisture into conduit.

.20 Test all conduits for clear bore using ball mandrel, brushes and snake. Clear any conduit which rejects the ball mandrel. Replace if necessary. Bear all costs involved in making all work good, restoring all surfaces to original condition.

.21 Install a continuous nylon cord 180 kg (400 lb) test in each conduit left empty.

.22 Install a copper ground conductor within the flexible conduit at each connection.

.23 Provide conduit seals in conduits which pass to the outside.

.24 Provide pull boxes, fittings or junction boxes in conduit runs, on the basis of not more than two (2) right angle bends or their equivalent or not more than 30 m (100'), in straight runs between boxes. For outdoor direct buried conduit, up to 50m.

.25 Size conduits to code requirements, provide larger sizes where noted.

.26 Size conduits for low voltage wiring to manufacturer's recommendations.

.27 Provide conduit sealing fittings and correspond for hazardous application to Electrical Safety code requirements.

.28 Maximum conduit size permitted in a concrete slab shall be 35 mm. In any case verify with Structural Consultant for acceptability.

.29 Where multi-conduits parallel run and/or crossover in concrete slab/wall, verify with Structural Consultant for acceptability.

.30 Where EMT/steel conduit is used provide a separate ground wire in the conduit.

.4 Cable tray

.1 Provide cable tray where noted on the drawings.

.2 Cable tray shall be continuous, welded steel wire mesh, and cable tray with the following features:

.1 Permits continuous ventilation of cable and maximum dissipation of heat.
.2 Continuous safety edge T-welded wire lip.
.3 Welded at all intersections.
.4 Straight sections shall be minimum 150mm (H) x 450mm (W) in configurations unless otherwise noted. Cable trays shall support CAT 6a cable weight.
.5 Constructed of carbon steel wire, ASTM A 510, grade 1008. Wire welded, bent, and surface treated after manufacture.
.6 Post fabrication finish of electro-plated zinc galvanizing: ASTM B 633, Type 111, SC-1.
.7 Fittings: Field fabricated in accordance with manufacturer’s instructions from straight sections.

.3 The support system shall be Cablofil Field Mate hanger system. The necessary hardware, including splice connectors and support components furnished by manufacturer.

.5 Surface metal raceway

.1 Provide surface raceway as required. The surface metal raceway systems shall consist of surface metal raceway, appropriate fittings and device brackets to complete installation.

.2 The raceway is to be utilized in dry interior locations only as per Ontario Electrical Safety Code.

.3 Submit drawings for approval showing the complete layout of all products that make up the complete system for each floor prior to installation with raceway lengths, device type (power and data), locations and circuits identified, complete with data sheets and samples.

.4 The surface raceway system specified herein for branch circuit wiring and/or data network, voice, video and other low-voltage wiring shall be Hubbell HBL4750 series or Wiremold V4000 Series. The raceway shall be metal, two-piece design with a base and a snap-on cover. The raceway shall be complete with one integral barrier in the base for power/data separation. Power shall be in top; data in the bottom. Finish shall be ivory unless otherwise noted.

.5 For individual devices located on surfaces where conduit cannot be recessed provide single or double channel raceway system products.

.6 Receptacle / Data plates shall be Wiremold V4047 series, or equaled by Hubbell.

.7 Exposed raceway in finish area (not in service spaces, mechanical/Electrical room, ceiling, etc) shall be: Hubbell HBL500 series or Wiremold V700, ivory finish.

.6 Install raceways system complete with appropriate fittings such as connectors, bushings, elbows, couplings, locknuts, expansion fittings, fasteners and supports and accessories supplied as integral parts of assembly, as specified. Installation shall comply with Regulatory Authorities requirements.

.7 Neatly install exposed raceway running parallel to and at right angles to building lines and equally spaced in groups.

.8 Keep raceway ends parallel and on proper spacing to suit knockouts or raceway openings in equipment or enclosure.

.9 Keep raceways at least 150 mm clear of heating pipes, flues and hot item surfaces. Where required clearance cannot be provided, obtain written approval from engineer to alter layout or to reduce clearance.

.10 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.

.11 Use only metallic, enclosed raceway on installation that required shielding of electrical cables or where installed in ceiling used as return air plenum, as specified or indicated on Drawings.

.12 Raceways shall have established positive low resistance paths to ground and effectively isolate conductors so that any short-circuit arc is confined.

.13 Select appropriate fittings, such as grounding bushings, bonding and grounding straps, to maintain continuity and effectiveness of grounding of raceway system.

.14 Provide necessary fasteners and supports acceptable for type and size of raceways, to ensure rigid, complete assembly.

.15 Provide suitable inserts or expansion type machine bolts for fastening raceways, fittings, boxes and equipment to concrete surfaces.

.16 Do not use wood screws, lag screws, expansion shields, rawl plugs and nylon inserts.

.17 Secure raceway and other associate work to structure members. Raceway shall not be supported from ceiling suspension system.

.18 Thoroughly clean raceway and dry clear obstructions before pulling cable or wire.

.19 Minimum raceway size: 16mm (1/2”) conduit equivalent system.

2.4 OUTLET AND CONDUIT BOXES

.1 Comply with the requirements of latest edition of the followings:

.1 CSA Standard C22.2 No.18, Outlet Boxes, Conduit Boxes and Fittings.
.2 CSA Standard C22.2 No. 85, Rigid PVC Boxes and Fittings.

.2 Outlet and conduit boxes - general

.1 Size boxes in accordance with CSA C22.1.
.2 102mm 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 347V outlet boxes for 347V switching devices.
.6 Combination ganged boxes with appropriate steel removable barriers where outlets for more than one system are grouped.
.7 Where standard make boxes are not suitable, provide boxes of special design to fit space and other requirements.
.8 Where vapour proof lighting is specified, provide matching vapour proof ceiling or wall junction boxes and fittings as required.

.3 Sheet steel outlet boxes

.1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38mm or as indicated. 102mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
.2 Electro-galvanized steel utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48mm.
.3 102mm square or octagonal outlet boxes complete with steel fixture studs where supporting lighting fixtures. Die cast fittings not permitted.
.4 102mm square outlet boxes with extension and plaster rings for lush mounting devices in finished plaster or tile walls.

.4 Masonry boxes

.1 Electro-galvanized stamped steel masonry single and multi gang boxes for devices flush mounted in exposed block walls, minimum size 95x 50 x 64mm standard and 102 x 57 x 61mm for 347V.

.5 Concrete boxes

.1 Electro-galvanized stamped steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

.6 Floor boxes

.1 Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28mm for receptacles; 73mm for communication equipment.
.2 Round (Floor Mount): 84mm x 63mm deep minimum complete with side and bottom knock-outs.

.3 Rectangular: one, two, or three gang flush device floor boxes minimum size 110 x 81 x 70mm removable barriers for power/low voltage cables, complete with side and bottom knockouts.

.4 Multi-Outlet: Electro-galvanized tamped steel concrete type, combination power / communication, flush mounting complete with modular device plates, side and bottom knockouts, lift-up cast aluminium recessed cover and cable lid, black epoxy powder finished 229x257x76mm deep, or 64mm deep.

.5 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16mm and 21mm conduit.

.6 Raised Access Floor Boxes

.1 Electro-galvanized steel, combination power and communication. Flush in raised floor tile complete with lift-up cast aluminium recessed cover cand cable lid. Modular device plates, 254m flexible armoured dable and plug for power

.2 Dimensions: 203 x 152 x 114mm.

.7 Conduit boxes

.1 Cast FS or FD aluminium, or feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

.2 PVC FS or FD boxes or PVC conduit where required in special corrosive areas as indicated on Drawing.

.8 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 35mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

.9 Installation

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come with 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washer are not allowed.

.5 Size and install appropriate boxes and enclosures in accordance with applicable section(s) of Ontario Hydro Electrical Safety Code and manufacturer’s recommended procedures.

.6 Co-ordinate location and installation of boxes so as to be accessible and clear from building system equipment, etc.

.7 Install pull boxes in inconspicuous but accessible locations.

.8 Use pull boxes for conduits larger than 35mm. Use conduit outlet bodies for conduit 35mm.

.9 Provide approved hole plugs in unused conduit knockouts and openings.

.10 Furnish boxes and enclosures with corrosion resistant machine screws.

.11 Boxes and enclosures embedded in concrete for flush mounting, shall be secured properly with connecting conduits and related works set in place before concrete is poured. Forms, when used, shall be able to be removed without disturbing installed boxes or enclosures.

.12 Ensure junction and outlet boxes mounted in ceiling cavities do not interfere with removal of ceiling tiles.

.13 Use masonry boxes for flush mounting in exposed block walls, concrete boxes for flush mounting in concrete wall.

.14 Furnish conduit boxes with neoprene gaskets for outdoor area or hazardous area application.

.15 Install all wall boxes for door security access devices, fire alarm devices, etc., adjacent to lock side of door openings unless otherwise shown. Check door swing before installing any switch.

.16 Install all boxes in walls so that tapped holes for mounting wiring devices or fixtures will be aligned vertically or horizontally, as required. Where boxes are grouped at one location with common and varying mounting heights, align boxes horizontally and vertically from centre line unless otherwise indicated.

.17 Offset outlet boxes in sound attenuating partitions to avoid undue transmission of sound between the partition elements. Use flexible conduit connections where wiring is required between outlet boxes on opposite sides of partition.

.18 Offset outlet boxes where installed on either side of a fire separation.

.19 Where steel supports are required for outlet boxes, wood supports are not acceptable.

.20 Maintain integrity of vapour barriers along building perimeter wall where flush outlet boxes are required.

2.5 ACCESS PANELS AND DOORS

.1 All access panels and doors to be Milcor or Bel, 12 gauge with concealed hinges.

.2 In glazed tile walls provide #304 alloy stainless steel with #4 finish recessed frame and secured with stainless steel countersunk flush head screws.

.3 In plaster surfaces provide dished steel door for plaster finish with welded metal lath and plastic grommet for keyhole.

.4 In other finishes use plain steel door with lock and anchor straps, complete with factory prime coat.

.5 In lay-in ceilings, tiles properly marked may serve as access panels.

.6 Provide the appropriate Division of Work with panels and doors, complete with frames and all pertinent information for installation. Arrange and pay for that Division to install them. Ensure that all panels and doors are flush mounted and properly aligned with building modules and grids. Indicate locations on record drawings.

.7 Select all access panels and doors to provide adequate access, and to suit appropriate architectural finish, minimum size 150 mm x 150 mm (6" x 6"). Where necessary for persons to enter, provide minimum 600 mm x 450 mm (24" x 18") size doors.

2.6 SPRINKLER PROOF EQUIPMENT

.1 Provide all equipment in sprinklered areas with accessories to prevent the entry of water into the enclosures in the event that the sprinkler system is activated.

.2 Materials

.1 CSA enclosure type 2.

.2 Louvres facing outward and downward where openings are required for heat dissipation. Expanded metal screening is not acceptable.

.3 CSA certified sealing rings for rigid steel galvanized conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT) or other raceways as required.

.3 Provide seal rings and raintight connectors on all conduit terminations entering the top or side of all enclosures and for all conduit terminations for pull boxes, junction boxes, splitter troughs, wireways, auxiliary gutters, cable troughs and disconnect switches installed below the level of the sprinkler heads.

.4 Refer to Mechanical Drawings for extent of sprinklered areas.

2.7 BACKBOARDS

.1 Provide backboards for all surface mounted power distribution equipment. Provide backboards for telecommunication systems as indicated.

.2 Backboards shall be minimum 0.76” (19mm) thick, good one (1) side fire retardant plywood backboards, pressure impregnated with fire retardant chemicals, and stamp. Conform to CSA 080.

.3 Construct each backboard in a rectangular shape of the size as indicated. Where no size is indicated, provide a backboard a minimum 4” (100mm) higher than the equipment. Where more than one (1) piece of equipment is installed on the backboard, construct the backboard of a size to suit the maximum vertical and horizontal dimensions of the equipment. Backboards for Telecommunication system shall be minimum 4” (W) x 8” (H).

.4 Finish each backboard with one (1) coat of primer followed by a minimum of one (1) finish fire retardant coat of ASA 61 grey paint prior to installing any equipment.

.5 Fastenings:

.1 Fasten each backboard to a wall or to a support structure using cadmium plated hardware. Provide a flat washer under the head of each fastener. Recess the head of the mounting bolt where equipment, including future equipment, is to be installed.

.2 Use expansion shields, toggle bolts or other types of wall fastenings to suit the wall type. Align the mounting bolts with the wall studs for stud type walls.

.3 Install fastenings a maximum 20” (500mm) apart in both the vertical and horizontal directions.

.4 When installing equipment heavier than 50kg, fasten the equipment through the backboard directly to the wall or support structure.

2.8 METALS

.1 Metal construction required for the electrical work shown on the structural drawings will be carried out by Division 5.

.2 Provide all other electrical work such as, but not limited to, equipment bases, supports, catwalks, framework to support checker plates and electrical equipment above trenches and cable pits, ladders, etc. pit and trench covers, and as called for on the Electrical Drawings. Have such work carried out in accordance with the requirements of Division 5.

2.9 SLEEVES AND CURBS

.1 Provide conduit sleeves of galvanized steel for conduit and cable runs passing through concrete walls, beams, slabs and floor. Cut flush with finished surface.

.2 Extend galvanized conduit sleeves for conduit rising through slabs 4" minimum above finished floors.

.3 Through exterior walls below grade waterproofed floors, and other waterproof walls use heavy weight cast iron pipes machine cut. Extend sleeves 100 mm (4") above finished floors, and cut flush with underside of floor.

.4 For rectangular duct openings for bus ducts and cable tray use minimum 18 gauge galvanized steel sleeves or provide a removable wood box-out of the required size. Brace sleeves to retain their position and shape during the pouring of concrete and other work.

.5 Seal sleeves and openings to maintain fire rating. Use Dow-Corning #3-6548 `Silicone RTV' foam, Thomas & Betts `Flamesafe' firestop system, installed in accordance with the manufacturer's specifications and recommendations.

.6 Seal all openings and sleeves after installation of equipment:

.1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.

.2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.

.7 Size sleeves to provide 13 mm (1/2") clearance all around.

.8 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 7, Thermal and Moisture Protection.

.9 Except where furred in provide watertight concrete curbs, 100 mm (4") high by 100 mm (4") wide with 19 mm (3/4") chamfered edges around all sleeves and openings passing through waterproof floors.

2.10 SUPPORTS AND BASES

.1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with Work.

.2 Supply and erect special structural Work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.

.3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.

.4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.

.5 Secure supports, in general to structure, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.

.6 Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.

.7 Do not use explosive drive pins in any section of Work without obtaining prior approval.

.8 Hangers for electrical conduit shall be galvanized after fabrication. Conduit hangers shall be as manufactured by:

- Burndy Canada Ltd.
- Canadian Strut Products Ltd.
- E. Myatt & Co. Ltd.
- Steel City Electric Co.
- Pilgrim
- Thomas & Betts
- B-line

.9 Do not use, perforated strapping (grappler bars).

.10 Steel supports in wet or dry locations to be galvanized after fabrication.

.11 Provide concrete housekeeping pads or bases for all floor mounted equipment 100 mm (4") high with 19 mm (3/4") chamfered edges, keyed to the floor slab and extending at least 100 mm (4") on all sides of the equipment. Where draw-out truck type circuit breakers are provided extend pad to accommodate complete withdrawal of breaker. Provide and set all anchor bolts.

.12 Use only factory made threaded or toggle type insert.

.13 Place inserts only in structural members and not in the finishing material.

.14 Provide bus ducts, cable trays, and wireways with fire barriers at each floor level and fire separation.

.15 Provide locations and dimensions for all pads and curbs and provide and set all anchor bolts for all concrete work provided under Division 3, Concrete.

2.11 SPARE PARTS

.1 Furnish spare parts and maintenance materials as recommended by the equipment manufacturer and as appropriate for a period of two (2) years after acceptance of the Work.

PART 3 - EXECUTION

3.1 NEUTRALS AND PHASING

.1 Provide one (1) identified grounded neutral conductor for each set of branch circuits connected to different mains of each panel.

.2 For circuits identified as computer dedicated (D) or isolated ground (IG), provide individual neutral per identified circuit.

.3 Install a separate neutral for each GFCI circuit when the GFCI is located at the panelboard.

.4 Connect two or three (2 or 3) circuits sharing a common neutral to different mains or phases.

.5 Balance the connected loads across the mains of each panel to within 15%.

.6 Circuit numbers on the panels must correspond to the numbers on the Drawings.

.7 Connections in all equipment to be Phase A, B and C from left to right, and front to back when viewing from the front or accessible direction.

3.2 MOUNTING HEIGHTS

.1 Mounting heights are from floor level to centre line of device outlet, unless noted otherwise. Confirm all locations before installation. In all areas accessible to persons in wheelchairs , the mounting heights of all switches, thermostats, intercom switches, pull stations, etc., required by Building Code “Barrier Free” shall comply with Code requirements.

.2 The mounting heights of all power and lighting devices shall comply with Ontario Electrical Safety Code requirements. The mounting heights of all fire alarm devices shall comply with CSA requirements.

.3 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.4 Install electrical equipment at following heights (centre of device) unless indicated otherwise.

.1 Wall switches, dimmers, timers, speed controllers, speaker volume controllers, thermostats and hand dryers: 1100 mm.

.2 Wall receptacles:

- General: 600 mm in Apparatus Bay and 450 mm in other areas
- Above top of continuous baseboard heater: 250 mm minimum.
- Above top of counters or counter splash backs: 250 mm.
- In mechanical rooms: 1100 mm. (gang with switch)

.3 Panelboards: as required by Code or as indicated.

.4 Telephone, TV and data outlets: 600 mm in Apparatus Bay and 450mm in other areas.
.5 Wall mounted speakers: 150mm below ceiling or 2300 mm.
.6 Security key switches, card readers and intercom switches: 1200mm.
.7 Security wall-mounted motion sensor: 150mm below ceiling or 2300mm.

.5 Install all fire alarm equipment/devices in accordance with CAN/ULC-S524 "Standard for the Installation of Fire Alarm Systems" latest edition, the manufacturer's instructions, Ontario Building Code, Underwriter's Laboratory of Canada, Electrical Safety Code, these Documents and requirements of Local Authority Having Jurisdiction.

3.3 WIRING OF MECHANICAL EQUIPMENT

.1 Co-ordinate all the work with Mechanical Division. The locations of starters, motors and associated equipment indicated on the drawings are approximate and diagrammatic only. Co-ordinate with the work of the Mechanical Division Trade Sections to ensure proper location of equipment. The exact locations of conduit terminations at Mechanical units shall be determined from equipment manufactures' approved shop drawings. Conduits must be installed to enter only in the locations designated by equipment manufactures.

.2 Provide all electric baseboard heaters, cabinet heaters, force flow unit heaters and heating cables. Mechanical Division shall provide electric duct heaters.

.3 Provide safety disconnect switches required at motors by OESC whether shown on the drawings or not. Provide power wires and connections to all mechanical equipment.

.4 All the motor starters/controllers, and/or line voltage thermostats shall be supplied by Mechanical Division and installed by Electrical Division. Electrical Division shall provide safety disconnect switches and power connections to the motors. Mechanical Division shall provide all the control wiring, control devices and low voltage thermostats.

.5 Where motor starters, switches and the like, are grouped together, provide suitable plywood backboard to which all such equipment shall be secured.

.6 Where the single-phase exhaust fan shall be controlled by manual switch, Electrical Division shall provide power connections to the fan, heavy-duty toggle control switch and provide the safety disconnect means.

.7 Wiring and connections from fire alarm system to motor starters/control panels for motor control operations. Co-ordinate with Mechanical Division.

.8 Where applicable, power supplies to MCC. Mechanical Division will provide MCC, main lugs, power supplies and controls to motors.

.9 Fire alarm signals to starters / control panels and MCC.

3.4 SERVICES TO EQUIPMENT SUPPLIED BY OWNER / OTHER DIVISIONS

.1 Provide all necessary connections required for equipment supplied by the Owner and other Divisions. Examine all Drawings and Specifications and identify all requirements.

.2 Verify the type, rating and location of all outlets and/or connections required for all equipment provided by the Owner and other Divisions.

.3 Provide isolation devices as required to the equipment for all services.

3.5 PROVISION FOR FUTURE EQUIPMENT AND CONSTRUCTION

.1 Spaces designated for future equipment or building expansion shall be left clear.

.2 Provide services for future extensions complete with Products necessary for present termination and to permit future extension.

.3 Identify each service by a permanent marker at its termination point.

3.6 CUTTING AND PATCHING

.1 Provide all cutting and patching required for the Work of Electrical Division. Work shall be carried out in conformance with the requirements of Division 2. Include any radiography required to locate concealed services before penetrating into inaccessible locations.

.2 Any modifications to building shall be done so as not to diminish structural, fire resistance, or smoke barrier integrity.

.3 Proposed modifications to structure shall require acceptance by the Structural Engineer.

.4 Consultant shall be afforded the opportunity to review the intent prior to any major cutting.

3.7 PAINTING

.1 Provide all exposed ferrous metal work, and Products, except conduit, with at least one (1) factory prime coat or paint one prime coat on site. Clean up or wire brush all equipment before painting. Unless otherwise noted finish painting will be done under Division 9, Finishes of these Specifications.

.2 If not factory coated, clean, wire brush and paint all ferrous supports and hangers concealed in ceiling spaces of kitchens or other similar high humidity areas. Do not paint galvanized supports and hangers.

.3 Repaint or refinish all damaged factory applied finishes.

.4 Provide oil base red oxide primer applied as per manufacturer's recommendations.

3.8 VIBRATION AND NOISE CONTROL

.1 Spring type vibration isolations shall be complete with horizontal spring constant (kH) to vertical (kV) ratio between one and two to assure stability. Select springs to operate no greater than 2/3 solid deflection. For indoor mounting use springs with one (1) coat of zinc chromate primer and two (2) coats of paint. For outdoor mounting use springs of neoprene coated steel or stainless steel. All spring housings to be hot dipped galvanized. Where the spring assembly is bolted to the floor provide vibration isolation washers and pads to reduce transmission of vibration.

.2 Pad type isolators shall be rubber for indoor application, neoprene for oil filled devices and for outdoor use. Use 30 durometer rubber and 50 durometer neoprene. Select pad type isolators which do not exceed the mid-point of their recommended operating rate with maximum deflection of 20% of thickness. Use minimum 6 mm (1/4") thick pads under spring assemblies.

.3 Provide spring type vibration isolators for IC engine driven equipment. Raise equipment to operating height, leveled with blocks and shims so that connections can be made to a rigid system at operating level before isolator adjustments.

.4 For power class transformers provide spring or pad type isolators in accordance with the manufacturer's recommendations. Where dry type transformers are contained within unit substation enclosures mount the core and coils to the structural framing of the unit substation. Locate isolators between core and coil frame and unit substation structural frame.

.5 Provide pad type isolators for all floor mounted dry type distribution transformers. Locate isolators between transformer enclosure and floor.

.6 Where transformers are platform mounted from structure above provide spring hangers with leveling devices and sound pads in all supports.

.7 Make connections to rotating, vibrating, magnetic or other noise producing equipment such as motors, transformers, and between independent structure by means of loop flexible conduits.

.8 If objectionable noise or vibration should be transmitted to occupied portions of the building by any part of the electrical work, make necessary changes and/or additions, to the Consultant's approval, without addition to the contract price.

3.9 CONCRETE

.1 Concrete work shown on the structural drawings will be done as part of Division 3, Concrete of these Specifications.

.2 Provide all other concrete work necessary for the Work of this Division. Have such work carried out in accordance with Division 3, Concrete of these Specifications.

3.10 EXCAVATION AND BACKFILLING

.1 Before commencement of excavation of the Work, determine with the Consultant, the municipalities and utilities, the presence of existing underground services at the site and verify satisfactory condition. Locate such services and mark out same. Ensure that all trades concerned are aware of their presence.

.2 Do all excavation and backfilling up to grade required for the electrical work inside and outside of building. Check available soil test reports. Obtain instructions of the Consultant regarding the type of soils and their extent.

.3 Carry out all trench excavation in strict conformity with all applicable acts and bylaws.

.4 Excavate to the required depth and width. Backfill excess excavation.

.5 For direct buried cable in all soil conditions excavate to 150 mm (6") below and a minimum of 200 mm (8") to either side of the cable run. Fill back with a bedding of granular 'A' gravel or sand.

.6 Provide ducts under roads and paved areas.

.7 Refer to details and to Utility Company requirements for concrete encased duct installations.

.8 Where excavation is necessary in proximity to and below the level of any footing, provide a sleeve at the proximity and backfill with 14,000 kPa (2,000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Consultant.

.9 Protect the bottom of excavations against flooding and freezing. Use pumping or other means to keep bottom dry. Do not open more than weather will permit. Have excavations inspected at least once a week by authorities. Break up rocks and boulders and remove these by drilling and wedging. Do not use blasting unless approved in writing by the Consultant.

.10 Compact all backfill to a density of 95% Modified Proctor. Before backfilling, obtain approval. Remove all shoring during backfilling. Obtain approval for all compaction machines used.

.11 Backfill trenches within building, with clean sharp sand in individual layers of maximum 150 mm (6") thickness. Manually compact the first layers up to a compacted level of 300 mm (12”). Machine compact the balance up to grade, using approved equipment.

.12 Backfill trenches outside buildings, not under roads, parking lots, or traffic areas, manually compact up to a compacted level of 450 mm (18") above the cable or duct bank with individual layers of material up to 150 mm (6") thick, using sand or granular 'A' gravel. Machine compact the balance up to grade with 150 mm (6") layers of approved excavated material.

.13 Backfill all other trenches outside buildings with granular 'A' gravel in layers not exceeding 150 mm (6") thickness, up to grade level; manually compact up to 450 mm (18"), machine compact the balance.

.14 Do not use water for consolidation or during compaction of backfill, unless approved in writing by the Consultant.

.15 After a period has passed adequate to reveal any settlement fill all depressions to correct grade level with appropriate material, machine compacted. Pay all costs required to make good all damage caused by settlement.

.16 Store and dispose of excavated materials as follows:

.1 During the progress of the contract place the material as directed in such a manner that a minimum of damage or disfigurement of the existing ground will result and the material will not in any way impede the progress of the work. Dispose of surplus material as directed by the Consultant.

.2 Place surplus topsoil separately from subsoil. Leave the site clear and unencumbered.

.3 Protect, brace, support as required existing pipes, ducts, cables, etc. encountered in the work. Do not disturb or interrupt the operation of any services without written approval from the Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical General Requirements.

.3 Provide all grounding to comply with the Ontario Electrical Safety Code and the latest instructions of the Inspection Authority, with any further requirements as noted herein.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 All grounding conductors stranded copper, bare or insulated as required.

.2 All grounding conductors stranded copper, bare or insulated as required.

.3 Use Cadweld process for all weld connections. Burndy and/or AMP of Canada Ltd. mechanical grounding connectors are an acceptable equivalent to welded connections.

.4 All ground connectors to be designed and approved for grounding purposes.

.5 Ground buses – 7 mm x 40 mm, 305 mm long or as required.

.6 Ground electrodes - 3040 mm x 20 mm copper clad steel ground rods.

PART 1 - EXECUTION

3.1 INSTALLATION

.1 Provide ground busses in the main electrical room for use in bonding equipment in the room. Ground the buses per Electrical Safety Code. Provide ground connections from buses to main low voltage switchboards and all exposed metal work. Provide ground connections to the main water supply pipe.

.2 Connect the ground bus inside the switchgear assembly to the grounding system.

.3 Inside main secondary switchboard, connect the neutral bus to the ground bus with conductor rated minimum 25% main bus rating.

.4 Connect each transformer neutral to main ground bus in main electrical room with separate protected ground conductor to electrical safety code requirements.

.5 Connect the ground bus in each emergency distribution panel to the grounding system. Connect generator to the grounding system.

.6 Bond all interior non-electrical metallic piping systems to the electrical system ground including, but not limited to, water supply, wastewater, and gas systems.

.7 Bond all conduit, and all non-current carrying metal parts, equipment cases, frames, bases, brackets, etc.

.8 Bond each piece of fixed equipment back to the switchboard or panel feeding that equipment, by one of the following methods:

.1 Where equipment is fed by a steel conduit, provided sizing is adequate, utilize conduit for the ground return conductor. At switchboard provide a grounding bushing, and strap such conduits to the ground bus (size per Code).

.2 Where the size of the conduit is inadequate (per Code), or if the conduit is flexible, install a separate insulated copper ground inside the conduit. At the switchboard or distribution panel, provide a grounding bushing, loop the ground conductor through the bushing, and connect to the switchboard ground bus. At the fixed equipment, connect to an internal ground bus, or connect to the inside of the metal enclosure utilizing approved screws and connectors (remove all paint).

.3 For branch circuits, the conduits may be used for grounding, provided seamless steel fittings are used on EMT and threaded fittings are used on rigid conduit. At each receptacle connect a stranded copper ground wire from the outlet box to the grounding terminal on the receptacle. Install a separate grounding conductor in all PVC conduits.

.4 Where equipment is fed by a multi-conductor power cable, provide a ground conductor in the cable. At the switchboard or panel, connect to the ground bus. Use a grounding connector on the cable for positive grounding of the metallic sheath. Loop the ground wire to the grounding connector.

.9 Run a separate ground wire in all flexible conduits. Connect each end to ground bus or lug or connector.

.10 Where mechanical protection is required for insulated grounding conductors install in rigid conduit. Use rigid PVC conduit in concrete or below grade slab and aluminum conduit in other locations.

.11 Provide weld connection or mechanical grounding connectors for:

.1 All connections between grounding conductors.
.2 All connections to building steel.
.3 All connections between grounding conductors and cable lugs.

.12 Where single ground conductor is in one conduit, the conduit must be non-ferrous.

.13 Arrange grounding to provide the minimum impedance paths for ground fault currents. Provide any additional grounding required for approval by the inspecting authorities.

.14 All low voltage neutral ‘XO’ of the transformer shall be bonded to the transformer enclosure/frame with a minimum conductor sized as per Ontario Electrical Safety Code, Table 16.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This Section of the Specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general condition, Supplementary conditions of the contract, section 260100 – Electrical General Requirements

.3 Comply with section 260500 – Basic Materials & Method.

.4 Comply with EIA/TIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.

.5 Comply with J-STD-607-A, Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.2 SCOPE

.1 Provide empty raceway systems including conduits, cable trays, terminal cabinets, plywood backboards, pull boxes, outlets and cover plates for enclosure of wiring.

.2 Telecommunication systems include, but not limited to, telephone, data cabling, cable TV, P.A., security and access control, emergency alarm, etc.

.3 Co-ordinate with system contractors for all the work.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted. Provide stainless steel cover plates for the outlet boxes for future use.

.2 Conduit size shall be in accordance with systems contractor's requirements and recommended standards.

.3 Minimum pull box size shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:-
	Width	Length	Depth	
27mm	102mm	406mm	76mm	51mm
35mm	152mm	508mm	76mm	76mm
53mm	203mm	914mm	102mm	127mm
78mm	305mm	1219mm	127mm	152mm
103mm	381mm	1524mm	203mm	203mm

.4 Plywood backboards shall be minimum 1200 x 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.

.5 Provide a minimum of 2 duplex receptacles on separate circuits at each backboard.

.6 Provide grounding at each backboard.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8" nylon pull cord (minimum 400LB) continuously from outlet to outlet, through conduit and fasten at each box.

.3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.

.4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30,000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease.

.5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by systems contractors to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical General Requirements.

.3 Provide factory assembled panelboards as herein specified and as shown on the Electrical Drawings.

.4 Refer to the Electrical Drawings for: voltage; phase; size and type of mains; size, type and quantity of the branch devices; location; surface or flush mounting.

1.2 REFERENCES

.1 Comply with the requirements of the latest editions of the following:

.1 CSA C22.2 No. 29 - Panelboards and Enclosed Panelboards.
.2 CSA C22.2 No. 5 - Molded Case Circuit Breakers.
.3 CSA C22.2 No. 4 - Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 260100 – Electrical General Requirements.

.2 Shop drawings shall include electrical details and dimensions of panel, branch circuit device (breaker and switch) type, quantity and ampacity.

1.4 MANUFACTURERS

.1 The manufacturer of the panelboards shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.

.2 Product of one manufacturer for entire project. Acceptable manufacturers are:

.1 Cutler-Hammer
.2 Schneider
.3 Siemens

PART 2 - PRODUCTS

2.1 RATINGS

.1 Panelboards rated 120/208 volt AC shall have short-circuit rating as shown on the Drawing, but not less than 10 kA RMS symmetrical.

.2 Panelboards rated 347/600 volt AC shall have short-circuit rating as shown on the Drawing, but not less than 14 kA RMS symmetrical.

.3 Panelboards shall be labeled with the short-circuit rating.

.4 Where series ratings are applied, provide the labels in accordance with the requirements of Electrical Safety Code. The labels shall state but not limited to:

.1 Size and type of upstream devices;
.2 Branch devices that can be used;
.3 Short-circuit rating.

2.2 CONSTRUCTION

.1 Interiors shall be completely factory assembled devices.

.2 Enclosure:

.1 Indoor dry locations: CSA type 1.
.2 Indoor sprinkler locations: CSA type 2.
.3 Outdoor locations: CSA type 3R.

.3 Provide doors with concealed hinges, combined locks and latches for all panelboards except fusible disconnect switch type distribution panelboards.

.4 Two (2) keys for each panelboard and key all panelboards alike.

.5 Interior trim shall be dead-front construction to shield user from energized parts.

.6 Main bus shall be tin finished high quality copper and extend the full length of the panel. Ground bus shall be sized to accommodate branch circuit grounding conductors. 200% neutral as required.

.7 Sequence phase bussing with odd numbered sections on left and even on right, with each section identified by permanent number identification as to circuit number and phase.

.8 Provide bolt-on type circuit breakers and/or disconnect switch units.

.9 Means of locking off to meet the Department of Labour requirements for elevator panelboards.

.10 Minimum circuits shall be 42, unless otherwise noted.

.11 Trims and doors shall be painted ANSI 61 grey. Factory applied paint finish on all exterior surfaces.

.12 All required lugs.

.13 Connectors for future breakers and switches. Drill and tap bus work.

2.3 OWNER'S METERING

.1 Digital metering units shall be provided as owner's check meter and shall provide/possess at least the following items:

.1 Volts each phase.
.2 Volts each phase to neutral.
.3 Current per phase.
.4 Real power (kW).
.5 Reactive power (kVAR).
.6 Apparent power (kVA).
.7 Power factor.

.8 Frequency
.9 Energy (kWh).
.10 Peak demand (kW, kVAR, kVA).
.11 THD
.12 Recording hourly load to generate a load profile.
.13 Communications port to allow multipoint communications with remote monitor, PC, printer, etc
.14 Metering accuracy shall be at least to 0.25% of reading plus 0.05% of full scale for voltage and current, and 0.5% of reading plus 0.05% of full scale for power and energy, all through the 31st harmonic.
.15 Accept metering inputs of up to 600 Vac direct connections.
.16 Complete with 5A secondary current transformers.

.2 Units shall be Canadian revenue metering approved to Measurement Canada Standards.

.3 Owner's meter shall be installed as indicated on single line diagram drawing.

2.4 CIRCUIT BREAKERS

.1 Circuit breakers shall be quick-make, quick-break type, for manual and automatic operation, with over centre toggle handle. The handle shall reside in a position between “ON” and “OFF”.

.2 Circuit breakers shall have thermal and magnetic trip mechanism, to provide inverse time current tripping and instantaneous tripping, trip-free and trip indicating. Circuit breakers rated at 125A and larger shall have thermal and adjustable magnetic trip mechanism.

.3 Multi-pole breakers shall be common trip type and have a common handle. Tie handles are not acceptable.

.4 Clearly marked with their rated ampacity and respective trip rating and visible without removing bolted covers.

.5 Provide handle locking devices on all branch circuit breakers controlling communication equipment, lighting control, exit signs, emergency lighting, fire alarm system and other life safety equipment.

.6 Circuit breakers feeding unswitched lighting circuits shall be “switching duty” type.

.7 Provide class ‘A’ ground fault protection with the circuit breaker, where required by Electrical Safety Code.

2.5 FUSIBLE SWITCH UNITS

.1 Refer to Section of Disconnect Switches.

.2 Fusible pull-outs or door-operated type switches not acceptable.

2.6 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 260500.

.2 Identify circuits controlled by each breaker on directory cards provided with panels. Directories shall be typed and mounted in metal frame with clear plastic cover.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install panelboards securely, plumb, true and square, to adjoining surface.

.2 Provide three (2) empty 35 mm (1 ¼") conduits from all recessed lighting and receptacle panelboards, terminated in ceiling space above.

.3 Provide three (3) empty 53 mm (2") conduits from all recessed distribution panelboards, terminated in ceiling space above.

3.2 SYSTEM COORDINATION AND SHORT CIRCUIT STUDY

.1 Retain the services of an approved testing company to perform protective co-ordination study to establish optimum settings and selections for all protective devices. Provide system coordination study and short circuit study for HV switchgears and cables, power transformer, LV switchgears and cables, and emergency generator system.

.2 The study shall illustrate:

.1 Study single line diagrams, showing steady-state and transient values.

.2 Three phase bolted fault current, symmetrical and asymmetrical, and minimal arcing ground fault values.

.3 Time-current characteristics curves of all pertinent relays, breakers, fuses, etc.

.4 Thermal damage curves for cable, transformers, motors and the like.

.5 Summation chart showing all ratings and settings referenced to the appropriate time-current characteristic curve.

.3 Provide all circuit breakers and protective devices with relays, trip settings, frame sizes and short circuit withstand ratings as determined from the co-ordination study.

.4 Acceptable testing companies:

.1 Brosz and Associates
.2 G.T. Woods
.3 Cutler-Hammer (by Eaton Corporation)
.4 Schneider Electric
.5 Siemens Canada

3.3 ARC FLASH PROTECTION

.1 Retain the services of an approved testing company to perform arc flash hazard study and calculation for all switchboards, panel boards, transformer, panels, control panels, MCC, meters, disconnect switches, breakers, etc, that require examination, adjustment, servicing, or maintenance while energized.

.2 The study and calculation shall meet IEEE 1584-2002, Guide for Performing Arc-Flash Hazard Calculations.

.3 Provide arc flash report to include the following, but not limited to:

.1 Results of the study and calculation.
.2 Detailed hazard/risk category (0 to 5).
.3 Voltage shock hazard, incident current and energy.
.4 Flash protection boundary and shock approach boundaries.
.5 The protection plan including safe work procedures, preventive maintenance programs, personal protective equipment, etc. The protection plan shall meet CSA Z462-08, workplace electrical safety.

.4 Based on the arc flash report, provide required labels state the existence of arc flash hazard and the corrective action to take. The labels must meet ANSI Z535.4-2002, product Safety signs and Labels.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical General Requirements.

1.2 REFERENCES

.1 The specified unit shall be designed, manufactured, tested and installed in compliance with the latest edition of the following standards:

.1 ANSI/IEEE C62.41 and C62.45
.2 UL 1449 Listed and CUL Approved as a Transient Voltage Surge Suppressor and UL 1283 Listed as an Electromagnetic Interference Filter.

1.3 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 260100 – Electrical General Requirements.

1.4 QUALITY ASSURANCE

.1 The suppression filter system shall be designed and manufactured by a qualified manufacturer of suppression filter system equipment. The qualified manufacturer shall have been engaged in the commercial design and manufacture of such products for a minimum of five (5) years.

.2 The manufacturer shall provide a five-year warranty from the date of shipment, against any TVSS part failure, when installed in compliance with the manufacturer's written instructions and any applicable national or local codes.

PART 2 - PRODUCTS

2.1 TRANSIENT VOLTAGE SURGE SUPPRESSORS

.1 The unit shall include an engineered solid-state high performance suppression system, utilizing arrays of fused non-linear voltage dependent metal oxide varistors with similar operating characteristics. The suppression system's components shall optimally share surge currents in a seamless, low-stress manner assuring maximum performance and proven reliability.

.2 The unit shall include a high frequency extended range power filter. The filter shall reduce fast rise-time, high frequency, error-producing transients and electrical line noise to harmless levels.

.3 The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV.

.4 SPD shall provide surge current diversion paths for all modes of protection (i.e., L-N, L-G, N-G)

.5 SPD shall be modular in design. Each phase shall be equipped with a replaceable module to facilitate maintenance without removal of the entire SPD.

.6 SPD shall be installed in switchboard and/or panelboard and shipped from the electrical distribution equipment manufacturer's factory.

.7 Operating temperature range: -40o to +60oC (-40 to +140oF)

.8 The unit shall not generate any audible noise.

.9 Each suppression mode shall be individually fused with a 200kAIC UL recognized surge rated fuse.

.10 A front mounted status panel shall be provided with LED indication and an audible alarm. On-line diagnostics shall continuously monitor the SPD status and have redundant LED's to signal a reduction in surge capacity or loss of a suppression circuit. The audible alarm shall have test and silence features.

.11 SPD shall meet or exceed the following criteria:

.1 Minimum surge current capability (single pulse rated) shall be 60kA per phase and a response time/surge of less than 0.5 nanoseconds.

.2 UL1449 Suppression Voltage ratings between L-N, L-G, N-G should not be more than 330V for 208/120V and 1000V for 600/347V.

.12 SPD shall have a minimum EMI/FI filtering of –50dB at 100kHz with an insertion ratio of 50:1 using MIL-STD-220A methodology.

.13 The Suppression Filter System shall function in conjunction with other suppression filter devices of the same manufacturer via coordinated filters within the facility-wide suppression filter system.

.14 A dedicated circuit breaker for the SPD shall be provided or a circuit isolating switch to facilitate maintenance.

.15 Operating frequency between 47Hz to 63Hz.

.16 Install SPD in power panels and/or switchboards unless otherwise noted.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install and connect in accordance with the requirements of the manufacturer.

.2 All units shall be tested to the specified surge ratings to ensure that the devices(s) will achieve the required life expectancy and reliability and to verify internal construction quality of the suppressor(s).

.3 Carry out Testing and Commissioning in accordance with manufacturer's requirements and specification section 260100.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical general requirements.

.3 Provide all switches, receptacles, wiring devices, coverplates as required to complete the installation.

1.2 REFERENCES

.1 Comply with the requirements of the latest editions of the following:

.1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
.2 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices.
.3 CSA-C22.2 No.55, Special Use Switches.
.4 CSA-C22.2 No.111, General-Use Snap Switches.
.5 CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.

1.3 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 260100 – Electrical General Requirements.

1.4 MANUFACTURER

.1 Wiring devices shall be manufactured by 1) Hubbell; 2) Pass & Seymour; 3) Bryant. Catalogue numbers are referred below to indicate quality standard.

PART 2 - PRODUCTS

2.1 SWITCHES

.1 Switches shall be with following features:

.1 White premium specification grade, quiet type.

.2 Terminal holes approved for No. 10 AWG wire.

.3 Silver alloy contacts.

.4 Urea or melamine moulding for parts subject to carbon tracking.

.5 Suitable for back and side wiring.

.6 Fully rated for tungsten filament and fluorescent lamps.

.2 Switches for 120 Volt lighting circuits

.1 Hubbell CSB115W, CSB315W and CSB415W, 15 ampere for single pole, three-way and four-way switching as required for the application.

.3 Switches for motor or other control applications shall be horsepower rated, Hubbell, HBL7832D and HBL7810D 30Ampere for double-pole and three-pole for one application.

2.2 RECEPTACLES

.1 Receptacles shall be with following features:

.1 White premium specification grade, urea moulded housing.
.2 Suitable for No. 10 AWG for back and side wiring.
.3 Break off links for use as split receptables.
.4 Eight back wired entrances, four side wiring screws.
.5 Triple wipe contacts and riveted grounding contacts.
.6 Impact-resistant nylon face.
.7 U-ground.
.8 GFCI receptacles shall meet UL 943 requirements and be complete with self test and reset buttons, and LED indication light.

.2 Duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHI (CSA 5-15R).

.3 Duplex receptacle, 20 amp, 120 volt, 1 phase, 2 pole, 3 wire, our, Hubbell, BR20WHI (CSA 5-20RA).

.4 GFCI duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, GFST15W (CSA 5-15R).

.5 GFCI duplex receptacle, 20 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, GF20STW (CSA 5-20RA).

.6 Isolated ground receptacle, orange, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, IG5262 (CSA 5-15R).

.7 Single 30 amp, 120 volt, 1 phases, 2 pole, 3 wire, Hubbell, HBL9308 (CSA 5-30R).

.8 Single 30 amp, 120/208 volt, 2 phases, 3 pole, 4 wire, Hubbell, HBL9430A (CSA 14-30R).

.9 Single 50 amp, 120/208 volt and 120/240 volt, 2 phases, 3 pole, 4 wire, Hubbell, HBL9450A (CSA 14-50R).

.10 TVSS duplex receptacle, Gray, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, HBL5262GYWSA (CSA5-15R).

.11 Tamper-resistant duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHITR (CSA5-15R).

.12 Weather-resistant duplex receptacle, 15 amp, 120 volt, 1 phase, 2 pole, 3 wire, Hubbell, BR15WHIWR (CSA5-15R).

2.3 COVER PLATES

.1 Stainless steel type 302, complete with matching screw.

.2 Weatherproof covers shall be while-in-use type polycarbonate body, cover and plates, conform to NEMA3R. Hubbell # WP826MP.

.3 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

.5 Water-tight hinged cover suitable for floor box for ganged receptacles, data/telephone outlets, finish to Consultant's directions.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install single throw switches with handle in "UP" position when switch closed.

.2 Install devices in gang type outlet box when more than one switch is required in one location. When supplied from different voltages or power sources, provide metal barriers in the ganged box.

.3 Clean debris from outlet boxes.

.4 Install devices plumb and level.

.5 Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.

.6 Adjust devices and wall plates to be flush and level.

.7 Clean exposed surfaces to remove splatters and restore finish.

.8 Test each receptacle device for proper polarity.

.9 Test each GFCI receptacle device for proper operation.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general conditions, supplementary conditions of the contract, and section 260100 – Electrical General Requirements.

.3 Provide all disconnect switches, whether an integral part of equipment or separately mounted. Refer to Electrical Drawings for switches' voltage, ampacity and number of poles.

1.2 REFERENCE

.1 Comply with the requirements of the latest edition of the following:

.1 CSA C22.2 No. 4, Enclosed and Dead-Front Switches.
.2 CSA C22.2 No. 39, Fuseholder Assemblies.
.3 CSA C22.2 No. 248 (Part 1 to Part 16), Low Voltage Fuses.

1.3 SUBMITTALS

.1 Submit shop drawings and product data in accordance with Section 260100 – Electrical General Requirements.

.2 Product data: switches' ratings and enclosure dimensions.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

.1 Enclosures:

.1 Indoor dry locations: CSA Type 1.
.2 Indoor sprinkler locations: CSA Type 2.
.3 Outdoor locations: CSA Type 3R.

.2 Provision for padlocking in off switch position by locks.

.3 Mechanically interlocked door to prevent opening when handle in ON position.

.4 Fuses: size as indicated.

.5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.

.6 Heavy-duty horsepower rated, quick-make, quick-break action, front operation, with integral handle mechanism and visible contacts in "OFF" position.

.7 ON-OFF switch position indication on switch enclosure cover.

.8 Switches identified for use as service equipment are to be labelled for this application.

.9 Furnish solid neutral assembly and equipment ground bar.

.10 Lugs suitable for copper and/or aluminum conductors.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section of 260500.

.2 Indicate name of load controlled.

2.3 MANUFACTURERS

.1 Product of one manufacturer for entire project.

.2 Acceptable manufacturers:

.1 Cutler-Hammer.
.2 Schneider.
.3 Siemens.

2.4 FUSES

.1 Fuses up to 600 volts and over 600amps:

.1 Where used in motor, transformer and other circuits with an inrush: Class L time delay. Ferraz Shawmut type A4BT or equal by Bussman.

.2 All remaining fuses: Class L non-time delay. Ferraz Shawmut A4BY or equal by Bussman.

.2 Fuses up to 600 volts and up to and including 600amps:

.1 Where used in motor, transformer and other circuits with an inrush: Class J time delay. Ferraz Shawmut type AJT or equal by Bussman.

.2 All remaining fuses: Class J non-time delay. Ferraz Shawmut type A4J or equal by Bussman.

.3 Fuse storage cabinet: Wall-mounted sheet metal cabinet with shelves, suitable sized to store spare fuses and fuse pullers, complete with hinged door.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

.2 In finished areas, where disconnecting devices are required, provide a circuit breaker in flush mounted enclosure.

.3 Provide three spare fuses of each type and size used above 600 amp and six spare fuses of each type and size used up to and including 600amp.

.4 Install fuses in mounting devices immediately before energizing circuit.

.5 Ensure correct fuses fit to physically match mounting devices.

.6 Ensure correct fuse fitted to assigned electrical circuit.

.7 Mount the fuse storage cabinets on the wall in electrical rooms. Mount the spare fuses in clip neatly arranged and labeled.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED INSTRUCTIONS

.1 Refer to Section 26 01 00, Electrical General Requirements.

1.2 SCOPE

.1 Work includes, but not limited to:

.1 Provide new secondary feeders as indicated on drawings
.2 Supply and install a 1.25” rigid conduit complete with fish wire from Service Entrance Board metering compartment to Hydro meter cabinet. Provide phone line to meter.
.3 Obtaining approvals from, co-operation and scheduling the work with Supply and Inspection Authorities, before commencing work.
.4 Preparation of all necessary working drawings for submission to Inspection Authorities.
.5 Refer to drawings for more information and coordinate with Hydro for exact scope of work and provide all necessary material and labor for a fully operational system.
.6 Preparation of short circuit, coordination and Arc flash studies.

1.3 SYSTEM CO-ORDINATION & SHORT CIRCUIT STUDY

.1 Characteristics of protective devices (relays, circuit breakers, fuses and the like) shall be selected to provide a coordinated fully-rated protective system; affording minimum fault-clearing times, and fault values.

.2 Retain services of approved testing company to perform protective co-ordination study to establish optimum settings and selections for all protective devices.

.3 Study shall be plotted on reproducible logarithmic paper (K&E #48-5257) illustrating:
.1 Study single line diagram, showing steady-state and transient values.
.2 Three phase bolted fault current, symmetrical and asymmetrical, and minimal arcing ground fault values.
.3 Time-current characteristics curves of all pertinent relays, breakers, fuses, etc. including Supply Authority's primary protective devices, for the complete project.
.4 Thermal damage curves for cable, transformers, motors and the like.
.5 Summation chart showing all ratings and settings referenced to the appropriate time-current characteristic curve.

.4 Provide full scale transparencies for time-current characteristic curves of proposed devices.

.5 Submit study for approval. Make all necessary subsequent changes to form "as-built" document.

.6 Provide system coordination and short circuit study for complete 347/600V power system

1.4 ARC FLASH PROTECTION

.1 Retain the services of an approved testing company to perform arc flash hazard study and calculation for all main distribution panel, panel boards, transformer, panels, control panels, MCC, meters, disconnect switches, breakers, etc, that require examination, adjustment, servicing, or maintenance while energized.

.2 The study and calculation shall meet IEEE 1584 (latest edition), Guide for Performing Arc-Flash Hazard Calculations.

.3 Provide arc flash report to include the following, but not limited to:

.1 Results of the study and calculation.
.2 Detailed hazard/risk category (0 to 5).
.3 Voltage shock hazard, incident current and energy.
.4 Flash protection boundary and shock approach boundaries.
.5 The protection plan including safe work procedures, preventive maintenance programs, personal protective equipment, etc. The protection plan shall meet CSA Z-462 (latest edition), workplace electrical safety.

.4 Based on the arc flash report, provide required labels state the existence of arc flash hazard and the corrective action to take. The labels must meet ANSI Z535.4-2002, product Safety signs and Labels, also the labels shall be as per figure Q3 of CSA Z-462-12 (latest edition) standard (i.e. including the PPE required).

1.5 INSPECTION & TESTING

.1 Systems, equipment and all major items of material shall be tested to the satisfaction of the Engineer, and as required to establish compliance with plans and specifications, and with the requirements for the Supply and Inspection Authorities.

.2 Faulty and defective equipment shall be replaced with new materials Conductors which are found to be shorted or grounded, or to have less than proper insulation resistance, shall be replaced with new conductors.

.3 Tests shall include but are not limited to the following:

.1 Test of power cables shall include megger tests to establish proper insulation resistance, and phase-to-ground resistance of cables.

.2 Test of all adjustable electrical protective devices of switchgear to establish calibration and operation in accordance with specifications and approved co-ordination curves.

.3 Visual examination of switchgear to determine adherence to allowable manufacturing tolerance and compliance with manufacturer's recommended installation requirements.

.4 Proper functioning of all systems.

.5 Polarity tests - to establish proper polarity connections to all sockets and receptacles.

.6 Calibration setting, and test-tripping, of all protective relays and devices, using "Primary-injection" equipment, in accordance with approved co-ordination schedule.

.7 Test of all alarm devices and contacts.

.8 Test of system neutral to establish proper insulations resistance and isolation of neutral from ground except for required ground connection at service

.9 24 hours after the system is energized, an infrared thermographic examination of current carrying parts in switchgear, transformers, and at ducts shall be provided by the electrical contractor and the same examination shall be conducted again one year after the energization. The Contractor shall cooperate with Inspection personnel, open all equipment enclosures to permit inspection, and make good defective conditions.

.4 Testing Company

.1 Retain the services of an independent testing company, to Engineer's approval to perform the above tests.

.2 The testing company shall submit test results directly to the Engineer.

.3 Include copy of tests in Maintenance and Operating Manual.

.5 Certification of Tests

.1 When work is complete, submit three copies of test results and a signed statement listing all tests that have been performed as required by specifications and manufacturer's instructions.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE SWITCHBOARDS (the 800 Amp and the 600Amp switchboards).

.1 Provide metal enclosed 347/600 volt switchboard as arranged on the drawings and further described herein, and detailed on drawings.

.2 The switchboard shall comprise an indoor, metal enclosed free standing assembly employing breakers manufactured by Federal Pioneer or equal.

.3 Assembly shall be factory assembled CEMA Type 2 "Sprinkler Proof" construction, and constructed in accordance with applicable CEMA and AIEE Standards. The equipment design shall be CSA approved. Note that all other panels and equipment in Electrical Rooms shall be "Sprinkler Proof" as noted.

.4 Bus and connections shall be copper, supported and braced to withstand short-circuit stresses in excess of main breaker rating (50 KA SYM minimum).

.5 Structures shall consist of metal enclosed steel frame and front enclosures, which shall include separate compartments for each breaker and metering section. All joints of buses shall have tin-plated high pressure contacts and flame retardant bus supports.

.6 A ground bus shall be provided bolted to each unit.

.7 Provide bus extensions for connection to outgoing feeders and provide adequate space to suit connections to outgoing cables. Compression indent type terminals shall be used for all cable connections.

.8 Provide suitable worded engraved plastic laminate nameplates for each device and compartment, refer to item 2.1.4. under section 260500 for more information and comply accordingly.

.9 Provide all necessary fuses, fuse mounts, disconnect switches, small wiring, terminal blocks, and the like, as required for metering and relaying accessories as detailed.

.10 The switchgear shall be completely assembled, wired and tested at the factory. After assembly, the complete switchgear shall be tested for operation under simulated service conditions to assure the accuracy of the wiring and functioning of the equipment.

.11 The manufacturer shall provide necessary drawings prior to assembly of the equipment for approvals and provide final drawings upon completion of fabrication.

.12 The entire structure shall be thoroughly cleaned and phosphated prior to application of the primary and finishing coats of paint.

.13 Switchboard/s shall be be equipped with IR window.

.14 Main 347/600 volt switchboard (for COASTAL BUILDING) - to contain generally as detailed on drawings and as follows:

.1 800A ampere, 3 pole, 600 volt Main Bus - full capacity neutral with provisions for incoming bus and cables.

.2 Main breaker to comprise 800A/800AT amp 100% rated main circuit breaker with solid state trip unit, for metered distribution. Interrupting rating shall be 50 KA-Symmetrical minimum.

.3 Metering compartment for Supply Authority's transformers with hinged door complete with sealing and padlock provisions. Provide removable mounting pan within compartment for mounting of transformers. These provisions shall be submitted to and approved by the Supply Authority before manufacture.

.4 Distribution Sections - Distribution Sections have 800 ampere main bus and full capacity neutral and circuit breakers with coordinated fault and trip ratings to suit main and distribution switches.

.5 Auxiliary Customer Metering Compartments which shall include:

.1 Power Logic Digital Metering system capable of displaying voltage, current, KVA, KVAR, KW, PF, HZ, and the accumulated MWHR, and KW demand. It shall be capable of continuously monitoring and storing minimum values of volts and PF and maximum values of amps., - KW-KVA-KVAR-KWS.
All minimum/maximum values can be displayed.
KYZ Pulse output to BMS. 1pulse=1kwh.
Ethernet communications interface and all hardware/software.
Fieldserver RS232 to Ethernet Gateway and BACnet drivers for Ethernet and IP interface to BMS.

.2 All necessary instrument current and potential transformers and control protection devices.

.3 Metering shall be Eaton PXM3000 or Schneider PM5560

.4 Meter installation should allow the ability of future replacement without the need of power shutdown.

.6 The neutral conductor of the wiring system together with the conduit and service grounding system shall be bonded to the water service as detailed and in accordance with Hydro regulations.

.7 All access to unmetered bus to be provided with bolted panels and provisions for sealing and padlocking.

.8 Switchboard shall be provided c/w TVSS surge protection system.

.15 Main 347/600 volt switchboard (for CASTLE LAB BUILDING which shall be sub-fed from main switchboard of COASTAL BUILDING) - to contain generally as detailed on drawings and as follows:

.1 600A ampere, 3 pole, 600 volt Main Bus - full capacity neutral with provisions for incoming bus and cables.

.2 Main breaker to comprise 600A/600AT amp 100% rated main circuit breaker with solid state trip unit. Interrupting rating shall be 50 KA-Symmetrical minimum.

.3 Distribution Sections - Distribution Sections have 600 ampere main bus and full capacity neutral and circuit breakers with coordinated fault and trip ratings to suit main and distribution switches.

.4 Auxiliary Customer Metering Compartments which shall include:

.1 Power Logic Digital Metering system capable of displaying voltage, current, KVA, KVAR, KW, PF, HZ, and the accumulated MWHR, and KW demand. It shall be capable of continuously monitoring and storing minimum values of volts and PF and maximum values of amps., - KW-KVA-KVAR-KWS.
All minimum/maximum values can be displayed.
KYZ Pulse output to BMS. 1pulse=1kwh.
Ethernet communications interface and all hardware/software.
Fieldserver RS232 to Ethernet Gateway and BACnet drivers for Ethernet and IP interface to BMS.

.2 All necessary instrument current and potential transformers and control protection devices.

.5 The neutral conductor of the wiring system together with the conduit and service grounding system shall be bonded to the water service as detailed and in accordance with Hydro regulations.

.6 All access to unmetered bus to be provided with bolted panels and provisions for sealing and padlocking.

.7 Switchboard shall be provided c/w TVSS surge protection system.

2.2 MANUFACTURERS

.1 The manufacturer of the the switchboards shall be the manufacturer of the major components within the assembly, including circuit breakers and fusible switches.

.2 Product of one manufacturer for entire project. Acceptable manufacturers are:

Cutler-Hammer
Schneider
Siemens

PART 3 - EXECUTION

3.1 EXISTING PRIMARY AND SECONDARY DUCT BANK

.1 Existing encased duct banks to remain.

3.2 TRANSFORMER FOUNDATION, GROUNDING & BOLLARDS

.1 Existing transformer foundation, grounding and bollards to remain and to be utilized. Hydro to replace existing hydro's transformer with new larger transformer.

3.3 ELECTRICAL SERVICE

.1 Provide complete electrical service as shown on the drawings and as further described here.

.2 The Supply Authority will supply electrical service at 600 volt, 3 phase, 4 wire, 60 cycles.

.3 Grounding service, equipment, feeders, and the like shall be performed in accordance with Hydro regulations and the Supply Authority's requirements.

.4 The neutral conductor of the wiring system together with the conduit system and service equipment shall be bonded to the water service as near as practical to the service entrance. Confirm type of water service pipe system with Mechanical Division and provide grounding system in accordance with O.H.E.P.C. regulations.

.5 Provide an "Artificial Grounding" system in accordance with Canadian Electric Code, Section 10-702 and Ontario Hydro Supplement. Location shall be to approval of the Supply & Inspection Authority requirements.

.6 Provide an inside metering cabinet where noted with minimum dimensions of 36” x 36” x 12” deep and provided with removable sub-base and locking provisions, all to approval of Supply Authority, connected to switchboard with an empty 1.25” rigid conduit.

.7 Provide sub-feed service for main switchboard of Castle building to be fed from the main switchboard of Coastal Building, refer to electrical drawings for more information and details and provide all necessary material and labor for fully operational system.

3.4 PRIMARY & SECONDARY CABLES

.1 Existing primary cables to be disconnected and reconnected by hydro upon replacement of hydro’s transformer by hydro.

.2 Existing secondary cables to be disconnected and removed by electrical contractor and to be replaced with new secondary cables as indicated on drawings.
Refer to electrical drawings for more information and comply accordingly.

3.5 HYDRO STANDARDS / REQUIREMENTS

.1 Coordinate on site with Hydro representative regarding their requirements, standards and for more information & exact scope of work prior to commencing the work & comply accordingly.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of specification is an integral part of the contract documents and shall be read accordingly.

.2 Comply with Section 260100 – Electrical General Requirements.

.3 Provide all lighting fixtures with lamps, ballasts and accessories as specified herein and as shown on the Electrical Drawings.

1.2 REFERENCE

.1 Comply with all requirements of the latest edition of CSA Standards.

1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 260100.

.2 Include fixture catalogue data sheets with shop drawings. Arrange the fixture catalogue data sheets and identify in the same sequence as the specified fixture list. Fixture catalogue data sheets shall indicate the following:

.1 Dimensions, weight, material, finish and mounting details.

.2 Performance: Candle power distribution curves in two planes, C.V. chart of indoor fixtures and lumen output chart of outdoor fixtures and flood lights.

.3 Pole wind loading, weight, dimension, anchoring details and finish.

.4 Lamps: type and base, burning hours, CRI, CCT and lumens.

.5 Ballasts: type, wiring diagram, watts, voltage, P.F., sound rating, starting temperature, efficiency and other required characteristics.

.3 Where requested, submit fixture samples of each substituted fixtures.

.4 Submit color/finish chart for all lighting fixtures for final selection/approval.

.5 Where requested, submit certified heat-run test data for each type of ballast mounting.

.6 Where requested, within four (4) weeks of Contract award, provide information on electronic ballast operating frequency for Owner's co-ordination with Owner supplied equipment operating at high frequencies.

1.4 WARRANTY

.1 Warrant LED lamps and drivers for a period of minimum 5 years from the date of acceptance of the work. Include labour for replacing lamps and drivers in the warranty.

PART 2 - PRODUCTS

2.1 DRIVERS FOR LED FIXTURES

.1 Electronic Driver for LED Fixtures: Comply with UL 1310 Class 2 requirements for dry and damp locations. Include the following features unless otherwise indicated:

.1 Rated for 50,000 hours of life, unless otherwise noted.

.2 Sound Rating: Class A.

.3 Total Harmonic Distortion Rating: 20 percent or less.

.4 5 year warranty on the whole fixture including all components, minimum.

.5 Approved Manufacturer: Philips Advance or approved equal.

2.2 LED LIGHT FIXTURES

.1 Except as otherwise indicated, provide LED luminaires, of types and sizes indicated on fixture schedules.

.2 Include the following features unless otherwise indicated:

.1 Each Luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply). Minimum of two drivers for two step dimming (50% and 100%) luminaires.

.2 Luminaire optics shall consist of precision formed optical assembly with positively retained high grade high transmittance translucent polycarbonate lens.

.3 Each luminaire shall be rated for a minimum operational life of 50,000 hours (L70 compliance) utilizing a minimum ambient temperature of (25°C).

.4 Complies with LM-80 Standards.

.5 Color Rendering Index (CRI) of 80 at a minimum.

.6 Color temperature 3500°K, unless otherwise indicated.

.7 Fixture efficacy of 111 Lumens/Watt, minimum.

.8 Fixture depth shall be no greater than 7”.

.9 5 year luminaire warranty, minimum.

.10 Photometry must comply with IESNA LM-79.

.11 Luminaries shall be Design Lights Consortium Qualified wherever applicable (depends on fixture type being used and application, doesn't apply to potlights – Energy Star rating is more appropriate for these).

.12 The individual LEDs shall be constructed such that a catastrophic loss of the failure of one LED will not result in the loss of the entire luminaire.

.13 Luminaire shall be constructed such that driver may be replaced or repaired without the replacement of the whole fixture.

.14 Luminaires shall be UL 1598 and UL 2043 listed.

.15 Luminaires shall have natatorium finish, gasketed, sealed and suitable for pool application.

.3 Technical Requirements

.1 The luminaire shall not consume power in the off state.

.2 Operation Voltage: The luminaire shall operate from a 50 HZ to 60 HZ AC line over a voltage ranging from 120 VAC to 277 VAC/XX. The fluctuations of line voltage shall have no visible effect on the luminous output.

.3 Power Factor: The luminaire shall have a power factor of 0.9 or greater.

.4 THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20 percent.

.5 Operational Performance: The LED circuitry shall prevent visible flicker to the unaided eye over the voltage range specified above.

.4 Thermal Management

.1 The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life.

.2 Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

.3 The luminaire shall have a minimum heat sink surface such that LED manufacturer's maximum junction temperature is not exceeded at maximum rated ambient temperature.

.5 Fixture Schedule, See Drawings for Lighting Fixtures Schedule.

2.3 WIRING

.1 Refer to basic materials and methods.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install all fixtures in the standard manner for the type of fixture and in accordance with the manufacturer's instructions. Support all fixtures from structural members except the fixtures installed in suspended ceilings may be supported by the ceiling where the ceiling supports are reinforced to carry the weight of the fixtures. Co-ordinate with Division 9 and submit written confirmation to the requirements of the Inspection Authority.

.2 In non-accessible ceilings wire with not less than 1220 mm AC90 or RW90 wire in flexible conduit to adjacent outlet boxes placed above finished ceiling within reach of the fixture openings.

.3 In accessible ceilings wire with 1830 mm AC90 or RW90 wire in flexible conduit to adjacent outlet boxes.

.4 Where fixtures are not installed in approved ceiling system, provide steel fixture studs, brackets and hangers. Where fixtures are hung on chain hangers, provide chain of closed link type capable of supporting ten times the fixture weight. Use U-bolts for chain ends; S-hooks are not acceptable.

.5 Provide suitable trim for all fixtures installed in drywall ceiling or within lay in or snap in tiles.

.6 Provide I.C. frame/enclosure for all fixtures installed in insulated ceiling. Confirm the insulated ceiling areas with Architect. Provide fire rated boxes for all recessed fixture in fire rated ceiling area.

.7 Provide plaster frames for all fixtures recessed in plaster ceilings. Have plaster frames installed under Division #9 and ensure that they are located correctly. Pay for all work associated with this work.

.8 Protect fixtures from dirt and damage during construction and clean when the installation is completed. Replace fixtures showing marks or scratches due to handling or tool marks.

.9 Align fixtures shown in continuous rows or broken lines so that all rows appear as straight lines. Crooked lines and misplaced fixtures will not be accepted.

.10 Where luminaries are surface mounted on inverted T-bar ceilings, they shall be supported directly from the building structure. Where this is not possible due to presence of mechanical ducts or other obstruction, supply and install galvanized steel channel, Unistrut or equal, above the ceiling, securely attached to the structure and not from the suspension system for the ceiling and fasten the luminaires to the channel with clamping nut, bolt, flat washers and lock washer to the satisfaction of the Consultant. Provide bolts at least every 1.2m length of fixture (i.e., 3 bolts for 2.4m fixture).

.11 Fixtures are shown on the electrical drawings in approximate locations only. Install fixtures in accordance with reflected ceiling plans, details and/or field instructions issued by the Engineer.

.12 Install lighting fixtures in service areas, underground parking areas, unfinished areas, mechanical and electrical rooms after the mechanical and electrical equipment is in place. Locate fixtures on site to clear all obstructions to the approval of DCC. Provide auxiliary steel members for hanging fixtures below ducts and other equipment. Where ceiling height is more than 3 metres, suspend ceiling surface mounted fixtures at 3 metres AFF. Where ceiling height is more than 3 metres, suspend ceiling surface mounted fixtures at 3 metres AFF.

.13 Provide all mounting hardware for all fixtures.

.14 Check the latest ceiling finishes in all areas where recessed fixtures are specified to ensure that fixtures are purchased with suitable ceiling trim for the particular ceiling finish. Replace fixtures which are sent to the site with wrong ceiling trim or flanges with fixtures having the correct trims, flanges, etc. as required without additional cost.

.15 Provide safety chains for all HID fixtures with integral ballasts. Attach chain to fixture and building structure. Safety chain to be designed and secured so as to sustain the sudden weight of the fixture.

.16 In stairs, provide fixture on every main and half landing level. Co-ordinate with Architectural drawings for number of landings.

.17 Fixtures shall be installed in accordance with the reflected ceiling layouts with due consideration for mechanical diffusers, bulkheads, sprinkler heads, and other obstructions. Check Mechanical and Architectural drawings before roughing-in to avoid any possible conflict.

.18 Fixtures connected to ground fault interruptor circuits shall have separate neutrals (common neutrals for 2 or 3 circuits are not acceptable).

.19 Exterior wall mounted lighting fixtures shall be mounted on recessed boxes except where fixtures with integral outlet boxes are specified in which case the recessed outlet box is not required. Outlet boxes shall be firmly anchored to the wall.

.20 Unless otherwise indicated supply and install concrete bases for lighting standards. Concrete bases shall be trowel finished with all exposed corners beveled at 45 degrees. Junction boxes shall be carefully set and anchored to ensure flush fit of junction box cover. Concrete bases shall be constructed of 20 Mpa concrete air entrained and steel reinforced as shown on the Drawings.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This section of Specification is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with general CCDC2 2008 and City of Burlington Supplementary Conditions, and section 260100 – Electrical general requirements.

.3 Provide emergency lighting system including exit signs, remote heads, and battery units, as shown on the Drawings, as specified herein and as otherwise required.

1.2 REFERENCE

.1 Comply with the requirements of the latest edition of the following:
- .1 CSA-C22.2 No. 9, General Requirements for Luminaires.
- .2 CSA-C22.2 No. 141, Unit Equipment for Emergency Lighting.
- .3 CSA-C22.2 C860, Performance of Internally Lighting Exit Signs.

1.3 SUBMITTALS

.1 Submit Shop Drawings and Product Data in accordance with Section 260100.

.2 Include fixture catalogue data sheets with Shop Drawings indicating dimensions, components, electrical characteristics and performance data for each fixture and device. Arrange the fixture catalogue data sheets and identify in the same sequence as the specified fixture list.

.3 Submit test report and verifications following the completion of testing.

1.4 WARRANTY

.1 For complete system, provide a 2-year no-charge, unconditional guarantee, and 5-year pro-rate charge guarantee on workmanship and parts.

.2 For batteries, on the second 5-year, provide a pro-rate charge guarantee on workmanship and parts.

PART 2 - PRODUCTS

2.1 RUNNINGMAN EXIT SIGNS

.1 Extruded aluminum pictogram exit sign.

.2 Lamps: Less than 2W, LED.

.3 Inputs:
- .1 DC: 24V as shown.
- .2 AC: Universal: 120V/347V.

.4 Directional arrows: universal type for field adjustment.

.5 Mounting: wall or ceiling recessed for field selection.

.6 Beghelli-Quadra Series.

.7 Include for the supply, installation and wiring (to nearest normal & emergency lighting circuit) of 5 additional exit signs at locations later directed on site.

2.2 WEATHERPROOF EXIT SIGNS

.1 Same as standard exit signs, except:

.1 Housing to be industrial grade polyvinyl chloride fully gasketted around lens and canopy.

.2 The sealed face plate shall be constructed of heavy duty vandal-resistant polycarbonate.

2.3 STANDARD REMOTE HEADS

.1 Single or double cast aluminum head(s), complete with mounting plates, 300 degree horizontal and 80 degree vertical minimum adjustment. Vandal resistant polycarbonate cube.

.2 Lamps: 7W MR16 LED.

.3 Input: 24VDC.

.4 Mounting: ceiling or wall as shown.

.5 Beghelli #BTMR series

2.4 WEATHERPROOF AND VANDAL RESISTANT REMOTE HEADS

.1 Same as standard remote heads, except:
Fully gasketted cast aluminum back plate with clear polycarbonate vandal resistant cover.

2.5 BATTERY UNIT

.1 Supply voltage: as indicated on the Electrical Drawings.

.2 Output voltage: 24V DC.

.3 Operating time: 1/2 hour minimum.

.4 Battery: sealed, maintenance free, long-time lead with rated life of ten (10) years.

.5 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations capable of restoring a discharged battery to the fully-charged state within twenty-four (24) hours, and switched to a float charge when not in full charge mode.

.6 Solid state transfer circuit.

.7 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.8 Signal lights: solid state, for “AC Power ON’ and ‘High Charge’.

.9 Lamp heads: integral on unit and remote, 345° horizontal and 180° vertical adjustment, white painted cast aluminum head. Lamp type: wide beam flat 2-20W, unless noted otherwise.

.10 Cabinet: suitable for direct or shelf mounting to wall and complete with knockouts for conduits. Removable or hinged front panel for easy access to batteries.

.11 Finish: standard factory finish.

.12 Auxiliary equipment:
- .1 Advanced diagnostic printed circuit board with auto self test and time delay.
- .2 Test switch and LED trouble indicator.
- .3 Battery disconnect device.
- .4 AC input and dc output terminal blocks inside cabinet.
- .5 Mounting shelf.
- .6 Transient voltage surge suppressor on the supply side of power to the unit.

2.6 ACCEPTABLE EMERGENCY EQUIPMENT MANUFACTURERS ARE

.1 Lumacell

.2 Luxnet

.3 Emergi-lite

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Pendant mount exit sign in service rooms and other areas where necessary to clear obstructions. Install suspended exit signs using pendants supported from swivel hangers.

.2 Install all unit equipment, remote heads, exit signs, and accessories in accordance with manufacturer’s instruction.

.3 Direct heads for illumination to meet OBC requirements.

3.2 TESTING AND VERIFICATION

.1 Arrange with the manufacturer to conduct a complete inspection and test of all installed emergency lighting system.

.2 Manufacturer's representative shall be responsible for properly aiming remote heads, recording the light level readings, recording battery full load operation time, issuing a verification indicating that lighting levels meet OBC requirements, and the system has been installed properly.

.3 Submit report and verification to Consultant.

.4 Correct all deficiencies.

.5 Witnessed by Consultant.

.6 All cost involved in testing, verification, and corrections shall be included in the Tender Price.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:

1. Digital Lighting Controls
2. Relay Panels
3. Emergency Lighting Control (if applicable)

.2 Related Sections:

1. Section 262726 - Wiring Devices
2. Section 265000 – Lighting Equipment
3. Section 259500 – Building Automation System. Building integrator shall provide integration of the lighting control system with Building Automation Systems.
4. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section
5. Electrical Sections, including wiring devices, apply to the work of this Section.

.3 Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones
3. Initial time switch settings
4. Task lighting and receptacle controls
5. Emergency Lighting control (if applicable)

1.2 REFERENCES

.1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)

.2 Underwriter Laboratories of Canada (ULC)

.3 International Electrotechnical Commission (IEC)

.4 International Organization for Standardization (ISO)

.5 National Electrical Manufacturers Association (NEMA)

.6 WD1 (R2005) - General Color Requirements for Wiring Devices.

.7 Underwriters Laboratories, Inc. (UL)
1. 20 – Plug Load Controls
2. 508– Industrial Controls
3. 916 – Energy Management Equipment.
4. 924 – Emergency Lighting

1.3 SYSTEM DESCRIPTION & OPERATION

.1 The Lighting Control and Automation system as defined under this section covers the following equipment:

1. Digital Occupancy Sensors – Self-configuring, digitally addressable and calibrated occupancy sensors with LCD display and two-way active infrared (IR) communications.

2. Digital Switches – Self-configuring, digitally addressable pushbutton on/off, dimming, and scene switches with two-way active infrared (IR) communications.

3. Handheld remotes for personal control – One-button dimming, two-button on/off, or five-button scene remotes provide control using infrared communications. Remote may be configured in the field to control selected loads or scenes without special tools.

4. Digital Daylighting Sensors – Single-zone closed loop, multi-zone open loop and single-zone dual-loop daylighting sensors with two-way active infrared (IR) communications can provide switching, bi-level, tri-level or dimming control for daylight harvesting.

5. Digital Room Controllers – Self-configuring, digitally addressable one, two or three relay plenum-rated controllers for on/off control. Selected models include 0-10 volt or line voltage forward phase control dimming outputs and integral current monitoring capabilities.

6. Digital Plug-Load Controllers – Self-configuring, digitally addressable, single relay, plenum-rated application-specific controllers. Selected models include integral current monitoring capabilities.

7. Configuration Tools – Handheld remote for room configuration and relay panel programming provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow bi-directional communication of room variables and occupancy sensor settings. Computer software also customizes room settings.

8. Digital Lighting Management (DLM) local network – Free topology, plug-in wiring system (Cat 5e) for power and data to room devices.

9. Digital Lighting Management (DLM) segment network – Linear topology, BACnet MS/TP network (1.5 twisted pair, shielded,) to connect multiple DLM local networks for centralized control

10. Network Bridge – provides BACnet MS/TP-compliant digital networked communication between rooms, panels and the Segment Manager or building automation system (BAS) and automatically creates BACnet objects representative of connected devices.

11. Segment Manager – provides web browser-based user interface for system control, scheduling, power monitoring, room device parameter administration and reporting.

12. Programming and Configuration software – Optional PC-native application capable of accessing DLM control parameters within a room, for the local network, via a USB adapter, or globally, for many segment networks simultaneously, via BACnet/IP communication.

13. LMCP Digital Lighting Management Relay Panel – provides up to 8, 24, or 48 mechanically latching relays. Relays include a manual override and a single push-on connector for easy installation or removal from the panel. Panel accepts program changes from handheld configuration tool for date and time, location, holidays, event scheduling, button binding and group programming. Provides BACnet MS/TP-compliant digital networked communication between other lighting controls and/or building automation system (BAS).

14. Emergency Lighting Control Unit (ELCU) – allows a standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building

1.4 LIGHTING CONTROL APPLICATIONS

.1 Unless relevant provisions of the applicable local Energy Codes are more stringent, provide a minimum application of lighting controls as follows:

1. Space Control Requirements – Provide occupancy/vacancy sensors with Manual- or Partial-ON functionality in all spaces except toilet rooms, storerooms, library stacks, or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room, open plan system and training room. For spaces with multiple occupants, or where line-of-sight may be obscured, provide ceiling- or corner-mounted sensors and Manual-ON switches.

2. Bi-Level Lighting – Provide multi-level controls in all spaces except toilet rooms, storerooms, library stacks, or applications where variable dimming is used.

3. Task Lighting / Plug Loads – Provide automatic shut off of non essential plug loads and task lighting in all spaces except toilet rooms and storerooms. Provide Automatic-ON of plug loads whenever spaces are occupied. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.

4. Daylit Areas – Provide daylight-responsive automatic control in all spaces (conditioned or unconditioned) where daylight contribution is available as defined by relevant local building energy code:

   .1 All luminaires within code-defined daylight zones shall be controlled separately from luminaires outside of daylit zones.

   .2 Daytime setpoints for total ambient illumination (combined daylight and electric light) levels that initiate dimming shall be programmed in compliance with relevant local building energy codes.

   .3 Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.

   .4 Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.

5. Conference, meeting, training, auditoriums, and multipurpose rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four (4) pre-set lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to extinguish all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.

1.5 SUBMITTALS

.1 Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

.2 Shop Drawings:

1. Composite wiring and/or schematic diagram of each control circuit as proposed to be installed.

2. Show exact location of all digital devices, including at minimum sensors, room controllers, and switches for each area on reflected ceiling plans. (Contractor must provide AutoCAD format reflected ceiling plans.)

3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.

4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades.

.3 Product Data: Catalog sheets, specifications and installation instructions.

.4 Include data for each device which:

1. Indicates where sensor is proposed to be installed.

2. Prove that the sensor is suitable for the proposed application.

1.6 QUALITY ASSURANCE

.1 Manufacturer: Minimum [10] years experience in manufacture of lighting controls.

1.7 PROJECT CONDITIONS

.1 Do not install equipment until following conditions can be maintained in spaces to receive equipment:

1. Ambient temperature: 0° to 40° C (32° to 104° F).

2. Relative humidity: Maximum 90 percent, non-condensing.

1.8 WARRANTY

.1 Provide a five year limited manufacturer's warranty on all room control devices and panels.

PART 2 - - PRODUCTS

2.1 MANUFACTURERS

.1 Acceptable Manufacturer:

1. WattStopper

.1 System: Digital Lighting Management (DLM)

.2 Lutron

2. Basis of design product: WattStopper Digital Lighting Management (DLM) or subject to compliance and prior approval with specified requirements of this section, one of the following:

.1 Sensor Switch

.2 Substitutions:

1. All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.

2. By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring. The contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted for review and approval prior to rough-in.

2.2 DIGITAL LIGHTING CONTROLS

.1 Furnish the Company's system which accommodates the square-footage coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors, switches, daylighting sensors and accessories which suit the lighting and electrical system parameters.

2.3 DIGITAL WALL SWITCH OCCUPANCY SENSORS

.1 Wallbox mounted passive infrared PIR or dual technology (passive infrared and ultrasonic) digital occupancy sensor with 1 or 2 switch buttons.

.2 Digital Occupancy Sensors shall provide scrolling LCD display for digital calibration and electronic documentation. Features include the following:

.1 Digital calibration and pushbutton configuration for the following variables:

.1 Sensitivity – 0-100% in 10% increments

.2 Time delay – 1-30 minutes in 1 minute increments

.3 Test mode – Five second time delay

.4 Detection technology – PIR, Dual Technology activation and/or re-activation.

.5 Walk-through mode

.6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

.2 Programmable control functionality including:

.1 Each sensor may be programmed to control specific loads within a local network.

.2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.

.3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically during the configurable period of time (default 10 seconds) after turning off.

.4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:

.1 Ultrasonic and Passive Infrared

.2 Ultrasonic or Passive Infrared

.3 Ultrasonic only

.4 Passive Infrared only

.3 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

.4 Two RJ-45 ports for connection to DLM local network.

.5 Two-way infrared (IR) transceiver to allow remote programming through handheld configuration tool and control by remote personal controls.

.6 Device Status LEDs including:

.1 PIR detection

.2 Ultrasonic detection

.3 Configuration mode

.4 Load binding

.7 Assignment of occupancy sensor to a specific load within the room without wiring or special tools.

.8 Assignment of local buttons to specific loads within the room without wiring or special tools

.9 Manual override of controlled loads.

.10 All digital parameter data programmed into an individual wall switch sensor shall be retained in non-volatile FLASH memory within the wall switch sensor itself. Memory shall have an expected life of no less than 10 years.

.2 BACnet object information shall be available for the following objects:

.1 Detection state

.2 Occupancy sensor time delay

.3 Occupancy sensor sensitivity, PIR and Ultrasonic

.4 Button state

.5 Switch lock control

.6 Switch lock status

.4 Units shall not have any dip switches or potentiometers for field settings.

.5 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

.6 Two-button wall switch occupancy sensors, when connected to a single relay dimming room controller, shall operate in the following sequence as a factory default:

.1 Left button

.1 Press and release - Turn load on

.2 Press and hold - Raise dimming load

.2 Right button

.1 Press and release - Turn load off

.2 Press and hold - Lower dimming load

.7 Low voltage momentary pushbuttons shall include the following features:

.1 Load/Scene Status LED on each switch button with the following characteristics:

.1 Bi-level LED

.2 Dim locator level indicates power to switch

.3 Bright status level indicates that load or scene is active

.2 The following button attributes may be changed or selected using a wireless configuration tool:

.1 Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).

.2 Individual button function may be configured to Toggle, On only or Off only.

.3 Individual scenes may be locked to prevent unauthorized change.

.4 Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.

.5 Ramp rate may be adjusted for each dimmer switch.

.6 Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

.8 WattStopper part numbers: LMPW, LMDW. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.4 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR

.1 Wall or ceiling mounted (to suit installation) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.

.2 Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:

1. Digital calibration and pushbutton configuration for the following variables:

.1 Sensitivity – 0-100% in 10% increments

.2 Time delay – 1-30 minutes in 1 minute increments

.3 Test mode – Five second time delay

.4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.

.5 Walk-through mode

.6 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.

2. Programmable control functionality including:

.1 Each sensor may be programmed to control specific loads within a local network.

.2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.

.3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.

.4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:

.1 Ultrasonic and Passive Infrared

.2 Ultrasonic or Passive Infrared

.3 Ultrasonic only

.4 Passive Infrared only

3. Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.

4. One or two RJ-45 port(s) for connection to DLM local network.

5. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

6. Device Status LEDs, which may be disabled for selected applications, including:

.1 PIR detection

.2 Ultrasonic detection

.3 Configuration mode

.4 Load binding

7. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.

8. Manual override of controlled loads.

9. All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.

.3 BACnet object information shall be available for the following objects:

1. Detection state

2. Occupancy sensor time delay

3. Occupancy sensor sensitivity, PIR and Ultrasonic

.4 Units shall not have any dip switches or potentiometers for field settings.

.5 Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration will be required.

.6 WattStopper product numbers: LMPX, LMDX, LMPC, LMUC, LMDC

2.5 DIGITAL WALL SWITCHES

.1 Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:

1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.

2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

3. Configuration LED on each switch that blinks to indicate data transmission.

4. Load/Scene Status LED on each switch button with the following characteristics:

   .1 Bi-level LED

   .2 Dim locator level indicates power to switch

   .3 Bright status level indicates that load or scene is active

5. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.

6. Programmable control functionality including:

   .1 Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority

   .2 Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

7. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

.2 BACnet object information shall be available for the following objects:

1. Button state
2. Switch lock control
3. Switch lock status

.3 Two RJ-45 ports for connection to DLM local network.

.4 Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

.5 The following switch attributes may be changed or selected using a wireless configuration tool:

1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).

2. Individual button function may be configured to Toggle, On only or Off only.

3. Individual scenes may be locked to prevent unauthorized change.

4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.

5. Ramp rate may be adjusted for each dimmer switch.

6. Switch buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.

.6 WattStopper product numbers: LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101. Available in white, light almond, ivory, grey, red and black; compatible with wall plates with decorator opening.

2.6 HANDHELD REMOTE CONTROLS

.1 Battery-operated handheld devices in 1, 2 and 5 button configurations for remote switching or dimming control. Remote controls shall include the following features:

1. Two-way infrared (IR) transceiver for line of sight communication with DLM local network within up to 30 feet.

2. LED on each button confirms button press.

3. Load buttons may be bound to any load on a room controller and are not load type dependant; each button may be bound to multiple loads.

4. Inactivity timeout to save battery life.

.2 A wall mount holster and mounting hardware shall be included with each remote control

.3 WattStopper part numbers: LMRH-101, LMRH-102, LMRH-105.

2.7 DIGITAL PARTITION CONTROLS

.1 Partition controls shall enable manual or automatic coordination of lighting controls in flexible spaces with up to four moveable walls by reconfiguring the connected digital switches and occupancy sensors.

.2 Four-button low voltage pushbutton switch for manual control.

1. Two-way infrared (IR) transceiver for use with configuration remote control.

2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.

3. Configuration LED on each switch that blinks to indicate data transmission.

4. Each button represents one wall; Green button LED indicates status.

5. Two RJ-45 ports for connection to DLM local network.

6. WattStopper part number: LMPS-104. Available in white, light almond, ivory, grey and black; compatible with wall plates with decorator opening.

.3 Contact closure interface for automatic control via input from limit switches on movable walls (by others).

1. Operates on Class 2 power supplied by DLM local network.

2. Includes 24VDC output and four input terminals for maintained third party contract closure inputs.

.1 Input max. sink/source current: 1-5mA

.2 Logic input signal voltage High: >18VDC

.3 Logic input signal voltage Low: <2VDC

3. Four status LEDs under hinged cover indicate if walls are open or closed; supports LMPS-104 as remote status indicator.

4. Two RJ-45 ports for connection to DLM local network.

5. WattStopper part number: LMIO-102

2.8 DIGITAL DAYLIGHTING SENSORS

.1 Digital daylighting sensors shall work with room controllers to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type connected to a room controller. Daylighting sensors shall be interchangeable without the need for rewiring.

1. Closed loop sensors measure the ambient light in the space and control a single lighting zone.

2. Open loop sensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones.

3. Dual loop sensors measure both ambient and incoming daylight in the space to insure that proper light levels are maintained as changes to reflective materials are made in a single zone.

.2 Digital daylighting sensors shall include the following features:

1. The sensor's internal photodiode shall only measure lightwaves within the visible spectrum. The photodiode's spectral response curve shall closely match the entire photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.
2. Sensor light level range shall be from 1-6,553 footcandles (fc).
3. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
4. For switching daylight harvesting, the photosensor shall provide a field-selectable deadband, or a separation, between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling excessively after they turn off.
5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
6. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
7. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
8. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
9. Integral infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
10. Configuration LED status light on device that blinks to indicate data transmission.
11. Status LED indicates test mode, override mode and load binding.
12. Recessed switch on device to turn controlled load(s) ON and OFF.
13. BACnet object information shall be available for the following daylighting sensor objects, based on the specific photocell's settings:

    .1 Light level

    .2 Day and night setpoints

    .3 Off time delay

    .4 On and off setpoints

.5 Up to three zone setpoints

.6 Operating mode – on/off, bi-level, tri-level or dimming

14. One RJ-45 port for connection to DLM local network.

15. A choice of accessories to accommodate multiple mounting methods and building materials. The photosensors may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox. Standard tube photosensors accommodate mounting materials from 0-0.62” thickness (LMLS-400, LMLS-500). Extended tube photosensors accommodate mounting materials from 0.62”-1.25” thickness (LMLS-400-L, LMLS-500-L). Mounting brackets are compatible with J boxes (LMLS-MB1) and wall mounting (LMLS-MB2). LMLS-600 photosensor to be mounted on included bracket below skylight well.

16. Any load or group of loads in the room can be assigned to a daylighting zone

17. Each load within a daylighting zone can be individually enabled or disabled for discrete control (load independence).

18. All digital parameter data programmed into a photosensor shall be retained in non-volatile FLASH memory within the photosensor itself. Memory shall have an expected life of no less than 10 years.

.3 Closed loop digital photosensors shall include the following additional features:

1. An internal photodiode that measures light in a 100-degree angle, cutting off the unwanted light from bright sources outside of this cone.

2. Automatic self-calibration, initiated from the photosensor, a wireless configuration tool or a PC with appropriate software.

3. Automatically establishes application-specific setpoints following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of loads.

4. WattStopper Product Number: LMLS-400, LMLS-400-L.

.4 Open loop digital photosensors shall include the following additional features:

1. An internal photodiode that measures light in a 60-degree angle cutting off the unwanted light from the interior of the room.

2. Automatically establishes application-specific setpoints following manual calibration using a wireless configuration tool or a PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF setpoints for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.

3. Each of the three discrete daylight zones can include any non overlapping group of loads in the room.

4. WattStopper Product Number: LMLS-500, LMLS-500-L.

.5 Dual loop digital photosensors shall include the following additional features:

1. Close loop portion of dual loop device must have an internal photodiode that measures light in a 100 degree angle, cutting off the unwanted light from sources outside of this con

2. Open loop portion of dual loop device must have an internal photodiode that can measure light in a 60 degree angle, cutting off the unwanted light from the interior of the room.

3. Automatically establishes application-specific set-points following self-calibration. For switching operation, an adequate deadband between the ON and OFF setpoints shall prevent the lights from cycling; for dimming operation a sliding setpoint control algorithm with separate Day and Night setpoints shall prevent abrupt ramping of load.

4. Device must reference closed loop photosensor information as a base line reference. The device must be able to analyze the open loop photosensor information to determine if an adjustment in light levels is required.

5. Device must be able to automatically commission setpoints each night to provide adjustments to electrical lighting based on changes in overall lighting in the space due to changes in reflectance within the space or changes to daylight contribution based on seasonal changes.

6. Device must include extendable mounting arm to properly position sensor within a skylight well.

7. WattStopper product number LMLS-600

2.9 DIGITAL ROOM CONTROLLERS AND PLUG-LOAD CONTROLLERS

.1 Digital controllers for lighting and plug loads automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room and plug load controllers shall be provided to match the room lighting and plug load control requirements. The controllers will be simple to install, and will not have dip switches or potentiometers, or require special configuration for standard Plug n' Go applications. The control units will include the following features:

1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.

2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf.

3. Multiple room controllers connected together in a local network must automatically prioritize each room controller, without requiring any configuration or setup, so that loads are sequentially assigned using room controller device ID's from highest to lowest.

4. Device Status LEDs to indicate:

   .1 Data transmission

   .2 Device has power

   .3 Status for each load

   .4 Configuration status

5. Quick installation features including:

   .1 Standard junction box mounting

   .2 Quick low voltage connections using standard RJ-45 patch cable

.6 Based on individual configuration, each load shall be capable of the following behavior on power up following the loss of normal power:

   .1 Turn on to 100%

   .2 Remain off

   .3 Turn on to last level

.7 Each load shall be configurable to operate in the following sequences based on occupancy:

   .1 Auto-on/Auto-off (Follow on and off)

   .2 Manual-on/Auto-off (Follow off only)

.8 The polarity of each load output shall be reversible, via digital configuration, so that on is off and off is on.

.9 BACnet object information shall be available for the following objects:

   .1 Load status

   .2 Electrical current

   .3 Total watts per controller

   .4 Schedule state – normal or after-hours

   .5 Demand response control and cap level

   .6 Room occupancy status

   .7 Total room lighting and plug loads watts

   .8 Total room watts/sq ft

   .9 Force on/off all loads

10. UL 2043 plenum rated

11. Manual override and LED indication for each load

12. Dual voltage (120/277 VAC, 60 Hz), or 347 VAC, 60 Hz (selected models only). 120/277 volt models rated for 20A total load, derating to 16A required for some dimmed loads (forward phase dimming); 347 volt models rated for 15A total load; plug load controllers carry application- specific UL 20 rating for receptacle control.

13. Zero cross circuitry for each load

14. All digital parameter data programmed into an individual room controller or plug load controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.

.2 On/Off Room Controllers shall include:

1. One or two relay configuration

2. Efficient 150 mA switching power supply

3. Three RJ-45 DLM local network ports with integral strain relief and dust cover

4. WattStopper product numbers: LMRC-101, LMRC-102

.3 On/Off/Dimming enhanced Room Controllers shall include:

1. Real time current monitoring

2. Multiple relay configurations
   .1 One, two or three relays (LMRC-21x series)
   .2 One or two relays (LMRC-22x series)

3. Efficient 250 mA switching power supply

4. Four RJ-45 DLM local network ports with integral strain relief and dust cover

5. One dimming output per relay

   .1 0-10V Dimming - Where indicated, one 0-10 volt analog output per relay for control of compatible ballasts and LED drivers. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting. (LMRC-21x series)

   .2 Line Voltage, Forward Phase Dimming - Where indicated, one forward phase control line voltage dimming output per relay for control of compatible two-wire or three-wire ballasts, LED drivers, MLV, forward phase compatible ELV, neon/cold cathode and incandescent loads. (LMRC-22x series)

   .3 Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected ballast or driver.

.4 The LED level indicators on bound dimming switches shall utilize this new maximum and minimum trim.

.5 Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0-100% dimming range defined by the minimum and maximum calibration trim.

.6 Calibration and trim levels must be set per output channel.

.7 Devices that set calibration or trim levels per controller are not acceptable.

.8 All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.

6. Each load shall have an independently configurable preset on level for Normal Hours and After Hours events to allow different dimmed levels to be established at the start of both Normal Hours and After Hours events.

7. Fade rates for dimming loads shall be specific to bound switch buttons, and the load shall maintain a default value for any bound buttons that do not specify a unique value.

8. The following dimming attributes may be changed or selected using a wireless configuration tool:

.1 Establish preset level for each load from 0-100%

.2 Set high and low trim for each load

.3 Set lamp burn in time for each load up to 100 hours

9. Override button for each load provides the following functions:

.1 Press and release for on/off control

.2 Press and hold for dimming control

10. WattStopper product numbers: LMRC-211, LRMC-212, LRMC-213, LMRC-221, LMRC-222

.4 Plug Load Room Controllers shall include:

1. One relay configuration with additional connection for unswitched load

2. Configurable additive time delay to extend plug load time delay beyond occupancy sensor time delay (e.g. a 10 minute additive delay in a space with a 20 minute occupancy sensor delay ensures that plug loads turn off 30 minutes after the space is vacated).

3. Factory default operation is Auto-on/Auto-off, based on occupancy

4. Real time current monitoring of both switched and un-switched load (LMPL-201 only)

5. Efficient switching power supply

.1 150mA (LMPL-101)

.2 250mA (LMPL-201)

6. RJ-45 DLM local network ports

.1 Three RJ-45 ports (LMPL-101)

.2 Four RJ-45 ports (LMPL-201)

7. WattStopper product numbers: LMPL-101, LMPL-201.

2.10 DLM LOCAL NETWORK (Room Network)

.1 The DLM local network is a free topology lighting control physical connection and communication protocol designed to control a small area of a building.

.2 Features of the DLM local network include:

1. Plug n' Go® automatic configuration and binding of occupancy sensors, switches and lighting loads to the most energy-efficient sequence of operation based upon the device attached.

2. Simple replacement of any device in the network with a standard off the shelf unit without requiring commissioning, configuration or setup.

3. Push n' Learn® configuration to change the automatic configuration, including binding and load parameters without tools, using only the buttons on the digital devices in the local network.

4. Two-way infrared communications for control by handheld remotes, and configuration by a handheld tool including adjusting load parameters, sensor configuration and binding, within a line of sight of up to 30 feet from a sensor, wall switch or IR receiver.

.3 Digital room devices connect to the local network using pre-terminated Cat 5e cables with RJ-45 connectors, which provide both data and power to room devices. Systems that utilize RJ-45 patch cords but do not provide serial communication data from individual end devices are not acceptable.

.4 If manufacturer's pre-terminated Cat 5e cables are not used for the installation, the contractor is responsible for testing each cable following installation and supplying manufacturer with test results.

.5 WattStopper Product Number: LMRJ-Series

3.11 DLM SEGMENT NETWORK (Room to Room Network)

.1 The segment network shall be a linear topology, BACnet-based MS/TP subnet to connect DLM local networks (rooms) and LMCP relay panels for centralized control.

1. Each connected DLM local network shall include a single network bridge (LMBC-300), and the network bridge is the only room-based device that is connected to the segment network.

2. Network bridges, relay panels and segment managers shall include terminal blocks, with provisions for separate “in” and “out” terminations, for segment network connections.

3. The segment network shall utilize 1.5 twisted pair, shielded, cable supplied by the lighting control manufacturer. The maximum cable run for each segment is 4,000 feet. Conductor-to-conductor capacitance of the twisted pair shall be less than 30 pf/ft and have a characteristic impedance of 120 Ohms.

4. Network signal integrity requires that each conductor and ground wire be correctly terminated at every connected device.

5. Substitution of manufacturer-supplied cable must be pre-approved: Manufacturer will not certify network reliability, and reserves the right to void warranty, if non-approved cable is installed, and if terminations are not completed according to manufacturer’s specific requirements.

6. Segment networks shall be capable of connecting to BACnet-compliant BAS (provided by others) either directly, via MS/TP, or through NB-ROUTERs, via BACnet/IP or BACnet/Ethernet. Systems whose room-connected network infrastructure require gateway devices to provide BACnet data to a BAS are unacceptable.

.2 WattStopper Product Number: LM-MSTP, LM-MSTP-DB

3.12 CONFIGURATION TOOLS

.1 A wireless configuration tool facilitates optional customization of DLM local networks using two-way infrared communications, while PC software connects to each local network via a USB interface.

.2 Features and functionality of the wireless configuration tool shall include but not be limited to:

1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.

2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.

3. Must be able to read and modify parameters for room controllers, occupancy sensors, wall switches, daylighting sensors, network bridges and relay panels, and identify room devices by type and serial number.

4. Save up to eight occupancy sensor setting profiles, and apply profiles to selected sensors.

5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.

6. Adjust or fine-tune daylighting settings established during auto-configuration, and input light level data to complete configuration of open loop daylighting controls.

7. Set room mode for testing of Normal Hours (NH) and After Hours (AH) parameter settings.

8. Verify status of building level network devices.

.3 WattStopper Product Numbers: LMCT-100, LMCI-100/LMCS-100

3.13 NETWORK BRIDGE

.1 The network bridge module connects a DLM local network to a BACnet-compliant segment network for communication between rooms, relay panels and a segment manager or BAS. Each local network shall include a network bridge component to provide a connection to the local network room devices. The network bridge shall use industry standard BACnet MS/TP network communication and an optically isolated EIA/TIA RS-485 transceiver.

1. The network bridge shall be provided as a separate module connected on the local network through an available RJ-45 port.

2. Provide Plug n' Go operation to automatically discover room devices connected to the local network and make all device parameters visible to the segment manager via the segment network. No commissioning shall be required for set up of the network bridge on the local network.

3. The network bridge shall automatically create standard BACnet objects for selected room device parameters to allow any BACnet-compliant BAS to include lighting control and power monitoring features as provided by the DLM room devices on each local network. BACnet objects will be created for the addition or replacement of any given in-room DLM device for the installed life of the system. Products requiring that an application- specific point database be loaded to create or map BACnet objects are not acceptable. Systems not capable of providing BACnet data for control devices via a dedicated BACnet Device ID and physical MS/TP termination per room are not acceptable. Standard BACnet objects shall be provided as follows:

.1 Read/write the normal or after hours schedule state for the room

.2 Read the detection state of each occupancy sensor

.3 Read the aggregate occupancy state of the room

.4 Read/write the On/Off state of loads

.5 Read/write the dimmed light level of loads

.6 Read the button states of switches

.7 Read total current in amps, and total power in watts through the room controller

.8 Read/write occupancy sensor time delay, PIR sensitivity and ultrasonic sensitivity settings

.9 Activate a preset scene for the room

.10 Read/write daylight sensor fade time and day and night setpoints

.11 Read the current light level, in footcandles, from interior and exterior photosensors and photocells

.12 Set daylight sensor operating mode

.13 Read/write wall switch lock status

.14 Read watts per square foot for the entire controlled room

.15 Write maximum light level per load for demand response mode

.16 Read/write activation of demand response mode for the room

.17 Activate/restore demand response mode for the room

.2 WattStopper product numbers: LMBC-300

2.14 SEGMENT MANAGER

.1 For networked applications, the Digital Lighting Management system shall include at least one segment manager to manage network communication. It shall be capable of serving up a graphical user interface via a standard web browser utilizing either unencrypted TCP/IP traffic via a configurable port (default is 80) or 256 bit AES encrypted SSL TCP/IP traffic via a configurable port (default is 443).

.2 Each segment manager shall have integral support for at least three segment networks. Segment networks may alternately be connected to the segment manger via external routers and switches, using standard Ethernet structured wiring. Each router shall accommodate one segment network. Provide the quantity of routers and switches as shown on the plans.

.3 Operational features of the Segment Manager shall include the following:

1. Connection to PC or LAN via standard Ethernet TCP/IP via standard Ethernet TCP/IP with the option to use SSL encrypted connections for all traffic.

2. Easy to learn and use graphical user interface, compatible with Internet Explorer 8, or equal browser. Shall not require installation of any lighting control software to an end-user PC.

3. Log in security capable of restricting some users to view-only or other limited operations.

4. Automatic discovery of DLM devices and relay panels on the segment network(s). Commissioning beyond activation of the discovery function shall not be required to provide communication, monitoring or control of all local networks and lighting control panels.

5. After discovery, all rooms and panels shall be presented in a standard navigation tree format. Selecting a device from the tree will allow the device settings and operational parameters to be viewed and changed by the user.

6. Ability to view and modify room device operational parameters. It shall be possible to set device parameters independently for normal hours and after hours operation including sensor time delays and sensitivities, and load response to sensor including Manual-On or Auto-On.

7. Ability to set up schedules for rooms and panels, view and override current status of panel channels and relays, and assign relays to groups. Schedules shall automatically set controlled zones or areas to either a normal hours or after hours mode of operation. Support for a minimum of 100 unique schedules, each with up to four time events per day. Support for annual schedules, holiday schedules and unique date-bound schedules.

8. Ability to group rooms and loads for common control by schedules, switches or network commands.

9. Ability to monitor connected load current and display power consumption for areas equipped with room controllers incorporating the integral current monitoring feature.

10. Provide capabilities for integration with a BAS via BACnet protocol. At a minimum, the following points shall be available to the BAS via BACnet IP connection to the segment manager: room occupancy state; room schedule mode; room switch lock control; individual occupancy sensor state; room lighting power; room plug-load power; load ON/OFF state; load dimming level; panel channel schedule state; panel relay state; and Segment Manager Group schedule state control.

11. The Segment Manager shall allow access and control of the overall system database via Native Niagara AX FOX connectivity. Systems that must utilize a Tridium Niagara controller in addition to the programming, scheduling and configuration server are not acceptable.

.4 Segment Manager shall support multiple DLM rooms as follows:

1. Support up to 120 network bridges and 900 digital in-room devices (LMSM-3E).

2. Support up to 300 network bridges and 2,200 digital in room devices, connected via network routers and switches (LMSM-6E).

.5 WattStopper Product Numbers: LMSM-3E, LMSM-6E, NB-ROUTER, NB-SWITCH, NB-SWITCH-8, NB-SWITCH-16.

2.15 PROGRAMMING, CONFIGURATION AND DOCUMENTATION SOFTWARE

.1 PC-native application for optional programming of detailed technician-level parameter information for all DLM products, including all parameters not accessible via BACnet and the handled IR configuration tool. Software must be capable of accessing room-level parameter information locally within the room when connected via the optional LMCI-100 USB programming adapter, or globally for many segment networks simultaneously utilizing standard BACnet/IP communication.

1. Additional parameters exposed through this method include but are not limited to:

   .1 Occupancy sensor detection LED disable for performance and other aesthetic spaces where blinking LEDs present a distraction.

   .2 Six occupancy sensor action behaviors for each controlled load, separately configurable for normal hours and after hours modes. Modes include: No Action, Follow Off Only, Follow On Only, Follow On and Off, Follow On Only with Override Time Delay, Follow Off Only with Blink Warn Grace Time, Follow On and Off with Blink Warn Grace Time.

   .3 Separate fade time adjustments per load for both normal and after hours from 0 - 4 hours.

   .4 Configurable occupancy sensor re-trigger grace period from 0 - 4 minutes separate for both normal hours and after hours.

   .5 Separate normal hours and after hours per-load button mode with modes including: Do nothing, on only, off only, on and off.

   .6 Load control polarity reversal so that on events turn loads off and vice versa.

   .7 Per-load DR (demand response) shed level in units of percent.

   .8 Load output pulse mode in increments of 1second.

   .9 Fade trip point for each load for normal hours and after hours that establishes the dimmer command level at which a switched load closes its relay to allow for staggered On of switched loads in response to a dimmer.

2. Generation of reports at the whole file, partial file, or room level. Reports include but are not limited to:

   .1 Device list report: All devices in a project listed by type.

   .2 Load binding report: All load controller bindings showing interaction with sensors, switches, and daylighting.

.3 BACnet points report: Per room Device ID report of the valid BACnet points for a given site's BOM.

.4 Room summary report: Device manifest for each room, aggregated by common BOM, showing basic sequence of operations.

.5 Device parameter report: Per-room lists of all configured parameters accessible via hand held IR programmer for use with O&M documentation.

.6 Scene report: All project scene pattern values not left at defaults (i.e. 1 = all loads 100%, 2 = all loads 75%, 3 = all loads 50%, 4 = all loads 25%, 5-16 = same as scene 1).

.7 Occupancy sensor report: Basic settings including time delay and sensitivity(ies) for all occupancy sensors.

3. Network-wide programming of parameter data in a spreadsheet-like programming environment including but not limited to the following operations:

.1 Set, copy/paste an entire project site of sensor time delays.

.2 Set, copy/paste an entire project site of sensor sensitivity settings.

.3 Search based on room name and text labels.

.4 Filter by product type (i.e. LMRC-212) to allow parameter set by product.

.5 Filter by parameter value to search for product with specific configurations.

4. Network-wide firmware upgrading remotely via the BACnet/IP network.

.1 Mass firmware update of entire rooms.

.2 Mass firmware update of specifically selected rooms or areas.

.3 Mass firmware upgrade of specific products.

.2 WattStopper Product Number: LMCS-100, LMCI-100

2.16 LMCP LIGHTING CONTROL PANELS

.1 Provide lighting control panels in the locations and capacities as indicated on the plans and schedules. Each panel shall be of modular construction and consist of the following components:

1. Enclosure/Tub shall be NEMA 1, sized to accept an interior with 1 - 8 relays, 1 - 24 relays and 6 four-pole contactors, or 1 - 48 relays and 6 four-pole contactors.

2. Cover shall be configured for surface or flush wall mounting of the panel as indicated on the plans. The panel cover shall have a hinged and lockable door with restricted access to line voltage section of the panel.

3. Interior assembly shall be supplied as a factory assembled component specifically designed and listed for field installation. The interior construction shall provide total isolation of high voltage (Class 1) wiring from low voltage (Class 2) wiring within the assembled panel. The interior assembly shall include intelligence boards, power supply, DIN rails for mounting optional Class 2 control devices, and individually replaceable latching type relays. The panel interiors shall include the following features:

   .1 Removable, plug-in terminal blocks with connections for all low voltage terminations.

   .2 Individual terminal block, override pushbutton, and LED status light for each relay.

   .3 Direct wired switch inputs associated with each relay shall support 2-wire momentary switches only.

   .4 Digital inputs (four RJ-45 jacks) shall support 1-, 2-, 3-, 4-, and 8-button digital switches; digital IO modules capable of receiving 0-5V or 0-10V analog photocell inputs; digital IO modules capable of receiving momentary or maintained contact closure inputs or analog sensor inputs; digital daylighting sensors; and digital occupancy sensors. Inputs are divided into two separate digital networks, each capable of supplying 250mA to connected devices.

   .5 True relay state shall be indicated by the on-board LED and shall be available to external control devices and systems via BACnet.

   .6 Automatically sequenced operation of relays to reduce impact on the electrical distribution system when large loads are controlled simultaneously.

   .7 Group and pattern control of relays shall be provided through a simple keypad interface from a handheld IR programmer. Any set of relays can be associated with a group for direct on/off control or pattern (scene) control via a simple programming sequence using the relay override pushbuttons and LED displays for groups 1-8 or a handheld IR programmer for groups 1-99.

   .8 Relay group status for shall be provided through LED indicators for groups 1-8 and via BACnet for groups 1-99. A solid LED indicates that the last group action called for an ON state and relays in the group are on or in a mixed state.

.9 Single-pole latching relays with modular plug-in design. Relays shall provide the following ratings and features:

.1 Electrical:

.1 30 amp ballast at 277V

.2 20 amp ballast at 347V

.3 20amp tungsten at 120V

.4 30 amp resistive at 347V

.5 1.5 HP motor at 120V

.6 14,000 amp short circuit current rating (SCCR) at 347V

.7 Relays shall be specifically UL 20 listed for control of plug-loads

.2 Mechanical:

.1 Replaceable, ½" KO mounting with removable Class 2 wire harness.

.2 Actuator on relay housing provides manual override and visual status indication, accessible from Class 2 section of panel.

.3 Dual line and load terminals each support two #14 - #12 solid or stranded conductors.

.4 Tested to 300,000 mechanical on/off cycles.

4. Isolated low voltage contacts provide for true relay status feedback and pilot light indication.

5. Power supply shall be a multi-voltage transformer assembly with rated power to supply all electronics, occupancy sensors, switches, pilot lights, and photocells as necessary to meet the project requirements. Power supply to have internal over-current protection with automatic reset and metal oxide varistor protection.

6. Where indicated, lighting control panels designated for control of emergency lighting shall be provided with factory installed provision for automatic by pass of relays controlling emergency circuits upon loss of normal power. Panels shall be properly listed and labeled for use on emergency lighting circuits and shall meet the requirements of UL924 and NFPA 70 - Article 700.

7. Integral system clock shall provide scheduling capabilities for panel-only projects without DLM segment networks or BAS control.

   .1 Each panel shall include digital clock capability able to issue system wide automation commands to up to (11) eleven other panels for a total of (12) twelve networked lighting control panels. The clock shall provide capability for up to 254 independent schedule events per panel for each of the ninety-nine system wide channel groups.

   .2 The clock capability of each panel shall support the time-based energy saving requirements of applicable local energy codes.

   .3 The clock module shall provide astronomic capabilities, time delays, blink warning, daylight savings, and holiday functions and will include a battery back up for the clock function and program retention in non-volatile FLASH memory. Clocks that require multiple events to meet local code lighting shut off requirements shall not be allowed.

   .4 The clock capability of each panel shall operate on a basis of ON/OFF or Normal Hours/After Hours messages to automation groups that implement pre-configured control scenarios. Scenarios shall include:

      .1 Scheduled ON / OFF

      .2 Manual ON / Scheduled OFF

      .3 Astro ON / OFF (or Photo ON / OFF)

      .4 Astro and Schedule ON / OFF (or Photo and Schedule ON / OFF)

   .5 The user interface shall be a portable IR handheld remote control capable of programming any panel in the system (LMCT-100)

   .6 The clock capability of each panel shall employ non-volatile memory and shall retain user programming and time for a minimum of 10 years.

   .7 Schedules programmed into the clock of any one panel shall be capable of executing panel local schedule or Dark/Light (photocell or Astro) events for that panel in the event that global network communication is lost. Lighting control panels that are not capable of executing events independently of the global network shall not be acceptable.

8. The lighting control panel can operate as a stand-alone system, or can support schedule, group, and photocell control functions, as configured in a Segment Manager controller, via a segment network connection.

9. The lighting control panel shall support digital communications to facilitate the extension of control to include interoperation with building automation systems and other intelligent field devices. Digital communications shall be RS485 MS/TP-based using the BACnet® protocol.
   - .1 The panel shall have provision for an individual BACnet device ID and shall support the full 2^{22} range (0 – 4,193,304). The device ID description property shall be writable via the network to allow unique identification of the lighting control panel on the network.
   - .2 The panel shall support MS/TP MAC addresses in the range of 0 127 and baud rates of 9600k, 38400k, 76800k, and 115.2k bits per second.
   - .3 Lighting control relays shall be controllable as binary output objects in the instance range of 1 64. The state of each relay shall be readable and writable by the BAS via the object present value property.
   - .4 Lighting control relays shall report their true on/off state as binary input objects in the instance range of 1 64.
   - .5 The 99 group Normal Hours/After Hours control objects associated with the panel shall be represented by binary value objects in the instance range of 201 299. The occupancy state of each channel group shall be readable and writable by the BAS via the object present value property. Commanding 1 to a channel group will put all relays associated with the channel into the normal hours mode. Commanding 0 or NULL shall put the relays into the after hours mode.
   - .6 Setup and commissioning of the panel shall not require manufacturer-specific software or a computer. All configuration of the lighting control panel shall be performed using standard BACnet objects or via the handheld IR programming remote. Provide BACnet objects for panel setup and control as follows:
     - .1 Binary output objects in the instance range of 1 64 (one per relay) for on/off control of relays.
     - .2 Binary value objects in the instance range of 1 99 (one per channel) for normal hours/after hours schedule control.
     - .3 Binary input objects in the instance range of 1 64 (one per relay) for reading true on/off state of the relays.
     - .4 Analog value objects in the instance range of 101 199 (one per channel group) shall assign a blink warn time value to each channel. A value of 5 shall activate the blink warn feature for the channel and set a 5-minute grace-time period. A value of 250 shall activate the sweep feature for the channel and enable the use of sweep type automatic wall switches.
   - .7 The description property for all objects shall be writable via the network and shall be saved in non-volatile memory within the panel.

.8 The BO and BV 1 99 objects shall support BACnet priority array with a relinquish default of off and after hours respectively. Prioritized writes to the channel BV objects shall propagate prioritized control to each member relay in a way analogous to the BACnet Channel object described in addendum aa. (http://www.bacnet.org/Addenda/Add-135-2010aa.pdf)

.9 Panel-aggregate control of relay Force Off at priority 2 shall be available via a single BV5 object. Force On at priority 1 shall be available via a single BV4 object.

.10 Lockout of all digital switch buttons connected to a given panel shall be command-able via a single BV2 object. The lock status of any connected switch station shall be represented as BV101-196.

10. WattStopper Product Number: LMCP8, LMCP24 or LMCP48

.2 User Interface

Each lighting control panel system shall be supplied with at least (1) handheld configuration tool (LMCT-100). As a remote programming interface the configuration tool shall allow setup, configuration, and diagnostics of the panel without the need for software or connection of a computer. The user interface shall have the following panel-specific functions as a minimum:

1. Set network parameters including panel device ID, MS/TP MAC address, baud rate and max master range.
2. Relay Group creation of up to 99 groups. Group creation shall result in programming of all seven key relay parameters for member relays. The seven parameters are as follows: After-hours Override Time Delay, Normal Hours Override Time Delay, Action on Transition to Normal Hours, Action on Transition to After Hours, Sensor Action During Normal Hours, Sensor Action During After Hours, Blink-Warn Time for After Hours.
3. Program up to 254 separate scheduled events. Events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays. Holidays are also defined through the User Interface.
4. Program up to 32 separate Dark/Light events. Events shall have a selectable source as either calculated Astro with delay, or a digital IO module with an integral 0-5V or 0-10V analog photocell. Dark/Light events shall occur on seven day intervals with each day selectable as active or inactive, and shall be configurable as to whether the event is active on holidays.
5. Button binding of digital switches to groups shall be accessible via the handheld IR remote and accomplished from the digital switch station.
6. Programming of panel location information shall be accomplished by the handheld IR remote and include at a minimum LAT, LON, DST zone, and an approximate city/state location.

7. An additional handheld IR remote may optionally be specified to be permanently mounted to the panel interior via a retractable anti-theft lanyard to allow for convenient programming of the panel while assuring that the handheld programmer is always present at that panel. An unlimited number of handheld IR remotes may also be purchased for facilities staff as determined by the end user's representative.
8. WattStopper Product Number: LMCT-100

2.17 EMERGENCY LIGHTING CONTROL DEVICES

.1 Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:

1. 120/277 volts, 50/60 Hz, 20 amp ballast rating
2. Push to test button
3. Auxiliary contact for remote test or fire alarm system interface

.2 WattStopper Product Numbers: ELCU-100, ELCU-200.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETING

.1 A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:

1. Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
2. Review the specifications for low voltage control wiring and termination.
3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
4. Discuss requirements for integration with other trades.

3.2 CONTRACTOR INSTALLATION AND SERVICES

.1 Contractor to install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.

.2 Contractor to install all room/area devices using manufacturer's factory-tested Cat 5e cable with pre-terminated RJ-45 connectors. If pre-terminated cable is not used for room/area wiring, the contractor is responsible for testing each field-terminated cable following installation, and shall supply the lighting controls manufactuerer with test results. Contractor to install any room to room network devices using manufacturer-supplied LM-MSTP network wire. Network wire substitution is not permitted and may result in loss of product warranty per DLM SEGMENT NETWORK section of specification. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.

.3 Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.

.4 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.

1. Adjust time delay so that controlled area remains lighted while occupied.

.5 Provide written or computer-generated documentation on the configuration of the system including room by room description including:

1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.

2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)

3. Load Parameters (e.g. blink warning, etc.)

.6 Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Architect / Owner of post start-up activity.

3.3 FACTORY SERVICES

.1 Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.

.2 The electrical contractor shall provide both the manufacturer and the electrical engineer with three weeks written notice of the system start up and adjustment date.

.3 Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

3.4 COMMISSIONING SUPPORT SERVICES

.1 On this project, a commissioning agent will be hired to verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.

.2 The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

.1 General: Provide a complete communication system. Refer to the attachment appendix A (Queen's ITS Communications Infrastructure Guidelines - total of 14 pages) and comply accordingly.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

.1 This Specification Section is an integral part of the Contract Documents and shall be read accordingly.

.2 Comply with General Conditions, Supplementary Conditions, and Section 26 01 00 – Electrical General Requirements.

.3 Provide labour, materials, and equipment for installation, testing, and commissioning of a complete operating fire alarm system as specified herein, indicated on the Drawings, add/or required otherwise. The system shall be left ready for continuous and efficient satisfactory operation.

1.2 REFERENCE

.1 Comply with the requirements of the latest edition of the following:

.1 CAN/ULC-S524, Standard for the installation of Fire Alarm Systems.
.2 ULC/S525, Audible Signal Appliances for Fire Alarm Systems.
.3 CAN/ULC-S526, Visual Signal Appliances for Fire Alarm Systems.
.4 CAN/ULC-S527, Control Units for Fire Alarm Systems.
.5 CAN/ULC-S528, Manual Pull Stations for Fire Alarm Systems.
.6 CAN/ULC-S529, Smoke Detectors for Fire Alarm Systems.
.7 CAN/ULC-S530, Heat Actuated Fire Detectors for Fire Alarm Systems.
.8 CAN/ULC-S531 Smoke Alarms for Fire Alarm Systems.
.9 CAN/ULC-S533, Egress Door Security and Releasing Devices.
.10 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems
.11 CAN/ULC-S537, Standard for the Verification of Fire Alarm System Installations
.12 CAN/ULC-S541, Speakers for Fire Alarm Systems
.13 CAN/ULC-S553, Installation for Smoke Alarms

1.3 SUBMITTALS

.1 Submit shop drawings in accordance with Section 26 01 00 – Electrical General Requirements. Shop drawing shall include:

.1 Complete system riser diagram showing all devices, control equipment, circuits and wiring.

.2 Details of system operating sequence.

.3 Details and performance specifications for system control annunciation and peripherals.

.4 Details for devices.

.2 Submit arrangement and wording of annunciators for fire alarm zone indications to local fire department and provide changes as requested. Submit documents to the local fire department as required by the local fire department.

.3 Following completion of verification, and of acceptance of the installation by local fire department, submit the certification of the fire alarm system, together with detailed verification record sheets showing location of each device and all verification results.

.4 Submit the operating and maintenance manual in accordance with section 26 01 00 – Electrical General Requirements. The manual shall include:

.1 Instructions for the operation of the fire alarm system.

.2 Instructions for the maintenance of the fire alarm system.

.3 Approved shop drawings with all the connections.

1.4 QUALIFICATIONS

.1

.1 Acceptable Manufacturer: Siemens. All fire alarm devices/components/products to purchased directly from Siemens.

.2 Verifications & Programming to be provided only by Siemens.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

.1 The fire alarm system shall be an OBC, single stage, zoned non-coded, fully addressable, microprocessor based, electrically supervised system with all components listed by ULC and CSA.

.2 The fire alarm system shall include, but not limit to:

.1 Fire alarm control panel (FACP).

.2 Initiating devices: Manual pull station, automatic smoke and heat detectors.

.3 Signal devices: audible and visual.

.4 Auxiliary devices.

.5 Initiating circuits, signal circuits (minimum two circuits) and auxiliary circuits.

.6 Power and circuit wiring.

.3 System shall be electrically supervised in accordance with CAN/ULC S524.

.4 Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-Site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download. To accommodate this capability, the download of a new FACP program will be transferred to a "secondary" configuration memory bank, while the FACP continues to function on the "primary" configuration memory bank.

.5 History Logs: The system shall provide a means to recall alarms, supervisory and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

.6 Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.

.7 Non-interfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent addressable device activations.

.8 A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.

.9 FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values. The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations. The FACP shall automatically indicate when an individual sensor needs cleaning.

2.2 SYSTEM OPERATION

.1 Activation of any alarm initiating devices (sprinkler flow switch, manual pull station, heat detector, smoke detector, etc.) shall initiate the operations to occur as follows:

.1 All the audible signal devices sound the alarm tone throughout the building. All the visual signal devices shall be activated.

.2 The zone of initiation device shall be displayed on the control panel.

.3 Central station shall be signaled automatically for the notification of fire department.

.4 Release door hold open devices.

.5 Transmit signals to enable the following functions:

.1 Fans shut down
.2 Pressurization fans start-up.
.3 Mag-locks release
.4 Fire doors and/or smoke control doors, to close and/or open.
.5 Elevators to commence the fire mode sequence.
.6 Independent fire suspension systems to commence the fire mode sequence.
.7 Other functions as required on the drawings.

.2 After one minute of alarm, the system could be manually silenced via the silencing switch on the control panel. A subsequent alarm shall re-activate signals.

.3 The alarm condition shall be cleared only upon activation of the reset switch on the control panel.

.4 Activation of supervised sprinkler devices or other auxiliary systems (i.e. supervisory valves, pressure switches, fire pump, generator supervised contacts, etc.) shall initiate the following operations:

.1 The respective supervisory zone shall be displayed on the control panel.

.2 Activate an audible signal (steady tone) on control panel. The signal may be silenced via silencing switch on control panel.

.3 Activate a visual signal (indicator) on control panel.

.4 Transmit a general trouble signal to central station.

.5 The trouble condition shall be cleared only via reset switch.

.5 Any open circuit, circuit ground fault, short circuit condition, circuit loss of power, loss of main system power, system standby power trouble and removal of any system component shall initiate the following system trouble condition operations:

.1 The respective supervisory zone shall be displayed on the control panel.

.2 Activate the system trouble indicator on control panel.

.3 Activate system trouble audible signal (steady tone) on control panel. The signals may be silenced via silencing switch on control panel.

.4 Transmit a general trouble signal to central station.

.5 The trouble condition shall be cleared when the cause is rectified.

2.3 FIRE ALARM CONTROL PANEL

.1 Fire alarm control panel (FACP) shall provide power, annunciation, supervision and control for the system.

.2 Recessed or semi-recessed sprinkler-proof enclosure with lockable hinged front door.

.3 Alarm initiating circuits in accordance with the number of zone indicated on the Fire Alarm Schedules on Drawing E504 plus 20% spare space capacity for future expansion and for the quantity of field devices in accordance with the manufacturer's recommendations.

.4 Minimum two signal circuits in accordance with the manufacturer's recommendations, with provision for future signal circuits. Signal circuits shall not be loaded more than 80% in order to allow for future adjustment.

.5 High intensity LEDs for each zone circuit with 20% spare capacity for future zones as indicated. Type labels per the Fire Alarm Schedule (Drawing E504) and to the requirements of local Ontario Building Inspector and local Fire Department

.6 Common control module with LCD or LED backlit two-line character display of system function with the following additional features:

.1 Trouble LED, buzzer, silence switch. 'Signals Silenced' LED.

.2 'Power-On', 'Disable', 'Supervisory; and 'Alarm' LEDs.

.3 'Ground Fault' and 'Loss of Normal Power' LED.

.4 Test pushbutton.

.5 Alarm reset buttons.

.7 Individual trouble display for each detection and signal circuit.

.8 Auxiliary or output point for:

.1 Signal to motor controls for fan system shut-down or smoke control operations. Relays shall have contacts rated at 15 amps, pilot duty. Provide control measure to manually operate (turn on and turn off) each motor from the FACP.

.2 Transmission of signal to off-premises central monitoring station. Third Party Monitoring Company will be hired directly by the Region.

.3 Signals to elevator controllers.

.4 Signals to maglock release and hold open devices.

.5 Transmission of signal to security system for fire alarm monitoring.

.6 Other functions as required on the Drawings.

.7 20% spare output points for future.

.9 Operator interface keypad. Provide LCD display with wording to the Consultant's approval in accordance with Fire Alarm Schedule on Drawing E504.

.10 Coded terminal strips for external connections to signal circuits, initiating circuit, multiplex annunciators, etc.

.11 Receipt of a signal from an alarm initiating device shall cause audible signals to sound for a full period whether or not a previous alarm has been silenced manually.

.12 The necessary controls to ensure that a fire alarm signal is not initiated during under-voltage or over-voltage conditions caused by changeover from normal to emergency power supply and vice versa.

.13 Provide the necessary hardware and software required to provide a proper system operation.

.14 Provide main system power supply to operate the entire fire alarm system and power supply at 24 volts from a 120 VAC 60Hz input. The integral standby power shall consist of 24 volt dc sealed nickel-cadmium batteries or gell-cell batteries, automatic battery charger with power reversal protection, ammeter and voltmeter to monitor charge rate and battery voltage. Standby power requirements shall be in accordance with CAN/ULC-S524, Section 3.2, Power Supply. Battery capacity shall be sufficient to provide 24-hour supervision plus 60 minutes full alarm operation. Battery charger shall be capable of recharging batteries to 80% capacity in 24 hours.

2.4 SYSTEM DEVICES

.1 Manual Pull Stations

.1 Manual pull stations shall be single stage, extruded aluminum, semi-flush or surface, red, pull activated, wall mounted in 102mm square red box. At maglock doors, the station shall have a dual contact.

.2 Where required, provide tamper proof, weatherproof clear shield complete with a battery operated warning horn.

.2 Heat Detectors

.1 Combination fixed 57°C (135°F) and 8.3°C (15°F)/min rate-of-rise type, in all areas except where normal temperature fluctuations exceed 10°C (18°F)/min.

.2 Fixed temperature 91°C (195°F) type, provided in areas with normal ambient temperature between 38°C (100°F) and 66°C (150°F).

.3 Ceiling mounted in 102mm square outlet box.

.4 Detector in elevator shaft to be complete with auxiliary relays and wired to the elevator controller.

.3 Area Smoke Detectors

.1 Photoelectric type ceiling smoke detector with the following features:

.1 Sensitivity read-out;

.2 Snap-in base;

.3 Visual indication of detector actuation.

.2 Ceiling mounted in 102mm square outlet box.

.3 Smoke detectors required for door hold openers and fire automatic doors shall be provided with auxiliary relays, and wired to door hold openers.

.4 Duct-Mounted Smoke Detectors

.1 Product Description: photoelectric type with the following features:

.1 Auxiliary SPDT relay contact for locate fan shutdown;

.2 Key-operated normal-reset-test switch.

.3 Duct sampling tubes extending width of duct.

.4 Visual indication of detector actuation.

.5 Duct-mounted housing.

.6 Powered from FACP.

.2 Provide remote alarm indication for duct mounted smoke detectors installed in concealed spaces. Ensure that all detectors are accessible for maintenance.

.3 Refer to the Mechanical Drawings for duct sizes and air velocities to ensure that the proper quantity of detectors is provided to adequately monitor the cross-sectional area of the duct in accordance with the manufacturer's recommendations. Co-ordinate the proper location and installation with Mechanical Division 23.

.4 Where duct-mounted smoke detectors are installed outdoors, provide weather-proof enclosure. Provide heater and power and the manufacturer's instruction.

.5 Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.

.6 Duct Housing shall provide two test ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.

.5 Addressable Circuit Interface Modules

.1 Addressable Circuit Interface Modules: Modules shall be used for monitoring of non-addressable devices and/or circuit, and for control of evacuation indicating appliances and air handling units systems.

.2 Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two-wire pair running from an appropriate power supply as required.

.3 There shall be the following types of modules:

.1 Type 1: Monitor Circuit Interface Module:

.1 For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.

.2 For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.

.2 Type 2: Line Powered Monitor Circuit Interface Module

.1 This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.

.2 This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short). The two-wire signaling line circuit shall supply power and communications to the module.

.3 Type 3: Single Address Multi-Point Interface Modules

.1 This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.

.2 This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.

.3 This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.

.4 Type 4: Line Powered Control Circuit Interface Module

.1 This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.

.5 Type 5: 4-20 mA Analog Monitor Circuit Interface Module

.1 This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

.6 All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

.6 End-of-Line Devices

.1 Mount end of line devices in box with last device or separate box wall mounted, adjacent to last device.

.7 Horns:

.1 Temporal horns rated at 98 dba to 91dba at 3m, finished in red and operated on 24V DC. Mounted in 102mm square or single gang outlet box. High and Low field selectable sound output level setting.

.8 Fire Alarm Strobe

.1 Provide surface wall mounted synchronized high strobe lights to indicate alarm condition.

.2 The strobe light shall consist of a xenon tube with red lens. 75cd to 110 cd flash intensity.

.3 Mounted in 102mm square or single gang outlet box.

.9 Annunciator

.1 Annunciator shall form part of the control panel and contain necessary number of LED lights and LCD to displace all alarm, trouble and control zones.

.2 The annunciator shall contain a lamp test switch, trouble buzzer, acknowledge push button, signal silencing push button and reset push button.

.10 Passive Graphic

.1 Passive Graphic to be white back grounds with color lines and text. Show all F/A zone areas, stair and elevator shafts, interior walls and doors and sprinkler devices. Size graphic as required. Brushed aluminum trim with tempered glass front. Install passive graphic beside the control panel.

2.5 WIRING

.1 Install all wiring in conduit.

.2 Fire alarm system wiring shall be run in separate conduit.

.3 Provide shielded wiring when recommended by the manufacturer's specifications.

.4 Wires shall be CSA-FAS Type 105 copper conductor, 105°C rating, not less than 300V. Wiring shall be sized not less than requirement of Section 32-100 of the Electrical Safety Code, Class 1 or Class 2 circuits as required, with screw-terminal wiring connections.

.5 Stranded conductors with more than 7 strands shall be bunched-tinned or terminated in compression connectors.

.6 Provide watertight fittings for conduits entering the top or sides of surface mounted terminal cabinets, annunciator transponders and control panels.

2.6 SPECIAL ENVIRONMENT

.1 Devices shall be moisture-proof where located in any area that may be exposed to moisture. Devices shall be weather-proof where located outside.

.2 Provide heater and power provision to the heater completed with the required rough-ins breaker and wiring, (circuit breaker may not be shown on the Drawings), for devices located in cold area as required by the manufacturer in order to maintain operation of such respective devices.

.3 Where the devices located in cold area, locate addressable module in warm area, and conventional devices in cold and/ or hot area.

.4 Provide tamper proof wire guard where indicated on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Equipment

.1 Install all equipment in accordance with CAN/ULC-S524 “Standard for the Installation of Fire Alarm Systems”, the manufacturer's instructions, Ontario Building Code, Underwriter's Laboratory of Canada, Electrical Safety Code, these Documents and requirements of local Ontario Building Inspector and/or local Fire Department. This shall include appropriate settings for speaker transformer taps.

.2 In the event that the information given in the Specification and/or shown on the Drawings conflicts with the Ontario Building Code and/or ULC 524 and/or the requirement of local Ontario Building Inspector and/or local Fire Department, bring this to the attention of the Consultant, and do not proceed with the work until the matter is clarified by the Consultant.

.2 Connections to Other Systems

.1 Sprinkler and Fire Standpipe System Connections

.1 Provide wiring and connections to all flow switches, supervised valves and pressure switches supplied by Mechanical Division 23.

.2 Provide wiring and connections to sprinkler and fire standpipe pumps equipped with supervisory contacts provided by Mechanical Division for `Loss of Power', 'Phase Reversal' and `Pump(s) Running' indications.

.2 Motor Control Connections

.1 Provide all wiring and connections from the fire alarm system to motor starters as required for shutdown and/or start-up. Co-ordinate connection and location with the work of the Mechanical Division 23 for proper system operation.

.2 Wiring for local fans operation on smoke condition shall be installed by Electrical Division 26 from duct mounted smoke detectors to the terminal panel adjacent to the motor control panel or the starter.

.3 Door Device Connections

.1 Provide power, wiring, conduit and connections to electrical door hardware, door hold-open devices and door control (Maglocks) devices for proper release operation. Co-ordinate installation with the hardware installer.

.4 Generator Alarm Connections

.1 Provide wiring, conduit and connection to the generators for supervisory status and trouble signals.

3.2 TESTING AND CERTIFICATION

.1 Arrange with the manufacturer to conduct a complete inspection and test of all installed fire alarm and voice communication equipment including all components such as manual stations, signaling devices, heat detectors, smoke detectors, speakers, fire fighters handsets, controls, etc. Test and verify connections to the equipment of other Divisions such as sprinkler valves, elevators, etc. Co-ordinate with and arrange for staff of other divisions to be present where required.

.2 Provide staff to test devices and all operational features of the system for witness by the Consultant and Ontario Building Inspector and/or local Fire Department Provide two-way radio communication at each annunciator, control point and other areas in the building as required. All testing must be witnessed by Owner's representative prior to acceptance.

.3 Test and verify the total system to ensure satisfactory operation in conformance with latest version of CAN/ULC-S536 and CAN/ULC-S537, "Standard for the Verification of Fire Alarm System Installations".

.4 Carry out testing, verification and certification as follow:

.1 Verifications & Programming to be provided only by Siemens.

.2 System test in conjunction with the manufacturer.

.3 Correction of all deficiencies.

.4 Submission of test results to Consultant for review including letter of certification from the manufacturer(s).

.5 Witness of complete system by Consultant and/or his representatives.

.6 Correction of any deficiencies noted.

.7 Acceptance of the system by the Consultant.

.8 Witness of system test by authority having jurisdiction.

.9 Correction of any deficiencies requested by authority having jurisdiction.

.10 Submission of manuals with final verification sheets.

.5 All costs involved in the testing and certification shall be included in the Contract Price.

3.3 TRAINING

.1 Provide the services of a factory-authorized service representative to demonstrate the system and train the Owner's maintenance personnel as specified below.

.1 Train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 4 hours of training. Schedule training with the Owner a minimum of seven Days in advance.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 31 05 10 - Corrected Maximum Dry Density for Fill.

.2 Section 31 23 10 - Excavating, Trenching and Backfilling.

1.2 References

.1 Ontario Provincial Standard Specification OPSS 314 - Construction Specification for Untreated Granular, Sub-base, Base, Surface Shoulder and Stockpiling.

.2 Ontario Provincial Standard Specification OPSS 1010 Material Specification for Aggregates, Base, Sub-base, Select Sub-grade and Backfill Material.

.3 City of Kingston Sub-Division Development Guidelines and Technical Standards.

1.3 Samples

.1 Submit test results for granular gradation in accordance with Section 01 33 00 Submittal Procedures.

PART 2 - PRODUCTS

2.1 Materials

.1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.

.2 Use of recycled materials on this project is not permitted.

2.2 Source Approval

.1 Inform Consultant of proposed source of aggregates and provide test results for sampling at least 4 weeks prior to commencing production.

2.2 Source Approval (Cont'd)

.2 If, in opinion of Consultant, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.

.3 Should a change of material source be proposed during work, advise Consultant 2 weeks in advance of proposed change and provide documentation for testing.

.4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

.5 Pay cost of sampling and testing of aggregates which fail to meet specific requirements.

PART 3 - EXECUTION

3.1 Processing

.1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.

.2 Blend aggregates, if required, to obtain gradation requirements, percentage of crushed particles, or particle shapes, as specified.

.3 Wash aggregates, if required to meet specifications. Use only equipment approved by Consultant.

3.2 Handling

.1 Handle and transport aggregates to avoid segregation, contamination and degradation.

3.3 Stockpiling

.1 If stockpiling is required by Contractor

3.3 Stockpiling (Cont'd)

.1 (Cont'd)
.1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Consultant. Do not stockpile on completed pavement surfaces.

.2 Stockpile aggregates in sufficient quantities to meet project schedules.

.3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.

.4 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.

.5 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Consultant within 48h of rejection.

.6 Stockpile materials in uniform layers of thickness as follows:
.1 Max 1.5m for coarse aggregate and base course materials.
.2 Max 1.5m for fine aggregate and sub-base materials.
.3 Max 1.5m for other materials.

.7 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.

.8 Do not cone piles or spill material over edges of piles.

.9 Do not use conveying stackers.

.10 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.4 Aggregate Stockpile Clean up

.1 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water. Remove sand base and restore stockpile site at completion of the work.

END OF SECTION

PART 1 - GENERAL

1.1 Related Requirements

.1 Section 31 23 10 - Excavation, Trenching and Backfilling.

.2 Section 31 22 13 - Rough Grading.

1.2 Definitions

.1 Clearing consists of cutting off trees and brush vegetative growth to not more than specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.

.2 Close-cut clearing consists of cutting off standing trees, brush, scrub, roots, stumps and embedded logs, removing at, or close to, existing grade and disposing of fallen timber and surface debris.

.3 Clearing isolated trees consists of cutting off to not more than specified height above ground of designated trees, and disposing of felled trees and debris.

.4 Underbrush clearing consists of removal from treed areas of undergrowth, deadwood, and trees smaller than 50 mm trunk diameter and disposing of fallen timber and surface debris.

.5 Grubbing consists of excavation and disposal of stumps and roots.

1.3 Storage and Protection

.1 Prevent damage to fencing, trees, landscaping, natural features, bench marks, existing buildings, existing pavement, utility lines, site appurtenances, water courses, and root systems of trees which are to remain.
.1 Repair damaged items to approval of Consultant.
.2 Replace trees designated to remain, if damaged, as directed by Consultant.

PART 2 - PRODUCTS

2.1 NOT USED

.1 NOT USED.

PART 3 - EXECUTION

3.1 Preparation

.1 Inspect site and verify with Consultant, items designated to remain.

.2 Locate and protect utility lines: preserve in operating condition active utilities traversing site.
.1 Notify Consultant immediately of damage to or when unknown existing utility lines are encountered.
.2 When utility lines which are to be removed are encountered within area of operations, notify Consultant in ample time to minimize interruption of service.

.3 Notify utility authorities before starting clearing and grubbing.

.4 Keep roads and walks free of dirt and debris.

3.2 Clearing

.1 Clearing includes felling, trimming, and cutting of trees into sections and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within cleared areas.

.2 Clear as indicated and directed by Project Manager, by cutting at height of not more than 300 mm above ground. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 1000 mm above ground surface.

.3 Cut off branches and cut down trees overhanging area cleared as directed by Consultant.

3.3 Close Cut Clearing

.1 Close cut clearing to ground level to within 100 mm of ground surface.

.2 Cut off branches overhanging area cleared as directed by Consultant.

.3 Cut off unsound branches on trees designated to remain as directed by Consultant.

3.4 Isolated Trees

.1 Cut off isolated trees as indicated and directed by Consultant at height of not more than 300 mm above ground surface.

.2 Grub out isolated tree stumps.

3.5 Underbrush Clearing

.1 Clear underbrush from areas as indicated at ground level.

3.6 Grubbing

.1 Grub out stumps and roots to not less than 200 mm below ground surface.

.2 Grub out visible rock fragments and boulders, greater than 300 mm in greatest dimension, but less than 0.25 m^3.

3.7 Removal and Disposal

.1 Remove cleared and grubbed materials off site.

3.8 Finished Surface

.1 Leave ground surface in condition suitable for immediate grading operations to approval of Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 Related Requirements

.1 Section 31 23 13 - Rough Grading.

.2 Section 32 91 21 - Topsoil Placement and Grading.

.3 Appendix B - Excess Soils Management Plan

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 Stripping of Topsoil

.1 Remove topsoil before construction procedures commence to avoid compaction of topsoil.

.2 Handle topsoil only when it is dry and warm.

.3 Strip topsoil and avoid mixing topsoil with subsoil where textural quality will be moved outside acceptable range of intended application.

.4 Pile topsoil in locations as directed by Consultant, height not to exceed 2.0 m.

.5 Dispose of unused topsoil is to be an environmentally responsible manner.

.6 Protect stockpiles from contamination and compaction.

.7 Follow Excess Soils Management Plan - Appendix B

3.2 Preparation of Grade

.1 Verify that grades are correct and notify Consultant if discrepancies occur, do not begin work until instructed by Consultant.

3.2 Preparation of Grade (Cont'd)

.1 (Cont'd)

.1 Grade area only when soil is dry to lessen soil compaction.

.2 Grade soil with scrapers establishing natural contours and eliminating uneven areas and low spots, ensuring positive drainage.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 31 14 13 - Soil Stripping and Stockpiling.

.2 Section 31 23 13 - Rough Grading.

.3 Section 31 23 16 - Rock Removal.

.4 Section 32 11 18 - Granular Base (Granular 'A').

.5 Section 32 11 19 - Granular Sub-base, (Granular 'B' Type II).

1.2 Description

.1 Excavating or trenching includes the excavation or trenching of all materials of whatever nature, including topsoil, granular, asphalt, concrete curbs, concrete sidewalk, dense tills, hardpan, frozen materials and partially cemented materials that can be ripped and excavated with heavy construction equipment.

.2 Any required shoring, bracing, and de-watering of excavation is part of this work.

1.3 References

.1 ASTM C 117-04, Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C 136-06, Method for Sieve Analysis of Fine and Coarse Aggregates.

.3 ASTM D 422-63(R2007), Method for Particle-Size Analysis of Soils.

.4 ASTM D 1557-09, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbs/ft^3) (2,700 kN-m/m^3).

.5 ASTM D 4318-10, Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 References (Cont'd)

.6 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

.7 CAN/CSA-A23.1-09, Concrete Materials and Methods of Concrete Construction.

.8 OPSS 1010 Material Specification for Aggregates - Base, Sub-base, Select Sub-grade and Backfill Material.

.9 City of Kingston Subdivision Development Guidelines and Technical Standards.

1.4 Definitions

.1 Unclassified excavation: excavation of deposits of whatever character encountered in work.

.2 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

.3 Waste material: excavated material unsuitable for use in work or surplus to requirements.

.4 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of work.

.5 Unsuitable materials:
.1 Organic Soil.
.2 Weak and compressible materials under excavated areas.
.3 Frost susceptible materials under excavated areas.
.4 Frost susceptible materials:
.1 Fine grained soils with plasticity index less than 10 when tested to ASTM D 4318, and gradation within limits specified when tested to ASTM D 422 and ASTM C 136: Sieve sizes to CAN/CGSB-8.1.

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

.2 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

1.5 Samples

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

1.6 Protection of Existing Features

.1 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 Prior to commencing excavation work, arrange with the designated utility locator to stake existing municipal and private utility locations.
.3 Where test holes are specified, existing utilities are to be exposed in advance by means of a Hydro-Vac Truck System.
.4 Maintain and protect from damage, water, sewer, gas, electric, telecommunication and other utilities and structures encountered.
.5 Where utility lines or structures exist in area of excavation, obtain direction of Project Manager before removing or re-routing.
.6 Record location of maintained, re-routed and abandoned underground lines.

.2 Existing features:
.1 Protect existing features from damage while work is in progress. In event of damage, immediately make repair to approval of the Consultant.

PART 2 - PRODUCTS

2.1 Materials

.1 Granular 'A' for granular fill shall meet the requirements of Granular Base, Section 32 11 18.

.2 Granular 'B' Type II for granular backfill shall meet the requirements of Granular Sub-base, Section 32 11 19 .

.3 Concrete for use in over-excavation in rock and earth shall be Granular 'B' Type II meeting the requirements of Granular Sub-Base, Section 32 11 19.

2.1 Materials (Cont'd)

.4 Engineered Fill: Granular 'A' compacted in lifts to a density of 95% Modified Proctor Maximum Dry Density (MPMDD).

PART 3 - EXECUTION

3.1 Site Preparation

.1 Remove obstructions, from surfaces to be excavated within limits indicated.

.2 Cut existing pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.2 Stockpiling

.1 Topsoil shall be disposed of off site in locations arranged by the Contractor.

.2 Protect fill materials from contamination.

3.3 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.

.3 Avoid excavation below groundwater table if quick condition or heave is likely to occur. Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.

.4 Protect open excavations against flooding and damage due to surface run-off.

.5 Dispose of water in manner not detrimental to public and private property, or any portion of work completed or under construction.

.6 Provide silt fence, straw bales, sediment dewatering traps, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, water courses or drainage areas.

3.4 Excavation

.1 Excavate unsuitable material and earth to lines, grades, elevations and dimensions as indicated.

.2 Transition treatment between earth and rock cut as per OPSD 205.050.

.3 Excavation must not interfere with normal 45° splay of bearing from bottom of any footing.

.4 For trench excavation, unless otherwise authorized by Consultant do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 5m at end of day's operation.

.5 Dispose of waste material (i.e., excess or unsuitable excavated material) off site.

.6 Do not obstruct flow of surface drainage or natural watercourses.

.7 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or unsuitable material.

.8 Notify Consultant when bottom of excavation is reached.

.9 Obtain Consultant approval of completed excavation.

.10 For footing excavations, geotechnical engineer on behalf of Consultant shall approve all bearing surfaces prior to commencing footing construction.

.11 Remove unsuitable material from trench bottom to extent and depth as directed by Project Manager.

.12 Correct unauthorized over-excavation as follows:
.1 In non-structural areas (beyond limit of building footprint, fill with Granular 'B' Type II.
.2 In structural areas (within building footprint) fill with 30 MPa concrete.

3.4 Excavation (Cont'd)

.13 Trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.

.14 Protect existing pavements and facilities and repair any damage to the satisfaction of the Consultant at no cost to the Owner.

3.5 Backfilling

.1 Do not proceed with backfilling operations until Consultant has inspected and approved installations.

.2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.

.3 Do not use backfill material which is frozen or contains ice, snow or debris.

.4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.

.5 Backfill around installations.
.1 Do not backfill around or over cast-in-place concrete within 24 h after placing of concrete.
.2 Place layers simultaneously on both sides of installed work to equalize loading. Difference not to exceed 0.5 m.
.3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
.1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Consultant or:
.2 If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.

3.5 Backfilling (Cont'd)

.5 (Cont'd)

.3 (Cont'd)

.6 Fill for non-structural slabs, parking areas (granular and asphalt), entrances and concrete walks shall be Granular 'B' Type II. Backfill shall be placed in maximum 300 mm lifts for compaction.

.7 Backfill for all trenches within the building footprint shall be Granular 'B' Type II to within 150 mm of the underside of slabs and footings and 150 mm Granular 'A'. Granulars to be compacted in lifts to a density of 95% Modified Proctor Maximum Dry Density (MPMDD).

3.6 Compaction

.1 Compaction of Engineered Fill shall be to a density of 100% Standard Proctor Maximum Dry Density (SPMDD).

3.7 Restoration

.1 Upon completion of work, remove waste materials and debris, trim slopes, and correct defects as directed by Consultant.

.2 Clean and reinstate adjacent areas affected by work such as pavement, sidewalks and lawns, to elevations which existed before excavation, or as shown on Contract Drawings, or as directed by the Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 31 11 00 - Clearing and Grubbing.

.2 Section 31 14 13 - Soil Stripping and Stockpiling.

.3 Section 31 23 10 - Excavating, Trenching and Backfilling.

.4 Section 32 91 21 - Topsoil Placement and Grading.

1.2 References

.1 American Society for Testing and Materials (ASTM)
.1 ASTM D 698-07, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 Ft lb/ft3 (600KN m/m3)).

.2 City of Kingston Subdivision Development Guidelines and Technical Standards.

1.3 Scope of Work

.1 Work shall include rough grading including grading for swales, ditches and surface treatments to levels and profiles allowing for surface treatment as indicated on Contract Drawings.

.2 This Section does not include work within the building footprint.

1.4 Existing Conditions

.1 Underground and surface utility lines and buried objects indicated on site plan are approximate only and shall be confirmed by the Contractor.

1.5 Protection

.1 Protect existing fencing, trees, buildings, pavement, surface or underground utility lines which are to remain. If damaged, restore to original or better condition unless directed otherwise.

1.5 Protection (Cont'd)

.2 Maintain access roads to prevent accumulation of construction related debris on roads.

.3 The Contractor will be required to expose the existing utility where the proposed utilities cross the existing service or cover is to be removed. Utility locates shall be completed prior to new utility installations.

PART 2 - PRODUCTS

2.1 Materials

.1 Fill material for non-structural slabs, parking areas (granular and asphalt), entrances and concrete walks:
.1 Granular 'B' Type II in accordance with Section 32 11 19 - Granular 'B' Type II.

PART 3 - EXECUTION

3.1 Grading

.1 Rough grade to levels and profiles allowing for surface treatment as indicated.

.2 Slope rough grade away from building as indicated on Contract Drawings.

.3 Grade ditches to depth as indicated on the Contract Drawings.

.4 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

3.2 Placing Fill

.1 Do not place material which is frozen nor place material on frozen surfaces.

.2 Maintain a crowned surface during construction to ensure run-off of surface water. Do not place material in free standing water. Drain or pump low areas, before placing material.

3.3 Compacting

.1 Proceed with placing fill only after soft spots and inconsistencies have been reworked and compacted or excavated, backfilled and compacted as required to eliminate such conditions.

.2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.

.3 Apply water as necessary during compacting to obtain specified density. If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.

.4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers acceptable to Consultant.

.5 Proofroll subgrade with loaded triaxle.

.6 For areas outside building footprint compact Granular 'B' Type II Fill to density not less than 100% Standard Proctor Maximum Dry Density (SPMDD) as per OPSS 501.

3.4 Subgrade Compaction in Pavement Areas

.1 In cut areas, remove stones and boulders exceeding 150 mm maximum dimension within specified depth, for subgrade compaction.

.2 Bring moisture content of soil to level required to achieve specified compaction. Add water or aerate as required.

.3 Shape subgrade to required cross section and grade.

.4 Proofroll subgrade with loaded triaxle.

.5 If subgrade preparation and compaction can not be achieved to requirement in single layer, temporarily remove upper portion to depth necessary to achieve requirement. Remove, replace and compact such materials at no extra cost.

3.5 Finishing and Tolerances

.1 Blade finished surfaces in cut and fill areas free from ruts and depressions.

.2 Roll finished surfaces to a tight dense condition.

.3 Finished pavement subgrade to be within 15 mm of design elevations, but not uniformly high or low.

.4 Finished graded area to be within 30 mm of design elevations, but not uniformly high or low.

.5 Surfaces to be free from depressions exceeding 25mm in 5 m.

3.6 Disposal

.1 Any excess material taken off site shall be disposed of in accordance with OPSS 180.

3.7 Maintenance

.1 Maintain finished surfaces in a condition in accordance with this Section until succeeding material is applied or until acceptance by the Consultant.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 31 23 10 - Excavating, Trenching and Backfilling.

1.2 References

.1 Definitions:
.1 Rock: any solid material in excess of 0.25 m^3 and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m^3 bucket. Frozen material not classified as rock.

.2 OPSS 403 - Construction Specification for Rock Excavation for Pipelines, Utilities and Associated Structures in Open Cut.

1.3 Submittals

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

1.4 Scope of Work

.1 This work includes the excavation and disposal of rock as required to complete the work indicated on the Contract Drawings.

.2 Rock excavation shall be carried out as required for, but not limited to areas of work including slabs, footings, elevators, pits, holding tank, parking areas (granular and asphalt), bollards, utilities, concrete walks, ditches, fencing, grading, and any other items shown on the drawings which requires rock removal for their installation.

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Not used.

PART 3 - EXECUTION

3.1 Rock Removal

.1 In accordance with OPSS 403 - Construction Specification for Rock Excavation for Pipelines, Utilities and associated structures in open cut.

.2 Explosive blasting is not permitted.

.3 Remove rock to alignments and profiles necessary to complete the work shown on the Contract Drawings.

.4 Transition treatment between earth and rock cut as per OPSD 205.050.

.5 Use rock removal procedures to produce uniform and stable excavation surfaces. Minimize overbreak, and to avoid damage to adjacent structures.

.6 Rock shatter is to be removed within building footprint area. Correct over-excavation in accordance with Section 31 23 10 - Excavating, Trenching and Backfilling.

.7 Prepare rock surfaces which are to bond to concrete, by scaling, pressure washing and broom cleaning surfaces.

.8 Excavate trenches to lines and grades to minimum of 150 mm below pipe invert indicated. Provide recesses for bell and spigot pipe to ensure bearing will occur uniformly along barrel of pipe.

.9 Cut trenches to widths as indicated.

.10 Remove boulders and fragments which may slide or roll into excavated areas.

.11 Correct unauthorized rock removal at no extra cost, in accordance with Section 31 23 10 - Excavating, Trenching and Backfilling.

END OF SECTION

PART 1 - GENERAL

1.2 References

.1 CSA G40.21-09, Structural Quality Steels.

.2 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

.3 CAN/CGSB-4.2, Textile Test Methods.

.4 CAN/CGSB-148.1, Methods of Testing Geosynthetics.

.5 ASTM D 4491-99a (2009), Test Methods for Water Permeability of Geotextiles by Permittivity.

.6 ASTM D 4751-04, Test Method for Determining the Apparent Opening Size of a Geotextile.

1.3 Samples

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

.2 Submit to Consultant the following samples at least 2 weeks prior to commencing work.
.1 Minimum length of 2 m of roll width of geotextile.
.2 Minimum of 1 m seam with at least 300 mm of geotextile on both sides of seam.

1.4 Mill Certificates

.1 Submit to Consultant copies of mill test data and certificate at least 2 weeks prior to start of work.

1.5 Delivery and Storage

.1 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

1.6 Description

.1 Geotextile for subdrain and silt fences as indicated on the Contract Drawings.

PART 2 - PRODUCTS

2.1 Material

.1 Geotextile: synthetic fibre fabric, supplied in rolls.

.1 Composed of: minimum 85% by mass of polypropylene, polyester, or polyethylene with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure.

.2 Geotextile for use in subdrains:

.1 Non-woven type.

.2 Mass per unit area: to CAN/CGSB-148.2. 2, minimum 180 g/m^2.

.3 Tensile strength and elongation (in any principal direction:

.1 Grab tensile strength: to CAN/CGSB-148.1. 7.3-9.2: minimum 440 N, wet condition.

.2 Elongation at break: minimum 70%.

.3 Seam strength: equal to or greater than tensile strength of fabric.

.4 Mullen burst strength: to CAN/CGSB-4.2: minimum 1.4 MPa

.5 Filtration opening size (FOS): to ASTM D 4751, 50-150 micrometres.

.6 Permeability: to CAN/CGSB-4.2 11.1-94: 2.0 x 10 cm/s.

.4 Geotextile for use in silt and barrier fences:

.1 Physical properties: to OPSS 577 and 1860, Class I, woven, FOS 105-210 micrometers.

.2 Bursting strength: to CAN/CGSB-148.1. 6.1, minimum 1.8 MPa.

.3 Slurry flow rate: maximum 25 L/min/m^2.

.4 Sediment retention efficiency: 75% minimum.

.5 Securing pins and washers: to CSA G40.21, Grade 300W, hot-dipped galvanized with minimum zinc coating of 600g/m^2 to CAN/CSA-G164.

PART 3 - EXECUTION

3.1 Installation of Silt Fences

.1 Silt fence as part of Erosion and Sediment Control is considered mandatory and shall be implemented prior to and maintained during the construction phases, and shall be installed in accordance with manufacturer's instructions and these specifications.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 31 22 13 - Rough Grading.

.2 Section 32 92 23 - Sodding.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CSA G30.5-M1983(R1998), Welded Steel Wire Fabric for Concrete Reinforcement.

.2 Department of Justice Canada (Jus).
- .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .2 Fertilizers Act (R.S. 1985, c. F-10).
- .3 Fertilizers Regulations (C.R.C., c. 666).
- .4 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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

1.3 DEFINITIONS

.1 Mycorrhiza: association between fungus and roots of plants. This symbiosis, enhances plant establishment in newly landscaped and imported soils.

1.4 SUBMITTALS

.1 Submit monthly written reports on maintenance during warranty period, to Project Manager identifying:

- .1 Maintenance work carried out.
- .2 Development and condition of plant material.
- .3 Preventative or corrective measures required which are outside Contractor's responsibility.

1.5 QUALITY ASSURANCE

.1 Health and Safety:
- .1 Do construction occupational health and safety in accordance with Ministry Standards.

1.6 MAINTENANCE DURING WARRANTY PERIOD

.1 From the time of acceptance by Project Manager to end of warranty period, perform the following maintenance operations.

- .2 Water to maintain soil moisture conditions for optimum growth and health of plant material without causing erosion.
- .3 Apply fertilizer in early spring at a rate of 0.025 kg of nitrogen/m²
- .4 Remove dead, broken or hazardous branches from plant material. Dispose of

debris through alternative disposal composting or mulching.

2 PRODUCTS

2.1 MATERIALS

.1 Fill: Do not use materials which will affect pH levels of soil.

.1 Type A: excavated soil, free from roots, rocks larger than 75 mm, building debris, and toxic ingredients (salt, oil, etc). Excavated material shall be approved by Project Manager before use as fill.

.2 Peatmoss:

.1 Derived from partially decomposed species of Sphagnum Mosses.
.2 Elastic and homogeneous.
.3 Free of wood and deleterious material which could prohibit growth.
.4 Shredded minimum particle size: 5 mm.

.3 Fertilizer:

.1 To Canada Fertilizer Act and Fertilizers Regulations.
.2 Complete, commercial, slow release with 35 % of nitrogen content in water-insoluble form.

.4 Anti-desiccant: commercial, wax-like emulsion.

.5 Filter Cloth:
.1 Type 1: 100 % non-woven needle punched polyester, 2.75 mm thick, 240 g/m² mass.
.2 Type 2: biodegradable burlap.

.6 Steel T-bar, 40 x 40 x 2440 mm long

3 EXECUTION

3.1 IDENTIFICATION AND PROTECTION

.1 Do construction occupational health and safety in accordance with Ministry Standards.

.2 Identify plants and limits of root systems to be preserved as approved by Project Manager.

.3 Protect plant and root systems from damage, compaction and contamination resulting from construction as approved by Project Manager.

.4 Ensure no pruning is done inside drip line. If pruning inside drip line is required consult an arbourist or Canadian Certified Horticultural Technician (CCHT) as approved by Project Manager.

3.2 ROOT CURTAIN SYSTEM

.1 Identify limits for required construction excavation as approved by Project Manager.

.2 Prune exposed roots cleanly at side of trench nearest plants to be preserved. Pruned ends to point obliquely downwards.

3.3 AIR LAYERING SYSTEM

.1 Construct drywell around trunk of tree.

.1 Ensure open ends of vertical vent pipes are left exposed for air circulation to root system.
.2 Protect openings from blockage during construction.
.3 Install protective caps on exposed horizontal openings.

.2 Place 200 mm depth of coarse washed stone on surface of original ground and horizontal pipe system to limits.

.3 Place Type 1 filter fabric over surface of granular layer.

.4 Place Type A fill over filter fabric to required depth without disturbing or damaging drain pipe system. Avoid damage to filter fabric.

.5 Complete topsoil and sodding, finished paving over area of sub-surface system within one week of placing fill.

.6 Remove temporary protective covering from vent pipe openings. Install protective caps flush with finished grade.

3.4 TRENCHING AND TUNNELING FOR UNDERGROUND SERVICES

.1 Centre line location and limits of trench/tunnel excavation to be approved by Project Administrator prior to excavation. Tunnel excavation to extend 2000 mm from edge of trunk on either side.

.2 Excavate manually within zone of root system. Do not sever roots greater than 40 mm diameter except at greater than 500 mm below existing grade. Protect roots, and cut roots cleanly with sharp disinfected tools.

.3 Excavate tunnel under centre of tree trunk using methods and equipment approved by Project Administrator.

.4 Minimum acceptable depth to top of tunnel: 1000 mm.

.5 Backfill for tunnel and trench to 85% Standard Proctor Density. Avoid damage to trunk and roots of tree.

.6 Complete tunnelling and backfilling at tree within 2 weeks of beginning Work.

3.5 LOWERING GRADE AROUND EXISTING TREE

.1 Begin Work in accordance with schedule approved by Project Administrator.

.2 Cut slope not less than 500 mm from tree trunk to new grade level.

.3 Excavate to depths as indicated. Protect from damage root zone which is to remain.

.4 When severing roots at excavation level, cut roots with sharp tools.

.5 Cultivate excavated surface manually to 15 mm depth.

.6 Prepare homogeneous soil mixture consisting by volume of:

.1 60 % excavated soil cleaned of roots, plant matter, stones, debris.
.2 25 % coarse, clean sterile sand.
.3 15 % organic matter.
.4 Grade 2:12:8 fertilizer at rate of 1.5 kg/m³.

.7 Place soil mixture over area of excavation to finished grade level. Compact to 85% Standard Proctor Density.

.8 Water entire root zone to optimum soil moisture level.

.9 Install surface cover of sodding in accordance with Section 32 92 23 - Sodding.

3.6 ANTI-DESICCANT

.1 Apply anti-desiccant to foliage where applicable and as directed by Project Manager.

3.7 GUARANTEE

.1 All existing trees will have a guarantee from start of construction to 120-days beyond substantial completion. If an existing tree is damaged or suffers external shock and declines through improper protection measures, it shall be replaced at the contractor expense with equally valued materials based on the council of Tree and Landscape Appraisers Valuing methods.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

.1 Labour, products, equipment and services necessary for Granular 'A' in accordance with the Contract Documents.

.2 The supply and installation of Granular 'A' shall include the following items of work, but not limited to:
.1 Supply, placement and compaction of Granular 'A' for parking areas (granular and asphalt), site entrance, concrete walks and concrete slabs.

1.2 Related Sections

.1 Section 31 05 10 - Corrected Maximum Dry Density For Fill.

.2 Section 31 05 17 - Aggregate Materials.

.3 Section 31 23 10 - Excavating, Trenching and Backfilling.

.4 Section 32 11 19 - Granular Sub-Base.

.5 Section 32 13 15 - Concrete Walks, Pads, Curbs and Gutters.

1.3 References

.1 OPSS 1010 - Material Specification for Aggregates - Base, Sub-base, Select Sub-grade and Backfill Material.

1.4 Delivery, Storage, and Handling

.1 Deliver and stockpile aggregates in accordance with Section 31 05 17 - Aggregate Materials.

PART 2 - PRODUCTS

2.1 Materials

.1 OPSS 1010

2.1 Materials (Cont'd)

.2 The use of recycled materials will not be permitted.

2.2 Compaction

.1 Granular 'A' shall be compacted in maximum 200 mm lifts to 100% SPMDD.

END OF SECTION

PART 1 - GENERAL

1.1 Section Includes

.1 Labour, products, equipment and services necessary for Granular 'B', Type II in accordance with Contract Documents.

.2 The supply and placement of Granular 'B', Type II shall include the following items of work, but not limited to:
.1 Supply, placement and compaction of Granular 'B', Type II for parking areas (granular and asphalt), concrete walkways, and site entrance.

1.2 Related Sections

.1 Section 31 05 10 - Corrected Maximum Dry Density for Fill.

.2 Section 31 05 17 - Aggregate Materials.

.3 Section 31 23 10 - Excavating, Trenching and Backfilling.

.4 Section 32 11 18 - Granular Base.

1.3 References

.1 OPSS 1010 - Material Specification for Aggregates - Base, Sub-base, Select Sub-grade and Backfill Material.

PART 2 - PRODUCTS

2.1 Materials

.1 OPSS 1010.

.2 The use of recycled materials will not be permitted.

2.2 Compaction

.1 Granular 'B' Type II shall be compacted in maximum 300 mm lifts to 100% SPMDD.

END OF SECTION

PART 1 - GENERAL

1.1 Related Sections

.1 Section 31 23 10 - Excavating, Trenching and Backfilling.

.2 Section 32 11 18 - Granular Base (Granular 'A').

1.2 References

.1 Canadian Standards Association (CSA).
- .1 CAN/CSA-A23.1-09, Concrete Materials and Methods of Concrete Construction.
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-1.2-98, Boiled Linseed Oil.
  - .2 CAN/CGSB-3.3-07, Kerosene.
- .3 American Society for Testing and Materials (ASTM).
  - .1 ASTM D 698-07, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3).

1.3 Scope of Work

.1 Concrete sidewalks and walkways to the varying widths shown on the Contract Drawings, including excavation, granular bedding, sawcutting and work as described herein.

.2 Concrete curbs (all types) including excavation, grading, sawcutting and preparation of granular base and additional curb width for curb face sidewalks or concrete strips and curb terminations, transitions and work as described herein.

.3 Non-structural concrete pads, walkways, and slabs, to the dimensions shown on the Contract Drawings, including excavation, granular bedding, reinforcing steel and work as described herein.

PART 2 - PRODUCTS

2.1 Materials

.1 Concrete mixes and materials: Section 03 30 00 - Cast-in-Place Concrete, 30 MPa, air entraining (6.0% - 8.0%), Maximum Slump (75mm), Maximum Course Aggregate (19mm), Curing Compound (white pigmented, OPSS 1315).

.2 Joint filler Curing Compound: Section 03 30 00 - Cast-in-Place Concrete.

.3 Granular base: Section 31 11 18 - Granular Base (Granular 'A').

.4 Non-staining mineral type form release agent: chemically active release agents containing compounds that react with free lime to provide water soluble soap.

.5 Boiled linseed oil: CAN/CGSB-1.2.

.6 Kerosene: CAN/CGSB-3.3.

PART 3 - EXECUTION

3.1 Grade Preparation

.1 Do grade preparation work in accordance with Section 31 23 10 - Excavating, Trenching and Backfilling.

.2 Construct embankments using excavated material free from organic matter or other objectionable materials. Dispose of surplus and unsuitable excavated material off site.

3.2 Granular Base

.1 Obtain Consultant's approval of subgrade before placing granular.

.2 Place granular base material to lines, widths, and depths as indicated. A minimum depth of 150 mm of Granular 'A' will be required under concrete sidewalk and non-structural concrete pads, unless noted otherwise.

3.2 Granular Base (Cont'd)

.3 Compact granular base in accordance with Section 31 11 18 - Granular Base (Granular 'A').

3.3 Concrete

.1 Obtain Consultant's approval of Granular 'A' prior to placing concrete.

.2 Do concrete work in accordance with the structural drawings & specifications.

.3 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2 mm deep, by drawing broom in direction normal to centre line.

.4 Provide edging as indicated with 10 mm radius edging tool.

.5 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable to Consultant can be demonstrated.

.6 Concrete sidewalk depth shall be 150 mm, unless noted otherwise.

3.4 Tolerances

.1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.5 Expansion and Contraction Joints

.1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 1.5 m.

.2 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structures.

.3 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.

3.5 Expansion and Contraction Joints (Cont'd)

.4 Bituminous fibre expansion joints shall be placed at each end of the sidewalk driveway bays and at maximum 6 metre intervals. In the event that the measurement exceeds 6 metres but less than 12 metres between driveways, the expansion joint shall be placed at midpoint.

.5 Expansion joints of bituminous fibre material shall also be used abutting rigid object or other concrete works (OPSD 310.040).

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDE

.1 Materials and installation for chain link fences and gates.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).
.1 ASTM A53/A53M-07, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
.2 ASTM A90/A90M-09, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
.3 ASTM A121-07, Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
.4 ASTM A653/A653M-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.5 ASTM C618-08a, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
.6 ASTM F1664-08, Standard Specification for Poly(Vinyl Chloride) (PVC)-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.
.5 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.3 Canadian Standards Association (CSA International).
.1 CSA-A23.1-09/A23.2-09, Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.
.2 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.2 REFERENCES (Cont'd)

.3 (Cont'd)
.3 CAN/CSA-A3001-08, Cementitious Materials Compendium. Includes.

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

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

.6 The Master Painters Institute (MPI) - Architectural Painting Specification Manual - 2003.
.1 MPI # 18, Organic Zinc Rich Primer.

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

.8 Ontario Provincial Standard Specification
.1 OPSS 2410 (Nov. 2000), Material Specification for Extra-Low Voltage Cable.
.2 OPSS 604 (Nov. 2010), Construction Specification of Installation of Cable.
.3 OPSS 620 (Nov. 2007), Construction Specification for Traffic Signal Equipement and Electrical Traffic Control Devices.

.9 Ministry of Transportation Ontario
.1 MTOD 2901.401 (Oct. 2008), Standard drawing for Traffic Data Collection Detector Loops - General Installation 1.
.2 MTOD 2901.402 (Oct. 2008), Standard drawing for Traffic Data Collection Detector Loops - General Installation 2.

1.3 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00.

1.4 HEALTH AND SAFETY

.1 Do construction occupational health and safety in accordance with Section 01 35 29.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

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

.3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers accordance with Waste Management Plan.

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

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

.7 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.

.8 Divert unused concrete materials from landfill to local quarry facility as approved by Departmental Representative.

.9 Unused paint or coating material must be disposed of at official hazardous material collections site as approved by Departmental Representative.

.10 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

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

PART 2 - PRODUCTS

2.1 MATERIALS

.1 Chain-link fence fabric: to CAN/CGSB-138.1.

2.1 MATERIALS (Cont'd)

.1 (Cont'd)

.1 Type 1, 4.8mm x 50mm, Class A, heavy style, Grade 1, galvanized, continuous from top to bottem. Height of fabric: as indicated.

.2 Posts, braces and rails: to CAN/CGSB-138.2, galvanized steel pipe.

.1 Line posts minimum 73mm O.D., 8.6 kg/m

.2 Strain posts minimum 114 O.D., 15.92 kg/m.

.3 Corner, end, and gate posts minimum 150mm O.D., 21.0 kg/m.

.4 Top and bottom rails minimum 42mm O.D., 3.4 kg/m.

.3 Top and bottom tension wire: to CAN/CGSB-138.2, single strand, galvanized steel wire.

.4 Tie wire fasteners: 3.7mm aluminum wire @ 300mm O.c.

.5 Tension bar: to ASTM A 653/A 653M, 5 x 20 mm minimum galvanized steel.

.6 Fittings and hardware: to CAN/CGSB-138.2, galvanized steel.

.1 Tension bar bands: 3 x 20 mm minimum galvanized steel.

.2 Post caps to provide waterproof fit, to fasten securely over posts and to carry top rail.

.3 Overhang tops to provide waterproof fit, to hold top rails and an outward projection to hold barbed wire overhang.

.4 Provide projection with clips or recesses to hold 3 strands of barbed wire spaced 100 mm apart.

.5 Projection of approximately 300 mm long to project from fence at 45 degrees above horizontal on side indicated.

.6 Turnbuckles to be drop forged.

.7 Organic zinc rich coating: to CAN/CGSB-1.181 MPI #18.

.8 Concertina Barbed Tape:

2.1 MATERIALS (Cont'd)

.8 (Cont'd)

.1 Galvanized tape: 20 X .5mm clenched around a 2.5mm diameter spring steel galvanized core wire to form a coil with nominal outside diameter of 710mm. When installed, the coil will have minimum diameter of 635mm.

.2 20mm long blade-type barbs spaced at 45mm on centre.

.3 Formed by clipping coils together at a minimum of three points on the circumference.

.4 Coil, when stretched, to form a cylindrical pattern. Loop spacing not to exceed 230mm.

.9 Barbed wire : to ASTM A 121 2 mm diameter galvanized steel wire or aluminum coated steel wire 4 point barbs 125 mm spacing.

.10 Grounding rod: 16 mm diameter copperwell rod, 3 m long.

2.2 SLIDING GATES

.1 System Dimensions: Clear gate opening width as indicated.

.2 Gate Operator:

.1 Manufacturer to have minimum ten years experience manufacturing hydraulic gate operators.

.2 Operation shall be by means of a metal rail passing between a pair of solid metal wheels with polyurethane treads. Operator motors shall be hydraulic, geroller type, and system shall not include belts, pulleys, gears, roller chains or sprockets to transfer power from operator to gate panel.

.3 Operator shall generate minimum horizontal pull of 136 kg without drive wheels slipping and without distortion of supporting arms, and shall be capable of holding gates weighing up to 1,814 kg.

.4 The operator shall have a 'soft stop' feature to prevent shock loads to the gate and operator assembly.

2.2 SLIDING GATES (Cont'd)

.2 (Cont'd)

.5 Backup manual operator located in the motor box, that will instantly release tension on both drive wheels and disengage them from contact with drive rail in a single motion. Provide an additional key-operated cable manual release on the secure side of the gate.

.6 Fully adjustable limit switches.

.7 Oversized , gasketted steel electrical enclosure with hinged lid.

.8 Lockable, 1.52mm galvanized welded sheet metal cover, painted.

.9 Drive wheels - two 152mm metal hubs with polyurethane tread.

.10 Drive rail - extruded 6061 T6, not less than 3.175 thick.

.11 Hydraulic valves shall be individually replaceable cartridge type, in an integrated hydraulic manifold.

.12 Pump motor shall be 1 HP, 56C, TEFC, continuous duty motor, with a service factor of 1.15 or greater.

.13 All electric components shall have overload protection.

.14 75VA transformer and 24VDC control circuit.

.15 Drive assembly and locking mechanisms to be enclosed for protection against tampering.

.16 Drive assembly installed on a concrete pedestal between 500mm and 700mm above grade for ease of access and to prevent interference from snow or ice.

.17 Provide a minimum gate speed of 150mm/second.

.18 Operator to be fitted with a thermostatically-controlled electric heater.

.3 Motor Housing:

.1 Motor box shall be water resistant and vandal resistant.

.2 Motor Box Lock: Motor box shall be locked. Provide three (3) keys per key code.

.4 System Components:

.1 Bottom guides: consisting of two guide wheels on a galvanized steel bracket, bolted to support posts.

.2 Vertical support posts shall be min. 100mm O.D. galvanized steel with concrete footings.

2.2 SLIDING GATES (Cont'd)

.4 (Cont'd)

.3 Gate frame shall be fabricated from 6063-T6 aluminum alloy extrusion:

.1 Top member: 76mm x 127mm, min. 5.8kg/m.

.2 Bottom member: Either single 50mm x 127mm aluminum structural tube, min. 2.9kg/m, or two 127mm aluminum structural channels, min. 3.9kg/m spliced together.

.3 Vertical members: alternate between 50mm x 50mm 1.6kg/m, and 25mm x 50mm 1.2kg/m aluminium, spaced no greater than half the height of the gate.

.4 Gate frame shall have a separate semi-enclosed 'keyed' track, extruded from 6105-T5 aluminum alloy, weighing not less than 4.3kg/m. When track is interlocked with the 'keyed' top member and welded to it, it forms a composite structure with the top of the gate frame.

.5 Diagonal 'X' bracing: 4.7mm min. diameter stainless steel aircraft cable.

.6 Gate panel to be covered with chain link fabric, identical to fabric on adjacent fence.

.4 The gate frame is to be supported from the track by two swivel type, self aligning, 4-wheeled, sealed lubricant, ball-bearing truck assemblies.

.5 Function and System Operation:

.1 Push Button Controls: Wired to guard tower #5 (south-east tower).

.2 Gate is to be fail-safe - in the event of a power failure, gate is to be operable in manual mode from either side.

.6 Fasteners: All fasteners, covers, caps, and lids that will be accessed for regular maintenance and servicing must be easily accessible.

2.3 INDUCTIVE LOOP VEHICLE DETECTION

.1 Inductive loop vehicle detector cable shall conform with OPSS 2410.

.2 Detector cable shall connect to a Vehicle Detector with:

.1 Adjustable output delay.

2.3 INDUCTIVE LOOP VEHICLE DETECTION (Cont'd)

.2 (Cont'd)
.2 Adjustable output extention.
.3 Externally accessible controls.
.4 Selectable pulse lengths.
.5 Automatic sensitivity boost to prevent gate closure on high-bed vehicles.
.6 Fail-safe operation.
.7 Fault indicator
.8 Operating temperature range from -25 to +80 degrees Celcius.

.3 Vehicle detector shall be housed in weather-proof, vandal-resistant casing within sliding gate operator.

.4 The presence of a vehicle over the detector loop shall actuate the sliding gate operator. The gate shall not close until the vehicle is cleared from the sensor loop, with an adequate delay to prevent gate closing on vehicle.

.5 The vehicle detector loop shall have a mushroom head pushbutton override in guard tower #5.

2.4 FINISHES

.1 Galvanizing:
.1 For chain link fabric: to CAN/CGSB-138.1 Grade2.
.2 For pipe: 550 g/m^2 minimum to ASTM A 90.
.3 For barbed wire: to ASTM A 121, Class 2 CAN/CGSB-138.2.
.4 For other fittings: to CAN/CSA-G164.

PART 3 - EXECUTION

3.1 GRADING

.1 Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.

3.2 ERECTION OF FENCE

.1 Erect fence along lines as indicated and to CAN/CGSB-138.3.

3.2 ERECTION OF FENCE (Cont'd)

.2 Excavate post holes to dimensions indicated 1220mm depth x 4 times post diameter.

.3 Space line posts maximum 2.5 m apart, measured parallel to ground surface.

.4 Space straining posts at equal intervals not to exceed 60 m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 60 m.

.5 Install end posts at end of fence and at buildings.
.1 Install gate posts on both sides of gate openings.

.6 Place concrete in post holes then embed posts into concrete to depths indicated.
.1 Extend concrete 50 mm above ground level and slope to drain away from posts.
.2 Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.

.7 Do not install fence fabric until concrete has cured minimum of 5 days.

.8 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.

.9 Install overhang tops and caps.

.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 300 mm intervals.

3.2 ERECTION OF FENCE (Cont'd)

.12 (Cont'd)
.1 Knuckled selvedge at bottom.
.2 Twisted selvedge at top.

.13 Secure fabric to top rails, middle rails, line posts and bottom tension wire with 3.7mm galvanized steel tie wires at 300 mm intervals.
.1 Give tie wires minimum two twists.

.14 Install barbed wire strands and clip securely to lugs of each projection.

.15 Install concertina wire as indicated.

.16 Install grounding rods.

.17 Fence assembly shall not have any gaps larger than 75mm wide.

.18 The application of a 12 kg perpendicular pull at the mid-point of the mesh panel (mid-point of posts/rails) shall show a displacement of no more than 30mm from the vertical plane.

3.3 INSTALLATION OF GATES

.1 Install gate in locations as indicated.

.2 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.

.3 Install gate stops where indicated.

.4 Gate assembly shall not have any gaps larger than 75mm wide.

.5 Patch and make good asphalt cut or damaged by this contract to match adjacent existing.

.6 If bedrock is encountered above required depth for grade beam, inform Departmental Representative so that geotechnical analysis can be executed.

3.4 INSTALLATION OF VEHICLE DETECTION

.1 Installation of inductive loop vehicle detector cable will conform to OPSS 604 and OPSS 620, and to standard drawings MTOD 2901.401 and MTOD 2901.402.

.2 Detection loop will be in a diamond loop formation.

.3 Saw-cut existing pavement and re-instate saw-cut with cold-applied sealant compound(rubberized asphalt emulsion).

.4 Comply with all manufacturer's written instructions for installation, tuning, and verification of vehicle detection system.

.5 Test and inspect loop after installation to ensure it is functioning properly.

3.5 TOUCH UP

.1 Clean damaged surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas as indicated in accordance with Section 09 91 23 - Painting.
.1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

3.6 CLEANING

.1 Clean and trim areas disturbed by operations.
.1 Dispose of surplus material and replace damaged turf with sod as directed by Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 Related Work

.1 Section 31 23 10 - Excavating, Trenching and Backfilling.

.2 Section 32 11 18 - Granular Base Granular A

.3 Section 32 91 21 - Topsoil Placement and Grading

.4 Section 31 14 13 - Soil Stripping and Stockpiling

.5 Section 31 32 21 - Geotextiles

.6 Section 32 32 43 - Precast Modular Stair System

1.2 Description of Work

.1 Supply all labour, materials and equipment necessary for the placement of armour stone, filter fabric and granular backfill.

.2 Armour stone retaining wall shall consist of tightly placed armour stone, as required by the drawings, and shall include all necessary excavation, supplying and placing of stone, all labour and equipment incidental to work.

1.3 Coordination

.1 Coodinate final grading with other work and include refilling and compaction of settled and washed out areas to incorporate the specified work.

1.4 Submittals

.1 Provide one (1) sample of armour stone for approval, minimum 600x300x300 size. Alternately, high resolution photos may be approved initially, but Project Manager reserves the right to reqest a physiscal sample.

1.4 Submittals (Cont'd)

.2 Submit engineered shop drawings. Shop drawings to show placement of stone, dimensions of units, reinforcing details, bearing requirements, all suited to site measurments and conditions.

.3 Submit PDF file of complete working drawings, and detailed design calculations, for review at least 4 weeks prior to beginning construction.
.1 Drawings and design calculations to be stamped and signed by Professional Engineer registered or licensed in the Province of Ontario, Canada.

1.5 Delivery, Storage and Handling

.1 Deliver, store and handle materials in accordance manufacturer's written instructions.

.2 Storage and Handling Requirements:
.1 Follow storage and handling recommendation of supplier.
.2 Prevent chipping and cracking of stones.
.3 Prevent damage to reinforcing elements and polymer geogrid reinforcement.
.4 Prevent staining or other defacement of front surfaces of stones during storage and handling.
.5 Replace defective or damaged materials as directed by the Project Manager.
.6 Store polymer geogrids at temperature above minus 25 degrees C.

PART 2 - PRODUCTS

2.1 Design Criteria

.1 Design codes: Ontario Building Code.

.2 Consider both internal and external stability of wall system in design.
.1 Ensure external stability includes safety against sliding, overturning, bearing failure and slip circle failure.

2.1 Design Criteria (Cont'd)

.3 Ensure length of reinforcing elements is as required for internal and external stability, but not less than 70% of wall height measured above levelling pad, or 2 m, whichever is greater.

.4 Use design method for internal stability consistent with magnitude of reinforcing element strains expected under working loads.

2.2 Armour Stone

.1 All armour stone walls shall consist of squared natural limestone as supplied by one quarry. The exposed face will have a natural chipped appearance and be free of drill holes. Stone size shall be approximately 800mm wide x 450mm tall x 1200mm long. Alternate sizes will be considered as long as the design intent can be met.

.2 All granular base and backfill used for armour stone installation shall be Type 1.

PART 3 - EXECUTION

3.1 Examination

.1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for retaining wall installation in accordance with manufacturer's written instructions and engineered shop drawings.
.1 Proceed with installation only after unacceptable conditions have been remedied.

3.2 Installation

.1 Install work in accordance with reviewed shop drawings.

.2 Stake out all work for armour stone to the Project Manager's approval.

.3 Have all excavation work inspected and approved prior to installation of armour stone.

3.2 Installation (Cont'd)

.4 Coordinate with installation of stair, as shown in drawings, to insure no interference and a fully functional end result.

.5 Armour stone shall be placed with tight joints. Stagger joints on subsequent courses. Fill gaps between armour stone to eliminate potential settlment or washout problems. Where material is loose or gaps are not filled, the contractor will fill the voids with low slump mortar to the satisfaction of the Project Manager.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 32 22 13 - Rough Grading.

.2 Section 32 92 23 – Sodding.

.3 Section 32 01 11.01 – Tree and Shrub Preservation.

1.2 TESTING

.1 Inspection and testing of topsoil will be carried out by a testing laboratory immediately after the Contractor receives notification of Contract award. Contractor will borne for cost of tests.

.2 All testing shall only be performed by an OMAFRA accredited commercial lab.

.3 Contractor to communicate to the testing laboratory the intended use to which the topsoil is to be used.

.4 Test samples shall be an amalgamation of at least three (3) samples randomly taken from the source. Samples shall be carefully mixed, recorded, labelled and otherwise documented prior to delivery to the testing laboratory.

.5 Submit one copy of the test results to the Project Manager. Unless otherwise indicated in the Special Requirements, test results shall include P, K, trace elements, soluble salt content, organic matter content, sand and silt content, and pH.

.6 In the event test results indicate that the topsoil does not meet the mentioned quality criteria, the Project Manager shall direct the Contractor to take the necessary remedial action. The cost of such remedial action shall be borne by the Owner.

.7 Make topsoil available for inspection at source by Project Manager. All topsoil shall be subject to Project Manager approval before use on job site, but subject to receipt and analysis of soil testing report. Advise Project Manager of sources of topsoil and manufactured topsoil to be utilized with sufficient lead time for testing.

1.3 REFERENCES

.1 Agriculture and Agri-Food Canada
- .1 The Canadian System of Soil Classification, Third Edition, 1998.

.2 Canadian Council of Ministers of the Environment
- .1 PN1340-2005, Guidelines for Compost Quality.

.3 U.S. Environmental Protection Agency (EPA)/Office of Water
- .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.4 DEFINITIONS

.1 Compost: Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner. Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test. Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below 25), and contain no toxic or growth inhibiting contaminates. Composed bio-solids to: CCME Guidelines for Compost Quality.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Quality control submittals:

.1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 1.2 - TESTING.

.2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.6 QUALITY ASSURANCE

.1 Pre-installation meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse, and recycling in accordance with municipal guidelines.

.2 Divert unused soil amendments from landfill to official hazardous material collections site approved by Project Manager.

.3 Do not dispose of unused soil amendments into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

.4 Follow requirements of excess soils management plan. Refer to Appendix B.

2 PRODUCTS

2.1 TOPSOIL

.1 Topsoil for seeded areas, sodded areas and planting beds: mixture of particulates, microorganisms and organic matter which provides suitable medium for supporting intended plant growth.

.1 Soil texture based on The Canadian System of Soil Classification, to consist of 50 to 70 % sand, maximum 20 % clay, 25-35% silt and contain 5 to 10 % organic matter by weight. Clay and silt combined not exceed 45%.

.2 Contain no toxic elements or growth inhibiting materials.

.3 Finished surface free from:
- .1 Debris and stones over 10 mm diameter.
- .2 Course vegetative material, 10 mm diameter and 50 mm length, occupying more than 2% of soil volume.

.4 Consistence: friable when moist.

2.2 SOIL AMENDMENTS

.1 Fertilizer:
- .1 Fertility: major soil nutrients present in following amounts:
- .2 Nitrogen (N): 20 to 40 micrograms of available N per gram of topsoil.
- .3 Phosphorus (P): 40 to 50 micrograms of phosphate per gram of topsoil.
- .4 Potassium (K): 75 to 110 micrograms of potassium per gram of topsoil.
- .5 Calcium, magnesium, sulfur and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
- .6 pH value: 6.5 to 8.0.

.2 Peatmoss:
- .1 Derived from partially decomposed species of Sphagnum Mosses.
- .2 Elastic and homogeneous, brown in colour.
- .3 Free of wood and deleterious material which could prohibit growth.
- .4 Shredded particle minimum size: 5 mm.

.3 Sand: washed coarse silica sand, medium to course textured.

.4 Organic matter: compost Category A in accordance with CCME PN1340, unprocessed organic matter, such as rotted manure, hay, straw, bark residue or sawdust, meeting the organic matter, stability and contaminant requirements.

.5 Use composts meeting Category B requirements for land fill reclamation and large scale industrial applications.

.6 Limestone:
- .1 Ground agricultural limestone.
- .2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.

.7 Fertilizer: industry accepted standard medium containing nitrogen, phosphorous, potassium and other micro-nutrients suitable to specific plant species or application or defined by soil test.

.8 Topsoil and soil amendments should meet the mechanical analysis noted in the table below;

Mechanical Analysis of Topsoil

Topsoil	Passing Percent (%)	Retained Percent (%)
1 inch screen	100	0
0.5 inch screen	97-100	0-3
#100 mesh sleeve	40-60	40-60

Mechanical Analysis of Soil Amendment Mix

Soil Amendment Mix	Passing Percent (%)	Retained Percent (%)
2 inch screen	100	0
1 inch screen	90-100	0-10
0.5 inch screen	50-80	20-50
#100 mesh sleeve	0-15	85-100

3 EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PREPARATION OF EXISTING GRADE

.1 Verify that grades are correct.
- .1 If discrepancies occur, notify Project Manager and do not commence work until instructed by Project Manager.

.2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.

.3 Remove debris, roots, branches, stones in excess of 25 mm diameter and other deleterious materials.
- .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
- .2 Remove debris which protrudes more than 50 mm above surface.
- .3 Dispose of removed material off site.

.4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.

- .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

3.3 PLACING AND SPREADING OF TOPSOIL/ROOT ZONE GROWING MIXTURE

.1 Place topsoil after Project Manager has accepted subgrade.

.2 Spread topsoil in uniform layers not exceeding 150 mm.

.3 For sodded areas keep topsoil 15 mm below finished grade.

.4 Spread topsoil as indicated to following minimum depths after settlement.
- .1 150 mm for Sodded areas.

.5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

3.4 SOIL AMENDMENTS

.1 Commercial processing and thorough mixing of the growing medium components shall be done thoroughly by a mechanized screening process. No hand mixing shall occur. The resulting product shall be homogeneous mixture having the required properties throughout. Product shall not be stored for excessive periods if a fertilizer component has been mixed.

.2 Contaminations of components or finished media shall be avoided by keeping amendments in closed bags or by covering outdoor piles.

.3 Mixes containing a significant amount of peat moss shall not be permitted to dry out. The moisture content of the peat moss at the time of mixing shall not be less than 60% to 75%.

.4 Growing medium shall be moist (25% to 75% of field capacity) but not wet, muddy or frozen when placed.

3.5 FINISH GRADING

.1 Grade to eliminate rough spots and low areas and ensure positive drainage.
.1 Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Consolidate topsoil to required bulk density using equipment approved by Project Administrator.
.1 Leave surfaces smooth, uniform and firm against deep foot printing.

3.6 ACCEPTANCE

.1 Project Manager will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading, prior to sodding, seeding and planting operations.

3.7 CLEANING

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

1 GENERAL

1.1 RELATED WORK

.1 Section 32 91 19.13 – Topsoil Placement and Grading

1.2 SOURCE QUALITY CONTROL

.1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.3 SCHEDULING

.1 Schedule sod laying to coincide with topsoil operations.

.2 Schedule sod installation when frost is not present in ground.

2 PRODUCTS

2.1 MATERIALS

.1 Number One Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.

.1 Turf Grass Nursery Sod types:
- .1 No. One Bluegrass Sod

.2 Turf Grass Nursery Sod quality:
- .1 Not more than 1 broadleaf weeds or 10 other weeds per 40 square metres and up to 1% native grasses.
- .2 Density of sod sufficient so that no soil is visible from height of 1500 mm when mown to height of 50 mm.
- .3 Mowing height limit: 35 to 65 mm.
- .4 Soil portion of sod: 6 to 15 mm in thickness.

.2 Sod establishment support:
- .1 Wooden pegs: 17 x 8 x 200mm.

.3 Water:
- .1 Supplied by Contractor

.4 Fertilizer:
- .1 Must comply to Canada’s "Fertilizers Act" and "Fertilizers Regulations".
- .2 Gro-In Starter Fertilizer 23-0-23 at the manufacturer’s specified rate, or an approved equivalent by Project Manager. Retain and submit empty containers for review by Project Manager.

2.2 SOURCE QUALITY CONTROL

.1 Obtain approval from Project Manager of sod supplier source, four weeks prior to installation.

3 EXECUTION

3.1 PREPARATION

.1 Verify that grades are correct and prepared in accordance with Section 32 91 21 - Topsoil Placement and Grading. If discrepancies occur, notify Project Manager and do not commence work until instructed.

.2 Do not perform work under adverse field conditions such as frozen soil, excessively wet soil or soil covered with snow, ice, or standing water.

.3 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated, to tolerance of plus or minus 8 mm, for Turf Grass Nursery Sod surface to drain naturally.

.4 Remove and dispose of weeds; debris; stones 25 mm in diameter and larger and other deleterious materials; in location as directed by Project Manager.

3.2 SOD PLACEMENT

.1 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.

.2 Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.

.3 Roll sod as directed by Project Manager. Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

3.3 SOD PLACEMENT ON SLOPES AND PEGGING

.1 Start laying sod at bottom of slopes.

.2 Peg sod on slopes steeper than 3 horizontal to 1 vertical, within 1 m of catch basins and within 1 m of drainage channels and ditches to following pattern:

.1 100 mm below top edge at 200 mm on centre for first sod sections along contours of slopes.

.2 Not less than 6 pegs per square metre.

.3 Not less than 6 pegs per square metre in drainage structures. Adjust pattern as directed by Project Manager.

.4 Drive pegs to 20 mm above soil surface of sod sections.

3.4 FERTILIZING PROGRAM

.1 Fertilize twice during the establishment period to ensure growth and the establishment of roots.

3.5 MAINTENANCE

.1 Perform following operations from time of installation until acceptance.

.2 Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75 to 100 mm as required for the first two weeks after installation.

.3 Cut grass to 65 mm when or prior to it reaching height of 80mm. Remove clippings which will smother grassed areas.

.4 Maintain sodded areas weed free 95%.

.5 Fertilize areas in accordance with fertilizer and fertilizing program noted within this specification. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.

3.6 ACCEPTANCE

.1 Turf Grass Nursery Sod areas will be accepted by Project Manager provided that:

.1 Sodded areas are properly established.
.2 Sod is free of bare and dead spots.
.3 No surface soil is visible from height of 1500 mm when grass has been cut to height of 65 mm.
.4 Sodded areas have been cut minimum 1 times prior to acceptance.

.2 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

3.7 CLEANING

.1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

1 GENERAL

1.1 RELATED REQUIREMENTS

.1 Section 31 22 13 - Rough Grading.

.2 Section 32 92 23 - Sodding.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CSA G30.5-M1983(R1998), Welded Steel Wire Fabric for Concrete Reinforcement.

.2 Department of Justice Canada (Jus).
- .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .2 Fertilizers Act (R.S. 1985, c. F-10).
- .3 Fertilizers Regulations (C.R.C., c. 666).
- .4 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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

1.3 DEFINITIONS

.1 Mycorrhiza: association between fungus and roots of plants. This symbiosis, enhances plant establishment in newly landscaped and imported soils.

1.4 SUBMITTALS

.1 Submit monthly written reports on maintenance during warranty period, to Project Manager identifying:

- .1 Maintenance work carried out.
- .2 Development and condition of plant material.
- .3 Preventative or corrective measures required which are outside Contractor's responsibility.

1.5 QUALITY ASSURANCE

.1 Health and Safety:
- .1 Do construction occupational health and safety in accordance with Ministry Standards.

1.6 MAINTENANCE DURING WARRANTY PERIOD

.1 From the time of acceptance by Project Manager to end of warranty period, perform the following maintenance operations.

- .2 Water to maintain soil moisture conditions for optimum growth and health of plant material without causing erosion.
- .3 Apply fertilizer in early spring at a rate of 0.025 kg of nitrogen/m²
- .4 Remove dead, broken or hazardous branches from plant material. Dispose of

debris through alternative disposal composting or mulching.

2 PRODUCTS

2.1 MATERIALS

.1 Fill: Do not use materials which will affect pH levels of soil.

.1 Type A: excavated soil, free from roots, rocks larger than 75 mm, building debris, and toxic ingredients (salt, oil, etc). Excavated material shall be approved by Project Manager before use as fill.

.2 Peatmoss:

.1 Derived from partially decomposed species of Sphagnum Mosses.
.2 Elastic and homogeneous.
.3 Free of wood and deleterious material which could prohibit growth.
.4 Shredded minimum particle size: 5 mm.

.3 Fertilizer:

.1 To Canada Fertilizer Act and Fertilizers Regulations.
.2 Complete, commercial, slow release with 35 % of nitrogen content in water-insoluble form.

.4 Anti-desiccant: commercial, wax-like emulsion.

.5 Filter Cloth:
.1 Type 1: 100 % non-woven needle punched polyester, 2.75 mm thick, 240 g/m² mass.
.2 Type 2: biodegradable burlap.

.6 Steel T-bar, 40 x 40 x 2440 mm long

3 EXECUTION

3.1 IDENTIFICATION AND PROTECTION

.1 Do construction occupational health and safety in accordance with Ministry Standards.

.2 Identify plants and limits of root systems to be preserved as approved by Project Manager.

.3 Protect plant and root systems from damage, compaction and contamination resulting from construction as approved by Project Manager.

.4 Ensure no pruning is done inside drip line. If pruning inside drip line is required consult an arbourist or Canadian Certified Horticultural Technician (CCHT) as approved by Project Manager.

3.2 ROOT CURTAIN SYSTEM

.1 Identify limits for required construction excavation as approved by Project Manager.

.2 Prune exposed roots cleanly at side of trench nearest plants to be preserved. Pruned ends to point obliquely downwards.

3.3 AIR LAYERING SYSTEM

.1 Construct drywell around trunk of tree.

.1 Ensure open ends of vertical vent pipes are left exposed for air circulation to root system.
.2 Protect openings from blockage during construction.
.3 Install protective caps on exposed horizontal openings.

.2 Place 200 mm depth of coarse washed stone on surface of original ground and horizontal pipe system to limits.

.3 Place Type 1 filter fabric over surface of granular layer.

.4 Place Type A fill over filter fabric to required depth without disturbing or damaging drain pipe system. Avoid damage to filter fabric.

.5 Complete topsoil and sodding, finished paving over area of sub-surface system within one week of placing fill.

.6 Remove temporary protective covering from vent pipe openings. Install protective caps flush with finished grade.

3.4 TRENCHING AND TUNNELING FOR UNDERGROUND SERVICES

.1 Centre line location and limits of trench/tunnel excavation to be approved by Project Administrator prior to excavation. Tunnel excavation to extend 2000 mm from edge of trunk on either side.

.2 Excavate manually within zone of root system. Do not sever roots greater than 40 mm diameter except at greater than 500 mm below existing grade. Protect roots, and cut roots cleanly with sharp disinfected tools.

.3 Excavate tunnel under centre of tree trunk using methods and equipment approved by Project Administrator.

.4 Minimum acceptable depth to top of tunnel: 1000 mm.

.5 Backfill for tunnel and trench to 85% Standard Proctor Density. Avoid damage to trunk and roots of tree.

.6 Complete tunnelling and backfilling at tree within 2 weeks of beginning Work.

3.5 LOWERING GRADE AROUND EXISTING TREE

.1 Begin Work in accordance with schedule approved by Project Administrator.

.2 Cut slope not less than 500 mm from tree trunk to new grade level.

.3 Excavate to depths as indicated. Protect from damage root zone which is to remain.

.4 When severing roots at excavation level, cut roots with sharp tools.

.5 Cultivate excavated surface manually to 15 mm depth.

.6 Prepare homogeneous soil mixture consisting by volume of:

.1 60 % excavated soil cleaned of roots, plant matter, stones, debris.
.2 25 % coarse, clean sterile sand.
.3 15 % organic matter.
.4 Grade 2:12:8 fertilizer at rate of 1.5 kg/m³.

.7 Place soil mixture over area of excavation to finished grade level. Compact to 85% Standard Proctor Density.

.8 Water entire root zone to optimum soil moisture level.

.9 Install surface cover of sodding in accordance with Section 32 92 23 - Sodding.

3.6 ANTI-DESICCANT

.1 Apply anti-desiccant to foliage where applicable and as directed by Project Manager.

3.7 GUARANTEE

.1 All existing trees will have a guarantee from start of construction to 120-days beyond substantial completion. If an existing tree is damaged or suffers external shock and declines through improper protection measures, it shall be replaced at the contractor expense with equally valued materials based on the council of Tree and Landscape Appraisers Valuing methods.

END OF SECTION