

Part 1 **GENERAL**

1.1 **REFERENCE STANDARDS**

- .1 Conform to the following standards:
 - .1 FC 403(M)-1985, Sprinkler Systems.
 - .2 NFPA 10-2018, Standard for Portable Fire Extinguishers.
 - .3 NFPA 13-2019, Standard for the Installation of Sprinkler Systems.
 - .4 NFPA 14-2019, Standard for the Installation of Standpipe and Hose Systems.
 - .5 National Building Code of Canada 2015.
 - .6 National Fire Code of Canada 2015.

1.2 **FIRE COMMISSIONER'S INSPECTION AND TEST**

- .1 Notify the Departmental Representative that the installation of fire protection system is complete. Provide certificate that components are compatible and the systems conform to the requirements of the specifications, applicable codes and standards. A copy of the contractor's Material and Test Certificate shall be submitted prior to the final inspection.
- .2 Fire protection systems shall be subject to the final inspection and test of the PSPC Fire Protection Engineer or their authorized representative. Work shall not be considered complete until a satisfactory inspection report from the PSPC Fire Protection Engineer is obtained.

1.3 **SHOP DRAWINGS AND PRODUCT DATA SHEETS**

- .1 Submit shop drawings and product data sheets in accordance with Sections 01 00 10, 01 61 00, 01 78 00 and 23 05 00 for review before commencing work.
- .2 Shop drawings shall bear the stamp of a Registered Professional Engineer, registered in the Province of Ontario.
- .3 Submit hydraulic calculations for review. Hydraulic calculations derived by computer shall be verified by the Insurers Advisory Organization Inc. (IAO) prior to submittal to Departmental Representative for review.
- .4 Shop drawings and product data sheets shall include the following equipment:
 - .1 Sprinkler system and components.
 - .2 Fire hose cabinets.
 - .3 Portable fire extinguishers.
 - .4 Hydraulic calculations.

1.4 **ENGINEERING DESIGN CRITERIA**

- .1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13, and as follows:

- .1 All areas shall be designed for hazard coverage indicated with design area and associated densities.
 - .1 Light hazard for office areas and ordinary hazard group 1 for storage area unless noted otherwise.
- .2 Pipe size and layout:
 - .1 Hydraulic design.
 - .2 Sprinkler head layout to NFPA 13 or as directed by authorities having jurisdiction
 - .3 The hydraulic design shall be sized to accommodate the higher and most remote zones.
 - .4 Allow for additional sprinkler heads and pipe distribution to suit all existing interferences.
 - .5 When sidewall sprinklers listed for light hazard occupancies are used, pipe sizing and spacing shall be according to ordinary hazard rules.
- .3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings. Allow for additional sprinkler heads and pipe distribution to suit all existing interferences.
- .4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.
- .5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.
- .6 Location of Sprinkler Heads:
 - .1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13 for light hazard occupancy.
 - .2 Uniformly space sprinklers on branch, where applicable.
 - .3 Water Distribution:
 - .1 Make distribution uniform throughout the area in which sprinkler heads will open.
 - .2 Discharge from individual heads in hydraulically most remote area to be 100% of specified density.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: company or person specializing in wet sprinkler systems with documented experience.
 - .2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

1.6 **MAINTENANCE MATERIAL SUBMITTALS**

- .1 Materials:
 - .1 Provide maintenance materials in accordance with General Requirements.
 - .2 Provide spare sprinklers and tools in accordance with NFPA 13

Part 2 **PRODUCTS**

2.1 **PIPE, FITTINGS AND VALVES**

- .1 Pipe: ferrous to NFPA 13 for Sprinkler Systems and to NFPA 14 for Standpipe and Hose Systems.
- .2 Fittings and joints to NFPA 13:
 - .1 Ferrous: screwed, welded, flanged or roll grooved.
 - .1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.
 - .2 Provide welded, threaded, grooved-end type fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.
 - .3 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
 - .4 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32 mm and larger.
 - .5 Fittings: ULC approved for use in wet pipe sprinkler systems.
 - .6 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.
 - .7 Side outlet tees using rubber gasketed fittings are not permitted.
 - .8 Sprinkler pipe and fittings: metal.
- .3 Valves:
 - .1 ULC listed and labelled for fire protection service.
 - .2 NPS 2 and smaller to be bronze, screwed ends, OS&Y gate.
 - .3 NPS 2½ or over to be cast iron, flanged or roll grooved ends, indicating butterfly valve.
 - .4 Swing check valves.
 - .5 Ball drip.
- .4 Pipe hangers to be ULC listed for fire protection services.
- .5 Drain valve to be NPS 1 complete with hose end, cap and chain.
- .6 Inspectors test connections to be NPS 1 gate valves.

2.2 **PENDANT SPRINKLER HEAD**

- .1 Quick response for hazard coverage as indicated, 5.6 K factor, corrosion resistant coating, chrome finish, glass bulb type; 68°C rated, 12mm orifice.
- .2 Provide extended escutcheon where required to suit ceiling.

2.3 **ESCUTCHEON PLATES**

- .1 Provide one piece type metal plates for piping passing through walls, floors, and ceilings in exposed spaces.
- .2 Provide polished chrome in finished spaces.

2.4 **PRESSURE GAUGES**

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

2.5 **FIRE HOSE CABINETS**

- .1 Relocate existing fire hose cabinets and accessories.

2.6 **PORTABLE FIRE EXTINGUISHERS**

- .1 Stored pressure rechargeable type with hose, nozzle, and activation lever, ULC labelled for A, B and C class protection.
- .2 FE-1:
 - .1 Weight: 2.25kg
 - .2 Rating: 3A-20B-C
 - .3 Mount: wall-mounted on manufacturer's bracket
- .3 FE-2:
 - .1 Weight: 2.25kg
 - .2 Rating: 3A-20B-C
 - .3 Mount: Semi-recessed wall cabinet

Part 3 **EXECUTION**

3.1 **INSTALLATION**

- .1 Install material and fixtures in accordance with referenced standards and manufacturer's written instructions.
- .2 Install, inspect and test to acceptance in accordance with NFPA 13 and NFPA 25.

3.2 TESTS

- .1 Conform to Section 23 05 00 for tests.
- .2 Conduct tests in the presence of the Departmental Representative and the Representative of PSPC Fire Protection Engineer.
- .3 Hydrostatically test fire hose and standpipe systems and sprinkler systems at 350 kPa in excess of nominal working pressure but at not less than 1.4 MPa for 2 h without loss under supervision of PWGSC Fire Protection Engineer.
- .4 During tests, repair any leaks and remove and replace any defective parts. Repeat test until satisfactory results are obtained.
- .5 Refer to other Sections for requirements of commissioning.

END OF SECTION

Part 1 GENERAL

1.1 MINIMUM STANDARDS

- .1 Conform to or exceed:
 - .1 Ontario Plumbing Code.
 - .2 Canadian Standards Association Standards.
 - .3 Local Municipal By-laws and Regulations.
 - .4 National Building Code of Canada (NBC) 2015.
 - .5 National Plumbing Code of Canada (NPC) 2015
 - .6 Ontario Building Code (OBC) 2012.
 - .7 National Fire Code of Canada 2015 (NFC)
 - .8 FCC No. 403(M)-1985 Sprinkler Systems
 - .9 CSA B651-18, Accessible Design for the Built Environment.

1.2 REFERENCE STANDARDS

- .1 Material standards:
 - .1 ASME A112.18.1-2018/CSA-B125.1-18, Plumbing Supply Fittings.
 - .2 ASME A112.18.2-2015/CSA-B125.2-15, Plumbing Waste Fittings.
 - .3 ASME B16.22-2018, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ASME B16.18-2018, Cast Copper Alloy Solder Joint Pressure Fittings
 - .5 ASTM B88M-18, Standard Specification for Seamless Copper Water Tube (Metric).
 - .6 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .7 ASTM B306-13, Standard Specification for Copper Drainage Tube (DWV).
 - .8 ASTM D2564-12(2018), Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - .9 CAN/CSA-B70:19, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .10 CSA B125.3-18, Plumbing Fittings.
 - .11 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code.
 - .12 CSA B1800-18, Thermoplastic Non-Pressure Piping Compendium.
 - .13 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
 - .14 PDI - WH201-2010, Water Hammer Arrestors Standard
 - .15 CAN/CGSB 51.9-92, Mineral Fibre Thermal Insulation for Piping and Round Ducting
 - .16 CAN/CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
 - .17 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts

1.3 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets in accordance with Sections 01 33 00, 01 78 00 and 23 05 00 for, but not limited to, the following:

- .1 Plumbing fixtures.
- .2 Cleanouts.
- .3 Trap seal primers.
- .4 Water Hammer Arrestors
- .5 Domestic H W heater.

Part 2 **PRODUCTS**

2.1 **SOIL, STORM, WASTE AND VENT PIPE AND FITTINGS**

- .1 Piping inside building above ground: copper tube type DWV to ASTM B306 with drainage pattern wrought copper or cast brass solder joint fittings to CSA B125.3; cast iron soil pipe to CSA-B70 with cast iron fittings, hub and spigot joints or mechanical joints, and with heavy bituminous coating.
- .2 Piping inside building below ground: cast iron soil pipe to CAN/CSA-B70 with cast iron fittings, hub and spigot joints or mechanical joints, and heavy bituminous coated. Buried vent pipe 40 mm and smaller to be copper tube type "L" to ASTM B88M with drainage pattern wrought copper or cast brass solder joint fittings to ASME B16.22.

2.2 **WATER PIPE AND FITTINGS**

- .1 Above ground water piping size 50 mm and smaller: copper tube type L to ASTM B88M with sweat wrought copper fittings to ASME B16.22.
- .2 Make joints with lead-free solder.

2.3 **VALVES**

- .1 Ball Valves NPS 2 and under, screwed:
 - .1 Class 150.
 - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle
- .2 Ball Valves NPS 2 and under, soldered:
 - .1 To ASME B16.18, Class 150.
 - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle, with NPT to copper adaptors
- .3 Check valve size 50 mm and smaller: bronze swing check, solder joint ends, ANSI 125, 1.4 MPa cold working pressure non-shock.
- .4 Provide quarter turn ball valves at each piece of plumbing equipment and at each branch line take-off.

2.4 **PLUMBING FIXTURES**

- .1 Water closets:
 - .1 WC-1:
 - .1 Wall-mounted, exposed flush valve, top spud ultra-low flush, dual flush at 4.1Lpf/6 Lpf maximum.
 - .2 Bowl: vitreous china, syphon jet, elongated rim
 - .3 Seat: white, elongated, open front, moulded solid plastic, stainless steel check hinges, stainless steel insert post.
 - .4 Carrier: concealed in wall, adjustable height for bowl mounting
 - .5 Height: Barrier-free, to National Building Code, CSA B651 seat between 400mm and 460mm above finished floor.
 - .6 See architectural for designation of barrier-free locations.
 - .7 Water Closet Flush Valves:
 - .1 Electronic Flush valve: top spud, chrome visible components, externally adjustable, diaphragm type with NPS 1 screwdriver angle stop, oscillating handle, seat bumper and vacuum breaker. Ultra low dual flush cycle: set for maximum 4.1Lpf/6Lpf.
 - .2 Flush valve sensor sensitivity shall be adjustable for distance of sensor effectiveness.
- .2 Counter-mounted lavatory:
 - .1 LAV-1:
 - .1 Integrated sink/counter provided by general contractor. Mechanical contractor provides plumbing connections and trim.
 - .2 Trim: Electronic faucet: Chrome plated brass, sensor activated faucet. Sensor activated by proximity sensor responding to presence of person's hands in lavatory, to CSA B651. Sensor to be waterproof, with impact-resistant plastic lens and anti-scratch coating, sensitivity adjustable from 100 mm to 450 mm. CSA approved stainless steel sheathed controls to include class 2 low voltage power transformer for plug-in to 115V/1/60 AC outlet, slow-closing type solenoid valve for water pressure of 138 kPa minimum to 1000 kPa maximum, integral flow control for 8.35 litres/minute at 413 kPa maximum. Maximum run time to be 30 seconds/run.
 - .3 Supplies: 12 mm dia. rigid CP supplies with screwdriver angle stops.
 - .4 Waste fitting: chrome plated strainer. Offset chrome trap. Provide drain insulation kit for all exposed drain piping within washrooms.
- .3 Wall-mounted lavatory:
 - .1 LAV-2:
 - .1 (Barrier-free) Wall-mount Lavatory, vitreous china, self-draining deck, shroud/knee contact guard, Coordinate faucet holes with trim selection.
 - .2 Trim: Electronic faucet: Chrome plated brass, sensor activated faucet. Sensor activated by proximity sensor responding to presence of person's hands in lavatory, to CSA B651. Sensor to be waterproof, with impact-resistant plastic lens and anti-scratch coating, sensitivity adjustable from 100 mm to 450 mm. CSA approved stainless steel sheathed controls to include class 2 low voltage power transformer for plug-in to 115V/1/60 AC outlet, slow-closing type solenoid valve for water pressure of 138 kPa minimum to 1000 kPa maximum, integral flow control for 8.35

litres/minute at 413 kPa maximum. Maximum run time to be 30 seconds/run.

- .3 Supplies: chrome plated (c.p.) flexible with screwdriver stops.
- .4 Carrier: Wall-mounted concealed lavatory carrier with adjustable epoxy-coated cast iron wall plate, steel back-up plate, epoxy-coated cast iron arms with levelling screws and basin locking device, plated hardware.

- .4 All exposed plumbing brass and metal work shall be heavy triple chromium-plated.

2.5 FIXTURE CONNECTIONS

- .1 Fixtures shall be serviced per schedule on drawing.
- .2 Insulate waste outlet and hot water supply pipes connected to standard and barrier-free, accessible lavatories and sinks to CSA B651.

2.6 FIXTURE MOUNTING HEIGHTS AND CLEARANCES

- .1 Mounting heights for wall hung fixtures measured from finished floor:
 - .1 Standard: to comply with manufacturer's roughing-in details unless otherwise indicated or specified.
 - .2 Barrier-free, accessible fixtures: to comply with NBCC, OBC and CSA B651.
- .2 Clearances to comply with NBC, OBC and CSA B651.

2.7 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

- .1 Provide arrestors sized and located on branch water supplies to each group of fixtures in accordance with Plumbing and Drainage Institute Standard PDI - WH201.
- .2 Construction: stainless steel with welded nested bellows.

2.8 TRAP SEAL PRIMER

- .1 Provide trap seal primer to each floor drain. Trap seal primer shall be all brass with integral vacuum breaker, NPS ½ solder inlet and outlet connections and NPS ½ drip line connection.

2.9 CLEANOUTS

- .1 Provide cleanouts to conform to National Plumbing Code and where shown on drawings.
- .2 Type: heavy CI male ferrule with bronze bolted plug.
- .3 Make each cleanout accessible and wherever necessary, extend branch connections to finished surfaces of wall, etc. and provide access covers or plates.

2.10 ELECTRIC DOMESTIC HOT WATER HEATER

- .1 Provide CSA approved and labelled domestic hot water heater of capacity and performance as indicated on the drawings.
- .2 Tank: glass lined steel, with replaceable magnesium anode, mineral wool or fiberglass insulation, enamelled steel jacket, hose threaded drain valve, ASME rated temperature and pressure relief valve, hand-hole cleanout with gasketed cover.

2.11 DOMESTIC HOT WATER RE-CIRCULATION PUMP

- .1 Wet-rotor, multi speed circulator with Lead Free Stainless Steel body and equal sized flange connections
- .2 Nominal Power(W): 33W
- .3 Impeller: Noryl
- .4 Shaft: Cermaic
- .5 Bearings: Ceramic
- .6 Gasket Material: EPDM

2.12 PIPE INSULATION

- .1 Insulate hot water piping with 25 mm thick rigid mineral fibre sleeving to CGSB-51.9 and factory applied all service jacket to CGSB 51-GP-52Ma.
- .2 Insulate cold water piping with 25 mm thick rigid mineral fibre sleeving to CGSB-51.9 and vapour barrier jacket to CGSB 51-GP-52Ma.
- .3 Provide polyvinyl chloride (PVC) cover over insulated piping in exposed areas:
 - .1 One-piece moulded type [and sheet] to CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: white
 - .3 Minimum service temperatures: -20°C.
 - .4 Maximum service temperature: 65°C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
- .6 Fastenings:
 - .1 Use self-adhesive tape rated under 25 for flame spread and under 50 for smoke development.
 - .2 Use quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.

2.13 **VENT PIPE AND FLASHING**

- .1 Pipes extending through roof shall be flashed with butyl or plastic flashing 600 x 600 mm, flanged to a plastic sleeve extended up around the vent pipes above the roofing and clamped to the pipe. In no case shall pipes be less than 75 mm diameter where passing through roof.

Part 3 **EXECUTION**

3.1 **INSTALLATION**

- .1 Install material and fixtures in accordance with referenced standards and manufacturer's written instructions.

3.2 **ADJUSTING**

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
 - .1 Adjust water flow rate to design flow rates.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
 - .3 Adjust flush valves to suit actual site conditions.
 - .4 Adjust urinal flush timing mechanisms.
 - .5 Adjust drinking fountain flow stream to ensure no spillage.
 - .6 Automatic flush valves for WC's and urinals: set controls to prevent unnecessary flush cycles during silent hours.
- .3 Checks:
 - .1 Water closets, urinals: flushing action.
 - .2 Aerators: operation, cleanliness.
 - .3 Vacuum breakers: operation under all conditions.
 - .4 Refrigerated water coolers: operation, temperature settings.
- .4 Thermostatic controls:
 - .1 Verify temperature settings, operation of control, limit and safety controls. Nd safety controls.
- .5 Refer to other Sections for requirements of commissioning.

END OF SECTION

Part 1 **GENERAL**

1.1 **GENERAL**

- .1 This Section covers items common to more than one section of the Mechanical Divisions 21, 22, 23 and 25.
- .2 "Provide" shall mean "supply, install and connect".
- .3 Provide new materials, equipment and plant of proven design and quality, and of current models with published ratings for which replacement parts are readily available.

1.2 **HALOCARBONS**

- .1 Comply with Federal Halocarbon Regulations 2003 under the Canadian Environmental Protection Act 1999, EPAM and PWGSC Ontario Region Halocarbon Information Sheet dated March 2010.

1.3 **MINIMUM STANDARDS**

- .1 Conform to or exceed:
 - .1 Ontario Plumbing Code.
 - .2 Canadian Standards Association Standards.
 - .3 Local Municipal By-laws and Regulations.
 - .4 National Building Code of Canada (NBC) 2015.
 - .5 National Plumbing Code of Canada (NPC) 2015
 - .6 Ontario Building Code (OBC) 2012.
 - .7 National Fire Code of Canada 2015 (NFC)
 - .8 FCC No. 403(M)-1985 Sprinkler Systems
 - .9 CSA B651-18, Accessible Design for the Built Environment.

1.4 **REFERENCE STANDARDS**

- .1 National Building Code
 - .1 ASME B31.1-2018, Power Piping.
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-2018, Power Piping.
- .3 Canadian Standards Association (CSA)
 - .1 CSA B51:19, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CSA C390-10(R2015), Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-Phase Induction Motors.
- .4 Canadian General Standards Board (CGSB)
 - .3 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.5 **EQUIPMENT LIST**

- .1 Complete list of equipment to be used on this project shall be submitted for review by Departmental Representative within two weeks of Award of Contract.
- .2 It is the Contractor's responsibility to ensure that the equipment to be used will meet the performance specifications and will fit the spaces allocated.

1.6 **CUTTING AND REMEDIAL WORK**

- .1 Cutting and remedial work is responsibility of general contractor. Coordinate requirements with other trades
- .2 Assume full responsibility for laying out mechanical work and for any damage caused by incorrectly located equipment and mechanical services.
- .3 Set sleeves and mark openings in concrete forms and in masonry before placing of concrete and erection of masonry.

1.7 **EXCAVATION AND BACKFILL**

- .1 Excavation and backfilling for mechanical work is responsibility of general contractor. Coordinate requirements with other trades.
- .2 Ensure that excavation for underground mechanical services is in location and at depth indicated. Provide protective materials around and over services and be present at all times during excavation and backfilling to supervise work.

1.8 **CO-ORDINATION**

- .1 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.
- .2 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials.

1.9 **DRAWINGS**

- .1 Working drawings, except where dimensioned, indicate general mechanical layouts only. Do not scale.
- .2 Existing equipment and services shown on the drawings:
 - .1 The information shown on the drawings is incomplete and is for reference only. Some of the existing equipment, ducts, pipes and other services are not shown on the drawings.
 - .2 The Contractor shall make arrangements to examine existing conditions, determine conditions affecting the work, and verify sizes and location of existing equipment, ducts, pipes and any other services. Refer to general requirements for instructions regarding site visits.

- .3 Unless the discrepancies are noted and reported to the Departmental Representative prior to close of the bid, the Contractor shall be responsible for the work to relocate existing equipment and to reroute existing ducts, pipes and any other services required for the installation of new work at no extra cost to the contract.
- .3 If required by Departmental Representative, provide field drawings to show relative positions of various services. Obtain approval before beginning work.

1.10 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets for major equipment listed in each section.
- .2 Submit early enough to permit Project Schedules to be met.
- .3 Show materials; sizes, dimensions, performance ratings, curves and operating characteristics, compliance with codes and standards, wiring, controls, piping diagrams, installation instructions, fabrication, assembly and installation details.
- .4 For additional requirements pertaining to shop drawings and product data refer to Division 1 general requirements.

1.11 OPERATION AND MAINTENANCE DATA

- .1 Supply operating and maintenance instructions complete with names and addresses of spare parts suppliers in accordance with requirements of Division 1 general requirements.

1.12 EQUIPMENT DESIGN AND INSTALLATION

- .1 Uniformity:
 - .1 For equipment or material of same type or classification, use product of one manufacturer.
- .2 Installation:
 - .1 Install equipment to manufacturer's recommendations with adequate and easy access for inspection, servicing and lubrication.
 - .2 Install equipment to permit maintenance and disassembly with minimum disturbance to connecting piping and duct systems and without interference with building structure or equipment.
 - .3 Provide screwdriver stops on supplies to plumbing fixtures.
 - .4 Provide support brackets, bases, and all necessary fastenings.
- .3 Pressure Tanks:
 - .1 Constructed, tested and stamped to CSA B51:19.

1.13 ELECTRIC MOTORS AND CONTROLS

- .1 Electrical equipment shall bear CSA label. Obtain inspection labels required by Provincial authority having jurisdiction.

- .2 Use high efficiency motors. Minimum acceptable motor efficiency levels shall be based on the latest table of motor efficiency levels in accordance with CSA C390.
- .3 Unless otherwise specified or indicated, motors ½ HP and larger shall be 3 phase.
- .4 Refer to Electrical Division 26, 27 & 28 regarding specifications of power wiring (i.e. wiring carrying the full load current), conduits, starters, disconnect switches, etc., for mechanical equipment specified in Mechanical Divisions. Unless noted and specified in Electrical Divisions to be provided by Electrical Divisions, all field installed power wiring, conduit, starters, disconnect switches, etc., shall be provided by Mechanical Divisions.
- .5 Provide motors, control wiring and controls together with associated relays, signaling devices, thermostats, control transformers, firestats, pressure switches, electric-pneumatic switches, required to form a complete control system for the equipment specified in Mechanical Divisions.

1.14 GUARDS

- .1 Provide vibration free guards on exposed drives and rotating parts to meet safety requirements of Provincial Ministry of Labour and local authorities having jurisdiction.
- .2 Provide OSHA Approved mesh wire screen on inlet or outlet of exposed fan blades.
- .3 Provide restraining chains and fasteners to hold access doors open when doors close in direction of air pressure.

1.15 EQUIPMENT SUPPORTS

- .1 Unless noted otherwise, fabricate equipment supports from structural grade steel. Submit structural calculations with shop drawings.
- .2 Mount base mounted equipment on chamfered edge concrete housekeeping pads, minimum of 100 mm high and 50 mm larger than equipment dimensions all around.

1.16 PIPING INSTALLATION

- .1 Conform to requirements of ASME B31.1.
- .2 Provide dielectric couplings where piping of dissimilar metals are joined.
- .3 Provide easily accessible unions close to equipment, to permit easy removal of equipment with minimum disturbance to piping systems.
- .4 Valves:
 - .1 Provide easy access for servicing and operation. Install access doors where concealed.
 - .2 Install with stems above horizontal.

- .5 Drainage:
 - .1 Provide easily accessible drain valves at low points to permit complete drainage of piping systems.
 - .2 Extend equipment drain piping to discharge into floor or hub drain.
 - .3 Provide drain piping from drain pan of air handling units, full size of outlet connection and equip with deep-seal trap.

- .6 Expansion and Contraction:
 - .1 Make adequate provision for expansion and contraction of piping systems.
 - .2 Use expansion joints and compensators, flexible connections, pipe loops and offsets as indicated and required.
 - .3 Support piping to prevent any stress or strain from occurring at connections to equipment.
 - .4 Install and guide expansion joints in accordance with manufacturer's recommendations.
 - .5 Provide steel anchors welded to piping, fastened to building structure or embedded in concrete pier so that forces acting on anchor points are restrained without causing damage to structure or systems.
 - .6 Base design axial traverse on temperature difference between -18°C ambient and corresponding fluid temperature plus 25% safety factor.

1.17 PIPE HANGERS AND SUPPORTS

- .1 Fabricate hangers, supports and sway braces in accordance with ASME B31.1.
- .2 Provide adjustable clevis type hangers on all sizes of pipe except where roller type hangers are required.
- .3 Minimum 150 mm hanger rod length.
- .4 Provide hangers on piping with heated or cooled contents as follows:
 - .1 Rigid hangers when rod length is 300 mm or more, pipe expansion to hanger rod length ratio is less than 1:24 and hanger is supported from top of structural steel.
 - .2 Swing hangers when rod length is 300 mm or more, pipe expansion to hanger rod length ratio is less than 1:6 and hanger is supported from top of structural steel.
 - .3 Roller hangers when rod length is less than 300 mm or pipe expansion to hanger rod length ratio is more than 1:6 or hanger is not supported from top of structural steel.
- .5 On uninsulated copper piping, ensure steel hangers in contact with copper piping are copper plated. Copper pipe shall not contact steel, iron or cinder materials. Covered 12 mm diameter copper pipe may be supported on copper straps.

1.18 SLEEVES, ESCUTCHEONS AND PLATES

- .1 Sleeves:

- .1 Provide schedule 40 steel pipe sleeves where pipes pass through masonry or concrete walls or floors. Apply watertight caulking compound between pipe and sleeve in exterior walls.
- .2 Escutcheons and plates:
 - .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
 - .2 Use chrome or nickel-plated brass, solid type, with set screws for ceiling or wall mounting. For equipment rooms, use cast-iron type.

1.19 **TESTS**

- .1 Give 48 hours notice of date when tests will be made.
- .2 Conduct tests in presence of Departmental Representative and representatives of agencies having jurisdiction.
- .3 Bear all costs in connection with all tests.
- .4 Obtain acceptance certificates from authorities having jurisdiction. Work shall not be considered complete until certificates are delivered to the Departmental Representative.
- .5 Piping pressure tests:
 - .1 Fill water piping with water and test at 1-1/2 times system operating pressure or at 860 kPa, whichever is greater.
 - .2 Maintain test pressures without loss for a 4-hour period.
 - .3 Test natural gas systems with nitrogen gas at 690 kPa for 24-hour period without loss.
 - .4 Repair leaks and defects. Retest until approved by Departmental Representative.
- .6 Flushing and cleaning:
 - .1 After pressure tests are completed and approved, prior to start-up and placing into operation, flush and clean out piping systems.
 - .2 For water and oil systems fill with solution of water and approved non-foaming, phosphate free detergent. Circulate solution throughout piping systems.
 - .3 Flush and drain systems until free of dirt, sludge, oil, grease and other foreign material. Clean strainers.
 - .4 Refill water systems with clean water.
 - .5 Use compressed air to remove moisture from interior surfaces of fuel oil piping systems before filling with oil.
- .7 Testing plumbing systems:
 - .1 Conform to requirements of National Building Code, National Plumbing Code, Ontario Plumbing Code, and Municipal regulations.
 - .2 Test in presence of Departmental Representative and Municipal Plumbing Inspector.
- .8 Testing and balancing of heating, ventilating, and air-conditioning systems:
 - .1 Use qualified personnel approved by the Departmental Representative to test and balance systems and keep records of operating results.

- .2 After systems balanced and tests concluded, submit test and balance report showing relevant operating data of equipment and systems.
- .3 Report shall certify compliance with requirements of drawings and specifications.

1.20 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.21 ACCESS DOORS

- .1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm for body entry and 300 x 300 mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
 - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Departmental Representative.
 - .2 Remaining areas: use prime coated steel.
- .4 Installation:
 - .1 Locate so that concealed items are accessible.
 - .2 Locate so that hand or body entry (as applicable) is achieved.

1.22 DRAIN VALVES

- .1 Minimum NPS 3/4 unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.

1.23 IDENTIFICATION

- .1 Existing identification systems:
 - .1 Apply existing identification system to new work.
 - .2 Where existing identification system does not cover for new work, use identification system specified this section.
 - .3 Before starting work, obtain written approval of identification system from Departmental Representative.
- .2 Identification of piping systems:
 - .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB- 24.3 except where specified otherwise.

- .2 Pictograms:
 - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.
- .7 Colours and Legends:
 - .1 Where not listed, obtain direction from Departmental Representative.
 - .2 Colours for legends, arrows: To following table:

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

.3 Background colour marking and legends for piping systems:

Contents	Background	
	Colour	Legend
City water	Green	CITY WATER
Condenser water supply	Green	COND. WTR. SUPPLY
Condenser water return	Green	COND. WTR. RETURN
Chilled water supply	Green	CH. WTR. SUPPLY
Chilled water return	Green	CH. WTR. RETURN
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Storm water	Green	STORM
Sanitary	Green	SAN

Plumbing vent	Green	SAN. VENT
Natural gas	to Codes	
Fire protection water Sprinklers	Red Red	FIRE PROT. WTR SPRINKLERS

- .4 Identification ductwork systems:
 - .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
 - .2 Colours: black, or co-ordinated with base colour to ensure strong contrast.
- .5 Valve tags: brass tags with 12 mm stamped identification data filled with black paint.
- .6 Location of identification on piping and ductwork systems:
 - .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: At not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
 - .2 Adjacent to each change in direction.
 - .3 At least once in each small room through which piping or ductwork passes.
 - .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of separations such as walls, floors, partitions.
 - .6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.
 - .7 At beginning and end points of each run and at each piece of equipment in run.
 - .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc.

1.24 INSTRUCTION OF OPERATING STAFF

- .1 Furnish competent instructors to fully instruct operating staff in care, adjustment and operation of mechanical systems. Use factory trained instructors.
- .2 Instruct during regular work hours before systems accepted and turned over to operating staff for regular operation.
- .3 Where significant changes or modifications in equipment are made under terms of guarantee, instruct operating staff about changes or modifications.

1.25 REVIEW/TAKEOVER PROCEDURES

- .1 Substantial performance will not be considered until the following items have been completed to the Consultant's satisfaction.
 - .1 All systems are complete and operation.
 - .2 All systems have been commissioned and successfully past testing over the entire range of their operating capacities under automatic control. (Note: seasonal or environmental conditions resulting in the delay of some testing will be accommodated by issuance of conditional certificate).

- .2 Commissioning and testing reports.
- .3 Air balancing reports.
- .4 "As-built" and/or record drawings and specifications.
- .5 Operations and Maintenance Manuals.
- .6 The Departmental Representative, operating and maintenance personnel have received training on all systems and equipment.

Part 2 **PRODUCTS**

2.1 **NOT USED**

- .1 Not used.

Part 3 **EXECUTION**

3.1 **NOT USED**

- .1 Not used.

END OF SECTION

Part 1 **GENERAL**

1.1 **GENERAL**

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section.
- .2 Standard: TAB to be to most stringent of TAB standards of AABC, NEBB, SMACNA and ASHRAE.
- .3 Do TAB of all systems, equipment, components, controls specified in Mechanical Divisions.
- .4 TAB shall be performed by an independent TAB agency engaged by the Contractor.

1.2 **QUALIFICATIONS OF TAB PERSONNEL**

- .1 Names of all personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative within 90 days of Award of Contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 Qualifications: personnel performing TAB to be current member in good standing of AABC, NEBB, or NBCTA.
- .4 Quality Assurance: perform TAB under direction of supervisor qualified by CAABC, NEBB, or NBCTA.

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 so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all 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 be 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 so as to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.6 **PRE-TAB REVIEW**

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

1.8 **OPERATION OF SYSTEMS DURING TAB**

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

1.9 **START OF TAB**

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB only when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Divisions 21, 22, 23 and 25.
 - .4 All provisions for TAB installed and operational.
 - .5 Start-up, verification for proper, normal and safe operation of all mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

- .4 Correct fan rotation.
- .5 Fire, smoke, volume control dampers installed and open.
- .6 Coil fins combed, clean.
- .7 Access doors, installed, closed.
- .8 All outlets installed, volume control dampers open.
- .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

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

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative 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 6 months of TAB. Provide certificate of calibration to Departmental Representative.

1.13 SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

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

1.15 **TAB REPORT**

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show all results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .3 Submit electronic copies of TAB Report to Departmental Representative for verification and approval.

1.16 **VERIFICATION**

- .1 All reported results subject to verification by Departmental Representative.
- .2 Provide manpower and instrumentation to verify up to 30% of all reported results.
- .3 Number and location of verified results to be at discretion of Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 **SETTINGS**

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.18 **COMPLETION OF TAB**

- .1 TAB to be considered complete only when final TAB Report received and approved by Departmental Representative.

1.19 **AIR SYSTEMS**

- .1 Measurements: to include, but not limited to, following 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.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.

- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 HYDRONIC SYSTEMS

- .1 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power voltage, noise, vibration.
- .2 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each heat exchanger (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each primary and secondary loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

1.21 DOMESTIC HWC SYSTEMS

- .1 Meet all requirements as specified for hydronic systems.
- .2 Locations of equipment measurements: To include, but not be limited to, following as appropriate: Inlet and outlet of each heater, tank, pump, circulator, at each controller, controlled device.
- .3 Locations of systems measurements to include, but not be limited to, following as appropriate: main, main branch, branch, sub-branch.

1.22 OTHER SYSTEMS

- .1 Plumbing systems:
 - .1 Flush valves: adjust to suit project pressure conditions.

1.23 OTHER TAB REQUIREMENTS

- .1 Refer to other mechanical specification sections for additional requirements.

1.24 POST- OCCUPANCY TAB

- .1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, in occupied areas.

Part 2 **PRODUCTS**

2.1 **NOT USED**

.1 Not Used.

Part 3 **EXECUTION**

3.1 **NOT USED**

.1 Not Used.

END OF SECTION

Part 1 **GENERAL**

1.1 **SPECIAL WARNING**

- .1 This project requires a special enhanced mechanical commissioning. The Mechanical Contractor must read and fully understand the special requirements specified in this Section prior to bidding this project.
- .2 One of the commissioning requirements is that the Mechanical Contractor must engage a qualified independent System Commissioning Administrator (SCA) to coordinate and organize all Pre-Commissioning Testing, Commissioning Testing, and O&M Training. The SCA must complete the Contractor's Commissioning Documentation as specified in this Section.
- .3 A total of 4% of the mechanical construction price will be held back by PSPC for unfinished commissioning work.

1.2 **RELATED SECTIONS**

- .1 Section 01 78 00 - Closeout Submittals.
- .2 Section 01 79 00.13 – Demonstration and Training – Building Commissioning.
- .3 Section 21,22,23 & 25 – Mechanical Specification for Fire Protection, Plumbing, HVAC and Integrated Automation.

1.3 **GENERAL**

- .1 "Commissioning" for this project is defined as a planned program of activities which enhance quality management and information transfer that extends throughout all stages of project delivery.
- .2 Commissioning activities shall include the standard activities and the enhanced activities which are traditionally not provided by the design and construction industry and which are defined in this document.

1.4 **REFERENCE STANDARDS**

- .1 The most stringent requirements of the following commissioning standards and guidelines shall apply:
 - .1 Associated Air Balance Council (AABC): National Standards for Total Systems Balance 7th Edition-2016.
 - .2 ASHRAE Guideline 1.1-2007, HVAC&R Technical Requirements for the Commissioning Process.
 - .3 ASHRAE Guideline 1.5-2017, The Commissioning Process for Smoke Management Systems.
 - .4 ASHRAE Guideline 4-2019, Preparation of Operating and Maintenance Documentation for Building System.

- .5 NEBB Procedural Standards for Building Systems Commissioning (1999).
- .6 CSA Z320-11 (2016), Building Commissioning

1.5 ROLES AND RESPONSIBILITIES

- .1 The key members of the commissioning team include the Contractor, the Consultant, and the PSPC Commissioning Manager (or its representative).
 - .1 It is the Mechanical Contractor's responsibility to engage a qualified independent System Commissioning Administrator (SCA) to represent the Contractor including the Sub-Contractors. The SCA shall be responsible for carrying out the Contractor's commissioning activities under the direction of the Consultant.
 - .2 The PSPC Commissioning Manager (or its representative) will be assisted by the Consultant and other project team members for overview of the commissioning activities on behalf of the PSPC Project Manager. The PSPC Commissioning Manager is the Commissioning Authority for this project.
 - .3 The Mechanical Contractor and its sub-trades shall fully co-operate and assist the PSPC Commissioning Manager (or its representative) in performing the system performance verification process throughout the construction, commissioning and operation phases of the project.

- .2 The Contractor is responsible for the following standard commissioning activities and enhanced commissioning activities during project construction, commissioning and operation phases.
 - .1 Construction Phase:
 - .1 Engage a qualified independent System Commissioning Administrator as single point of contact for all matters relating to commissioning.
 - .2 Conduct commissioning meetings and prepare minutes of meetings.
 - .3 Submit shop drawings.
 - .4 Conduct equipment installation and startup tests, and submit test reports.
 - .5 Perform TAB and submit TAB report.
 - .6 Conduct System Startup Verification Testing and complete Startup Checklists and PI Report forms.
 - .2 Commissioning Phase:
 - .1 Conduct commissioning meetings and prepare minutes of meetings.
 - .2 Conduct Functional Performance Testing and complete PV Report forms.
 - .3 Demonstrate system operation.
 - .4 Submit Maintenance Manuals (formerly called O&M Manuals)
 - .5 Conduct O&M training.
 - .3 Contractor's Responsibilities during Operation Phase:
 - .1 Conduct commissioning meetings and prepare minutes of meetings.
 - .2 Conduct deferred Functional Performance Testing and complete PV Report forms.
 - .3 Provide fine-tuning.
 - .4 Provide specified inspection and maintenance services during warranty period.

- .3 The Consultant will carry out the following commissioning activities related to the Contractor:
 - .1 Prepare Startup Checklists, PI and PV Report Forms

- .2 Prepare Standard Operation Procedures (SOP) Manual (formally called Systems Manual)
 - .3 Review and approve shop drawings.
 - .4 Review and inspect installation, and prepare construction deficiencies report.
 - .5 Review and approve TAB report.
 - .6 Direct and approve System Startup Verification Testing
 - .7 Direct and approve Functional Performance Testing
 - .8 Review and approve Maintenance Manuals.
 - .9 Review and approve "As-Built" drawings and specifications.
 - .10 Update Standard Operating Procedures (SOP) manual
 - .11 Review O&M training.
 - .12 Prepare commissioning report
 - .13 Witness post-acceptance commissioning testing
 - .14 Direct and approve post-acceptance fine-tuning and review warranty services.
 - .15 Update commissioning report
- .4 The PSPC Commissioning Manager (or its representative) will carry out the following commissioning activities related to the Contractor and the Consultant:
- .1 Review and approve the qualifications of the System Commissioning Administrator (SCA) submitted by the Contractor.
 - .2 Review and approve Startup Checklists, PI and PV Report forms prepared by the Consultant.
 - .3 Witness System Startup Verification Testing conducted by the Contractor and review test reports.
 - .4 Witness Functional Performance Testing conducted by the Contractor and review test reports.
 - .5 Review and approve O&M training conducted by the Contractor.
 - .6 Review commissioning documentation submitted by the Contractor and Consultant.
 - .7 Review and approve commissioning report prepared by Consultant.
 - .8 Witness the post-acceptance commissioning testing conducted by the Contractor and review test reports.
 - .9 Review and approve updated commissioning report prepared by Consultant.

1.6 QUALIFICATIONS OF SYSTEM COMMISSIONING ADMINISTRATOR (SCA)

- .1 The System Commissioning Administrator: a qualified independent System Commissioning Administrator (SCA) for scheduling, coordination and supervision of Contractor's commissioning activities during construction, acceptance, and post-acceptance stages. The System Commissioning Administrator shall provide Contractor's Commissioning Documentation.
- .2 Unless approved by the PSPC Commissioning Manager, the System Commissioning Administrator shall be a qualified SCA in building systems commissioning. The Contractor shall hire and submit the name of SCA with documentation confirming qualifications within 15 working days of Award of Contract.

1.7 SCHEDULING

- .1 Within 15 working days of Contract Award, the Contractor shall submit bar chart commissioning schedules indicating anticipated date of start, duration, and date of completion for the following key activities:
 - .1 Commissioning meetings.
 - .2 Shop drawings.
 - .3 Pre-startup installation inspections and tests.
 - .4 System and Equipment Startup and Verification.
 - .5 TAB.
 - .6 Functional Performance Test.
 - .7 O&M manuals.
 - .8 "As-Built" drawings and specifications.
 - .9 O&M Training.
 - .10 O&M Training Report.
- .2 A bar chart commissioning schedule shall be prepared for each component, equipment, sub-system, system and integrated system to be commissioned as listed under paragraph 1.11.
- .3 The Commissioning shall be carried out to meet the approved project schedule.

1.8 CONTRACTOR'S COMMISSIONING DOCUMENTATION

- .1 The Contractor's Commissioning Documentation shall include the following:
 - .1 Commissioning Schedule.
 - .2 Minutes of commissioning meetings.
 - .3 Shop drawings and product data.
 - .4 Installation inspection and test reports.
 - .5 TAB reports.
 - .6 Startup Checklists.
 - .7 Product Information (PI) Report forms.
 - .8 Performance Verification (PV) Report forms.
 - .9 Commissioning Deficiencies/Issues Log.
 - .10 "As-Built" drawings and specifications.
 - .11 Maintenance Manuals.
 - .12 O&M Training Schedule.
 - .13 O&M Training Report.

1.9 PRE-COMMISSIONING TESTING - STARTUPS

- .1 Requirements of Pre-commissioning Verification: range of checks and tests to determine that all components, equipment, systems, and interfaces between systems (e.g. emergency, fire, and life safety) operate in accordance with contact documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. Verification of the proper operation of the control system also includes verifying the interface of the control system with the TAB criteria and the response of EMCS controllers and sensors. Also, the Consultant shall select, at random, 10 percent of the reported TAB and EMCS data for verification, and a failure of selected items shall result in the rejection of the final TAB report or the report of system startup and testing.

- .2 The Startup Checklists and PI Report forms shall be completed by the Contractor and verified by the Consultant.

1.10 COMMISSIONING TESTING

- .1 Commissioning Testing shall include System Operation Demonstration and Functional Performance Testing of mechanical systems. Test each system independently and then in unison with integrated systems.
- .2 Requirements of Functional Performance Testing (FPT): FPT shall determine if the HVAC system is providing the required heating, ventilating, and cooling services in accordance with the finalized design intent. FPT shall also determine the as-built installed capacity of the heating and cooling plant and the heat transfer equipment. If FPT cannot be completed due to seasonal reasons, lack of occupancy, deficiencies beyond the scope of the mechanical work, or any other reason, this shall be noted along with an indication of when tests will be rescheduled. If any identified performance deficiencies need to be corrected, the tests shall be repeated after corrective work is carried out, and this process shall continue until acceptable performance is achieved.
- .3 The Functional Performance Tests forms shall be completed by the Contractor and verified by the Design Consultant and PSPC Commissioning Manager (or its representative).

1.11 EXTENT OF COMMISSIONING

- .1 Systems to be commissioned with the comprehensive commissioning to include:
 - .1 Air Systems.
 - .2 Plumbing System including hot water tank.
 - .3 Fire Protection System.
 - .4 Building Automation Systems including EMCS.
 - .5 Interface portion of the associated electrical and other building systems.

1.12 O&M TRAINING

- .1 The Contractor shall provide qualified training instructors to conduct O&M training.
- .2 Four weeks prior to commencement of O&M training, the Contractor shall submit training schedule with course outline, agenda and a copy of training manual in accordance with the training plan for review by the Consultant and the PSPC Commissioning Manager.
- .3 Training shall include familiarization sessions, hands-on instruction, and classroom sessions.
- .4 Classroom training shall include: review of Maintenance Manuals, Standard Operating Procedures (SOP) Manual, System Operational Procedures for all modes of operation, acceptable tolerances for system adjustments and procedures for dealing with abnormal and emergency situations.

1.13 UNFINISHED COMMISSIONING WORK

- .1 Prior to the "Interim Certificate of Completion" a total of 4% of the mechanical construction price will be held back by PSPC Project Manager until the acceptable Functional Performance Testing, O&M Training, and commissioning documentation have been completed.

1.14 ADDITIONAL COMMISSIONING REQUIREMENTS

- .1 Refer to other specifications sections for additional commissioning requirements.

Part 2 PRODUCTS

2.1 NOT USED

- .1 Not used.

Part 3 EXECUTION

3.1 FUNCTIONAL TESTING AND ACCEPTANCE

- .1 Functional Performance Testing for a specific piece of equipment shall not be executed until the start-up process for that piece of equipment has been completed and the start-up report is submitted for review and acceptance.
- .2 The SCA shall submit the completed functional test sheet to PSPC Commissioning Manager and its representatives for review and approval.
- .3 The Corrections or deficiencies identified during the tests shall be recorded in the Commissioning Deficiencies/Issues Log by SCA and distributed to the commissioning team on a regular basis for review and actions.
- .4 The Contractor shall retest the equipment/system operation once the identified deficiencies are resolved as necessary. After functionality of all required systems are verified and demonstrated with no deficiencies identified, the functional testing activities would be considered as completed for review and acceptance.

END OF SECTION

Part 1 **GENERAL**

1.1 **MINIMUM STANDARDS**

- .1 Conform to or exceed:
 - .1 CSA Standards.
 - .2 ASHRAE Standards.
 - .3 SMACNA Standards.
 - .4 Provincial Codes, Local Municipal By-Laws, all codes of utility authorities having jurisdiction.

1.2 **REFERENCES**

- .1 Material and installation standards:
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, ANSI/SMACNA 006-2006.
 - .2 SMACNA Duct Leakage Test Manual ANSI/SMACNA 016-2012.
 - .3 NFPA 90A-2018, Installation of Air Conditioning and Ventilating Systems.
 - .4 CAN/ULC-S110-13, Standard Methods of Test for Air Ducts.
 - .5 CAN/ULC-S112-10, Standard Method of Fire Test of Fire Damper Assemblies.
 - .6 CAN/ULC-S702.1-14, Standard for Mineral Fibre Thermal Insulation for Buildings.
 - .7 CSA B52-18, Mechanical Refrigeration Code.
 - .8 CSA B149.1-15, Natural Gas and Propane Installation Code.
 - .9 CGSB 51-GP-52MA-89, Vapour Barrier Jacket and Facing Material.
 - .10 ASTM A653/A653M-19, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.
 - .11 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .12 ASTM B280-19, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 - .13 ASTM C423-17, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .14 ASTM C518-17, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .15 ASTM C534/534M-19, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - .16 ASTM C547-19, Standard Specification for Mineral Fiber Pipe Insulation.
 - .17 ASTM C612-19, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .18 ASTM C919-19, Standard Practice for Use of Sealants in Acoustical Applications.
 - .19 ASTM C1071-19, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .20 ASTM F683-14, Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery.
 - .21 ASTM G21-15, Standard Practice for Determining Resistance of Synthetic

Polymeric Materials to Fungi.

- .22 ASTM G22-76(1996), Standard Practice for Determining Resistance of Plastics to Bacteria.
- .23 UL 181-2013, Standard for Factory-Made Air Ducts and Air Connectors

1.3 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets in accordance with Division 01 and 23 05 00 for the following:
 - .1 Fire & balancing dampers.
 - .2 Motorized dampers.
 - .3 Grilles, registers and diffusers.
 - .4 Variable volume terminal units.
 - .5 Split System air-cooled condensing unit.
 - .6 Controls and instrumentation.

Part 2 PRODUCTS

2.1 LOW PRESSURE DUCTWORK

- .1 Material: forming steel FS Type A steel with Z275 designation zinc coating to ASTM A653/A653M, minimum 30% recycled content.
- .2 Gauge and construction of ducts and fittings shall be in accordance with SMACNA HVAC Duct Construction Standards ANSI/SMACNA 006 for rectangular ducts for positive and negative static pressure up to 500 Pa with leakage rate of 5% maximum.
- .3 Seal classification: to SMACNA seal class A with longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.
- .4 Hangers:
 - .1 Ducts up to size 900 mm shall be supported with 25 mm x 1.6 mm thick galvanized strap hangers spaced at not over 3 m centres.
 - .2 Ducts over 900 mm shall be supported with 10 mm steel rods and 50 x 50 x 6 mm angles. Maximum spacing of hangers to be 2.5 m.
 - .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel deck or use powder actuated fasteners.
- .5 Radius of duct elbow shall be at least equal to the width of the elbow. Use square elbow with double thickness turning vanes when space is limited.
- .6 Provide balancing dampers at all branch ducts and as indicated. Each damper shall be fitted with locking type quadrant operator.
- .7 Duct leakage: in accordance with SMACNA HVAC Duct Leakage Test Manual ANSI/SMACNA 016.
- .8 Applications: supply air ducting downstream of VAV boxes, all exhaust air ducting, and

all return air ducting.

2.2 **MEDIUM PRESSURE RECTANGULAR DUCTWORK**

- .1 Material: lock-forming quality steel with Z275 designation zinc coating to ASTM A653/A653M, minimum 30% recycled content.
- .2 Gauge and construction of ducts and fittings shall be in accordance with SMACNA HVAC Duct Construction Standards ANSI/SMACNA 006 for rectangular duct for a positive static pressure up to 1.5 kPa with leakage rate of 1.5% maximum.
- .3 Seal classification: to SMACNA seal class A with longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.
- .4 Hangers:
 - .1 Ducts up to size 900 mm shall be supported with 25 mm x 1.6 mm thick galvanized strap hangers spaced at not over 3 m centres.
 - .2 Ducts over 900 mm shall be supported with 10 mm steel rods and 50 x 50 x 6 mm angles. Maximum spacing of hangers to be 2.5 m.
 - .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel deck or use powder actuated fasteners.
- .5 Radius of duct elbow shall be at least equal to the width of the elbow. Use square elbow with double thickness turning vanes when space is limited.
- .6 Provide opposed blade volume dampers with lockable quadrant operators at all branch ducts and as indicated.
- .7 Provide 25 mm test plugs with chain and cap, where required and indicated to accommodate testing and balancing instruments.
- .8 Duct Leakage: in accordance with SMACNA HVAC Duct Leakage Test Manual ANSI/SMACNA 016.
- .9 Applications: supply air ducting upstream of VAV boxes.

2.3 **MEDIUM PRESSURE RIGID ROUND DUCTS**

- .1 Material: lock-forming quality steel with Z275 designation zinc coating to ASTM A653/A653M, minimum 30% recycled content.
- .2 Gauge and construction of ducts and fittings shall be in accordance with SMACNA HVAC Duct Construction Standards ANSI/SMACNA 006 for round ducts for a positive static pressure up to 2.5 kPa with leakage rate of 1.5% maximum.
- .3 Round ducts, fittings and specialties shall be fabricated by one manufacturer. Use conical tees at branch takeoffs. Do not use straight 90° tee.
- .4 Seal classification: spiral wound round ducting up to 900 mm to SMACNA seal class A

with transverse joints, duct wall penetrations and connections made airtight with sealant.

- .5 Hangers:
 - .1 Ducts with diameter up through 450 mm shall be supported with 40 x 1.6 mm thick galvanized steel straps and 40 x 1.6 mm thick hanger rings spaced at not over 3 m centres.
 - .2 Ducts with diameter from 475 mm through 900 mm shall be supported with 40 x 3 mm thick galvanized steel straps and 40 x 3 mm thick hanger rings spaced at not over 3 m centres.
 - .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel deck or use powder actuated fasteners.
- .6 Provide round butterfly dampers with locking quadrants at all branch ducts and as indicated.
- .7 Duct Leakage: in accordance with SMACNA HVAC Duct Leakage Test Manual ANSI/SMACNA 016.
- .8 Applications: all rigid round ducts unless noted otherwise.

2.4 FLEXIBLE DUCTWORK

- .1 Factory fabricated Class 1 air duct to CAN/ULC-S110. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.
- .2 Duct must withstand 2.5 kPa internal pressure.
- .3 Material: spiral wound flexible aluminum.
- .4 SuDo not lay ducts across any lighting fixtures or hot surfaces.
- .5 Maximum length of flexible duct connections: 1.2m.
- .6 Make connections between flexible duct and terminal devices airtight with duct tape.

2.5 ACOUSTIC DUCT LINING

- .1 For rectangular duct liner: 25 mm thick meeting ASTM C1071 with air surface coated with acrylic coating treated with EPA register anti-microbial agent proven to resist microbial growth as determined by ASTM G21 and ASTM G22.
 - .1 'ksi' Value: ASTM C518, 0.036 at 24°C.
 - .2 Noise reduction coefficient: .65 or higher based on "Type A mounting" and tested in accordance to ASTM C423.
 - .3 Maximum velocity: 25.4 m/sec.
 - .4 Adhesive: meeting ASTM C919.
 - .5 Fasteners: duct liner galvanized steel pins, welded or mechanically fastened.
- .2 Fasten duct liner to interior sheet metal surfaces with 100% coverage of an approved fire resistant bonding adhesive. Ductwork with any side greater than 300 mm shall have

additional mechanical fasteners spaced at not more than 300 mm centres.

- .3 Seal edges, pin penetrations and joints with an approved fire resistant mastic. Protect leading and trailing edges with sheet metal edging.
- .4 Flame spread rating on interior lining shall not exceed 25, smoke development shall not exceed 50.
- .5 Duct sizes indicated on the drawing are sizes of inside liner. Increase sheet metal sizes to suit.

2.6 DUCT SEALANTS AND TAPES

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of -30°C to +93°C.
- .2 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.7 DUCT ACCESS DOORS

- .1 Provide for access to fire, balancing, and other dampers, for service and inspection for all HVAC equipment (VAV Boxes, control boxes etc.), and for cleanouts where required.
 - .1 Panel type access doors, 300 x 300 mm unless otherwise stated, complete with two sash locks.

2.8 BALANCING DAMPERS

- .1 Approved units of thicknesses and type of construction in accordance with SMACNA HVAC Duct Construction Standards ANSI/SMACNA 006.
- .2 Splitter dampers: where indicated with control rod with locking device on exterior of duct. Damper to be single thickness one gauge heavier than duct.
- .3 Single blade butterfly dampers: where indicated with locking quadrant.
 - .1 Round butterfly dampers to be 1.6 mm thick in medium pressure ducts and 0.8 mm in low pressure ducts.
 - .2 Rectangular butterfly dampers to thicknesses indicated in SMACNA.
- .4 Multi-leaf opposed blade dampers: designed to SMACNA details with locking quadrant.

2.9 FIRE DAMPERS

- .1 Fire dampers: listed and bear label of ULC, and shall meet requirements of PSPC Fire Protection Engineer formerly (FFC), CAN/ULC-S112 "Test of Fire Damper Assemblies", and authorities having jurisdiction.
- .2 Factory fabricated for fire rating requirement to maintain integrity of membrane being pierced.

- .3 Fire dampers shall be single-blade, multi-blade or curtain type, sized to maintain full flow cross section as indicated.
- .4 Complete with frame and 40 x 40 x 3 mm steel angle on full perimeter of frame on both sides of barrier being pierced.
- .5 Provide at each fire damper an access door for access to fusible links.
- .6 Follow NFPA 90A and manufacturer's installation instructions including the installation of drywall filler pieces when installed in a gypsum board wall.

2.10 MOTORIZED DAMPERS

- .1 Motorized dampers shall be supplied under Division 25 Integrated Automation, but installed under Division 23.
- .2 Sizes: blades maximum 150 mm wide and 1200 mm long. Modular maximum 1200 mm wide and 2400 mm high.
- .3 Materials: frame to be 2.5 mm thick galvanized sheet steel. Blades to be 1.6 mm thick galvanized sheet steel.
- .4 Bearings: oil impregnated sintered bronze or nylon bearings. Provide additional thrust bearings for vertical blades.
- .5 Linkage: zinc-plated steel.
- .6 Seals: replaceable neoprene seals on both sides, top and bottom of frame and along all blade edges and blade ends.
- .7 Performance: 50 L/s maximum allowable leakage against 1.0 kPa static pressure, and temperature range -40°C to 90°C.

2.11 GRILLES, REGISTERS AND DIFFUSERS

- .1 General:
 - .1 Sizes indicated are nominal. Provide correct standard product nearest to nominal.
 - .2 Construction: aluminum with baked enamel
 - .3 Refer to Grille and Diffuser Schedule on Drawings
- .2 Return and exhaust grilles and registers:
 - .1 For "T"-bar and drywall ceiling installation: 12 x 12 x 12 mm egg crate.
- .3 Square or circular diffusers:
 - .1 For lay-in "T"-bar and drywall ceiling installation: square type, size and capacity indicated for neck diameter indicated, having adjustable pattern and volume control dampers with flow straightening devices and blank-off quadrants. Diffuser face to be 500 x 500 mm unless otherwise noted.

- .2 Diffusers shall be aluminum face and core. Paint finish and colour shall match existing ceiling grid.

2.12 DDC VARIABLE AIR VOLUME BOXES

- .1 Provide DDC type variable volume terminal units of capacities and performance as indicated on the drawings.
- .2 The single zone VAV boxes and fan powered VAV boxes shall be pressure independent, reset to air flow between minimum and maximum air volume. The Multi-zone VAV boxes shall be designed to maintain a constant duct static pressure at 85 Pa (adjustable).
- .3 At inlet velocity of 10 m/s, differential static pressure for unit with attenuator section not to exceed 25 Pa.
- .4 Air velocity sensor for single zone VAV box or fan powered VAV box to have multiple averaging pickup points.
- .5 DDC control package furnished under Division 25 Integrated Automation shall include DDC controller, damper actuator, velocity sensor and transmitter, static pressure sensor and transmitter, control transformer and shall be installed by the VAV box manufacturer at factory.
- .6 Terminal unit to be CSA certified.
- .7 Casing: constructed of 0.9 mm thick galvanized steel, internally lined with 20 mm thick fibrous glass, to UL 181 and to NFPA-90A. Mount control components inside protective metal shroud.
- .8 Damper: galvanized steel with peripheral gasket and self-lubricating bearings. Air leakage past closed damper not to exceed 2% of nominal rating at 750 Pa inlet static pressure, in accordance with Air Diffusion Council test procedure.
- .9 Refer to Division 25, Integrated Automation for sequence of operation.

2.13 THERMAL INSULATION AND JACKETING

- .1 Insulate all supply air ducting, upstream of VAV terminal units, outside air intake ducting, all exhaust air ducting from fan to exhaust louvre, all return and transfer air ducting.
- .2 Material:
 - .1 On exposed rectangular ducting: 25 mm thick rigid mineral glass fibre board to ASTM C612 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .2 On concealed rectangular ducting: 25 mm thick rigid mineral glass fibre board to ASTM C612 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .3 On round ducting: 25 mm thick glass fiber blanket to CAN/ULS-S702 and vapour barrier jacket to CGSB 51-GP-52Ma.

- .3 Fastenings on rectangular ducts:
 - .1 Use 50% coverage of insulation adhesive. Flame spread 15, smoke development 0.
 - .2 If duct is over 635 mm wide, provide weld pins in addition to insulation adhesive. Place weld pins at not more than 200 mm centres, and not less than 2 rows per side.
- .4 Fastenings on round ducts: Use 100% coverage of insulation adhesive of flame spread 15, smoke development 0, and 100 mm wide self-adhesive tape rated under 25 for flame spread and under 50 for smoke development.
- .5 Vapour barriers: Use quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
- .6 Vapour barriers and insulation to be complete over the full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves.
- .7 Provide canvas cover over all insulated ducts in exposed areas. Canvas cover to be compact, firm, ULC listed heavy plain weave, cotton fabric at 272 g/m². Provide two coats of diluted fire retardant lagging adhesive over canvas covering.

Part 3 **EXECUTION**

3.1 **EXISTING AND REUSED CONTROLS**

- .1 Recalibrate and test existing and reused control devices shown on the drawings.
- .2 Report any inoperative control device to Departmental Representative immediately and obtain Departmental Representative's instructions.

3.2 **INSTALLATION**

- .1 Install material and equipment in accordance with referenced standards and manufacturer's written instructions.
- .2 Make good all existing insulation where previously damaged by others or damaged by work under this contract.

3.3 **AIR BALANCING**

- .1 Use qualified personnel and approved instruments to balance each air system to air flow rates specified on the drawings.
- .2 Do TAB of all air systems.
- .3 Measurements: to include, but not limited to, following 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, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.
- .8 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, run-out (or grille, register or diffuser).
- .9 Permissible deviation from design air quantities shall be 5%.
- .10 Permanently mark settings of all splitters, dampers and other adjustment devices.
- .11 For additional requirements refer to Sections 23 05 00, 23 05 93 and 23 08 00.

END OF SECTION

Approved: 2018-01-29

Part 1 General

1.1 REFERENCE STANDARDS

- .1 National Fire Protection Association (NFPA)
 - .1 NFPA 90A-17, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S112-10, Standard Test Method of Fire Test of Fire Damper Assemblies.
 - .2 ULC-S505-1974, Standard for Fusible Links for Fire Protection Service.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures
- .2 Product Data:
 - .1 Submit manufacturer s instructions, printed product literature and data sheets for fire dampers and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Fusible links.
 - .3 Design details of break-away joints.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: submit operation and maintenance data for fire dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer s written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer s name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer’s recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect fire dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 FUSIBLE LINK DAMPERS

- .1 Curtain blade type, dynamic, galvanized steel (unless otherwise specified) fusible link dampers, ULC classified to CAN/ULC S112 and in accordance with NFPA 90A requirements, factory tested for closure under airflow, 1-1/2 hour or 3 hour rated as required, and complete with a constant force type 301 stainless steel closure spring, a blade lock assembly, a steel sleeve, retaining angles, and, unless otherwise specified, a 74°C (165°F) rated standard fusible link
- .2 Fusible link dampers are to be Type "B" or Type "C" (as required) with folded curtain blade out of air stream except where damper size or location requires use of type "A" dampers with curtain blade in air stream.
- .3 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 Provide fusible link dampers. Ensure damper rating (1-1/2 or 3 hr.) is suitable for fire barrier it is associated with.
- .4 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .5 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.
- .6 Coordinate with installer of fire stopping
- .7 Install access door adjacent to each damper.
- .8 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .9 Install break-away joints of approved design on each side of fire separation.

END OF SECTION

Part 1 **GENERAL**

1.1 **GENERAL**

- .1 The "provide" in this Division shall be interpreted as "supply, install, and connect".
- .2 Energy Monitoring and Control System (EMCS) shall include Direct Digital Control (DDC) of mechanical systems as specified for this project.
- .3 Building Automation System (BAS) shall include the EMCS as specified for this project.

1.2 **DESCRIPTION OF SYSTEM**

- .1 Extend the existing Networked DDC Control System to meet the requirements specified for this project. The new and extended DDC products and services shall be fully compatible with the existing Delta Controls system. The extended Control System shall consist of but is not limited to the following:
 - .1 Master Control Units as specified.
 - .2 Software required to implement a complete and operational system.
 - .3 Input and output control devices including sensors, actuators, conduit and wiring, as required to provide the operations specified.

1.3 **ACCEPTABLE SYSTEM MANUFACTURERS AND PRODUCTS**

- .1 The System Manufacturer must have maintained local office within 400 kilometers of job site for at least 5 years with technical staff to provide technical information, routine and emergency maintenance on the system and all system components, and to provide training instructions to O&M staff.
- .2 The System Manufacturer must have proven record of successful experience on projects of similar type and size.
- .3 Submit the following information for review by Departmental Representative:
 - .1 Location of local office.
 - .2 Names and phone numbers of technical staff.
 - .3 Specification sheets for Master Control Units, Local Control Units and Terminal Control Units.
 - .4 Data communication network performance information including network protocols to be used, data rate, maximum number of nodes per Local Area Network (LAN).

1.4 **CO-ORDINATION**

- .1 Contractor shall co-ordinate its work with Mechanical and Electrical Trades. Unless noted otherwise, the Contractor shall provide all interface devices, control wiring, and controls as required to provide the control operation specified.

- .2 Unless noted in Division 26, Contractor shall provide line voltage and low voltage control wiring for equipment specified in Division 25. Refer to Division 26 for power wiring, starters, disconnect switches, etc., to be provided for mechanical equipment.
- .3 Contractor shall provide all necessary power and dedicated circuits as required from local 120 volt branch circuits panel board for all Master Control Units. Install tamper locks on breakers of circuit panel.
- .4 Unless noted otherwise, all other installation work required for the complete installation of EMCS, including all interface devices, control and power wiring, controls and controlled devices shall be provided by the one Contractor.

1.5 LOCKABLE PANELS

- .1 Provide lockable panel for each MCU or LCU. All panels shall be EEMAC rated to environment requirements with hinged doors.
- .2 Equip all panels for Master Control Units with standard keyed-alike cabinet locks, keyed to same key.

1.6 NAMEPLATES

- .1 Provide nameplates on all control items listed or shown in the submittal and approved control diagrams.
- .2 Identify all panels and items mounted on panel face by laminated plastic nameplates 3 mm thick. Lettering shall be accurately aligned and engraved into the white core. Size of nameplates shall be 20 mm by 100 mm minimum. Lettering shall be minimum 5 mm high normal black lettering.
- .3 Identify Field Sensors and Controlled Devices by plastic encased cards attached to the device by chain.
- .4 Warning signage: provide each motor starter under remote automatic control (DO point on I/O Point Schedules) with signage warning of automatic starting under control of EMCS. (i.e. "Caution - this equipment is under automatic remote control of EMCS").

1.7 SHOP DRAWINGS

- .1 Submit shop drawings and product data in accordance with Section 23 05 00. Submit control shop drawings within 15 days of Award of Contract.
- .2 Shop drawings shall include:
 - .1 Description of software programs included.
 - .2 Specification sheets for each piece of equipment or control devices to be provided.
 - .3 Equipment and DDC Controllers location drawings.
 - .4 Mechanical control schematics.
 - .5 Sequence of operation for each mechanical system.

- .6 DDC control point schedules.

1.8 INSTALLATION AND COMPLETION TESTS

- .1 Installation and Calibration:
 - .1 Set control points and calibrate sensors immediately after installing controls.
- .2 Completion Tests:
 - .1 After installation of each part of the system and completion of mechanical and electrical hood-up, perform tests to confirm correct installation and operation of equipment.
 - .2 Check and calibrate each AI using a calibrated digital thermometer, humidistat, velometer or transducer.
 - .3 Check each DI to insure proper settings and switching contacts.
 - .4 Check each AO to insure proper operation of valves and dampers. Verify tight closing, input and output signals.
 - .5 Check each DO to insure proper operation and lag time.
 - .6 Check all operating software.
 - .7 Check all application software. Provide samples of all logs and commands.
 - .8 Debug all software.
 - .9 The contractor shall be responsible for fine tuning and adjusting all control devices and make modifications as required to provide a fully operational EMCS.
 - .10 Submit test report with checklist showing all input/output control points and all software programs.
- .3 All reported results are subject to verification by the Departmental Representative.

1.9 SYSTEM STARTUP VERIFICATION TESTING

- .1 The Contractor shall provide technical personnel and instrumentation to conduct startup verification testing.
- .2 Verification:
 - .1 Perform point-by-point verification of entire system.
 - .2 Verify the calibration of all AI devices individually.
 - .3 Verify the calibration of all DI devices individually.
 - .4 Verify all AO devices are functional, start and span are correct, direction and normal positions are correct.
 - .5 Verify that all DO devices operate properly and that the normal positions are correct.
 - .6 Verify the system sequences of operation. Simulate all modes of operation.
 - .7 Verify the stability of all DDC loops and optimum start/stop routines.
 - .8 Check each alarm separately.
 - .9 Verify interlocks and conditional control response.
 - .10 Simulate alarm conditions to check the initiating value of variable and interlock action.
- .3 The contractor shall complete and submit System Startup Verification Forms. Each item

on the verification forms shall be signed off as verified (yes), or not verified (no) and actual date of verification.

1.10 OPERATION AND MAINTENANCE MANUAL

- .1 The manual shall be custom designed for this project and contain only information relevant to this project.
- .2 The manual shall provide full and complete coverage of the following subjects:
 - .1 Operational Requirements: This document shall describe, in concise English terms, all the functional and operational requirements for the system and its functions that have been implemented.
 - .2 System Operation: Complete step by step procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats; and emergency, alarm, and failure recovery. Step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes shall be provided.
 - .3 Maintenance: Documentation of all maintenance procedures for each and all system component including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective module.
 - .4 Test Procedures and Reports: The test implementation shall be recorded with a description of the test exercise script of events and documented as Test Procedures. A provision for the measurement or observation of results, based on the previously published Test Specification, forms the Test Reports.
 - .5 Configuration Control: Documentation of the basic system design and configuration with provisions and procedures for planning, implementing, and recording any hardware or software modifications required during the installation, test, and operating lifetime of the system.

1.11 TRAINING

- .1 Provide the services of competent instructors who will provide instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach.

1.12 WARRANTY AND MAINTENANCE

- .1 The Contractor shall provide all services; materials and equipment necessary for the maintenance of the Automatic Control Systems for a period of 12 months concurrent with the warranty period.
- .2 The Contractor shall provide three minor inspections or as required by the manufacturer and one major inspection per year, and all service for the required maintenance. Major inspection shall be scheduled in April or November. A major inspection shall involve a point by point check and/or calibration. Provide dated database log to indicate executed point to point system check.

- .3 Emergency Service: The Owner will initiate service calls when there is indication that the Automatic Control System is not functioning properly. The Contractor shall have qualified personnel available during the contract period to provide service to the "critical" overall control system components whenever required at no additional cost to the owner. The contractor shall furnish the Departmental Representative with a telephone number where the service personnel can be reached at all times. The service technician shall be on the job ready to service the control system within 4 hours after receiving a request for service. The work shall be performed continuously until the control system is back in reliable operating condition. This service shall be provided on a 24 hours basis 7 days a week.
- .4 Upon completion of each inspection or emergency service, submit fully detailed report in writing to Departmental Representative.

Part 2 PRODUCTS

2.1 BAS DATA COMMUNICATION NETWORK

- .1 The Control Manufacturer shall design, supply, install and connect a data communication network to link all Terminal Control Units, Local Control Units, Master Control Units, and Operator Workstation.
- .2 The data communication network shall include EMCS-LAN, EMCS-BUS, modems, network interface cards, network management hardware and software, and all network components including cables, connectors, repeater, hubs, and routers necessary for the internetwork.
- .3 EMCS Local Area Network (EMCS-LAN): a high speed, high-performance, local area network over which Master Control Units (MCUs) and Operator Workstations (OWS) communicate with each other, directly on a peer to peer basis using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol. Each LAN shall have a minimum capacity of supporting at least 50 MCUs.
- .4 EMCS Communication Bus (EMCS-BUS): a local secondary bus or subnetwork that links Local Control Units (LCUs) and Terminal Control Units (TCUs) to a Master Control Unit (MCU). The combined quantity of LCU's and TCUs directly connected to one EMCS-BUS subnetwork shall not exceed 50. Data transmission rate to be 9600 Baud minimum. Acceptable secondary Communication Bus: RS-485 LAN, Lontalk.
- .5 Master Control Units (MCUs): Stand-alone fully user programmable DDC Controllers that reside on EMCS-LAN.
- .6 Local Control Units (LCUs): Stand-alone fully user programmable DDC Controllers that reside on EMCS-BUS.
- .7 Terminal Control Units (TCUs): Stand-alone DDC Controllers that reside on EMCS-BUS. Terminal Control Unit is not fully user-programmable, but is configured with its hardware and firmware to match a specific application.

2.2 **OWS SOFTWARE**

- .1 Provide to existing OWS the most recent software programs to permit command entry, information management, alarm management and database management functions for the new chillers and pumps.
- .2 Workstation operating system shall be multitasking and Window based, e.g. Windows 10, Windows 8.2.
- .3 Workstation software shall include but not be limited to the following functions:
 - .1 Operator's commands and programming.
 - .2 Access control.
 - .3 Graphics software.
 - .4 Alarm management.
 - .5 Reports and logs.
 - .6 Database back-up and download.
- .4 Refer to the specification for additional requirements of each function.

2.3 **OPERATOR'S COMMANDS AND PROGRAMMING**

- .1 Provide software to enable non-programmer operator to perform global supervision tasks such as to view, and edit if applicable, the status of any object and property in the system.
- .2 Operator shall be able to terminate automatic software control, initiate DO and AO manual commands, and return DO and AO manual commands to automatic software controls.
- .3 Provide programming software at OWS to allow operator to create, edit, and download custom application programs to support MCUs and LCUs. On-line programming/configuration shall not interfere with normal system operation and control.

2.4 **ACCESS CONTROL**

- .1 A minimum of 4 levels of access shall be supported:
 - .1 Level 0 No Password = Data Access and Display.
 - .2 Level 1 = Operator Overrides.
 - .3 Level 2 = Level 1 + Database Modification and Generation.
 - .4 Level 3 = Level 3 + Password Assignment: Addition/Modification.
- .2 User-definable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line. Default setting shall be 3 minutes.

2.5 **GRAPHICS SOFTWARE**

- .1 Provide OWS with upgraded graphics software necessary to permit the operator to create, modify, delete, file, and recall all graphics. Operators shall be able to start and stop

equipment or change set points from graphical displays.

- .2 The Contractor shall utilize the graphics software to generate the custom Building Outline Drawings, Equipment and Sensors Location Diagrams, and Control Schematic Diagrams for this project.
- .3 Operator shall be able to build graphic displays that include on-line point data from multiple MCU panels. Data shall be updated every 10 seconds or less.
- .4 Windowing: the windowing environment of the OWS shall allow the user to simultaneously view several graphics at the same time.

2.6 ALARM MANAGEMENT

- .1 Provide the software to notify the operator of the occurrence of an alarm condition. All alarm messages shall be displayed and printed. Alarm messages shall include as a minimum: location of alarm, time of occurrence, and type of alarm. Each point shall have its own message. Assignment of messages to a point shall be an operator editable function.

2.7 MASTER CONTROL UNITS (MCU)

- .1 The Master Control Unit (MCU) is to be a stand-alone DDC controller with the following characteristics:
 - .1 MCU shall be micro processor based, multi-tasking, multi-user, real-time digital control processors capable of supervising other lower level programmable control units through a secondary network. Each MCU shall consist of modular hardware with plug-in processors, communication controllers, power supplies, and input/output modules.
 - .2 Each MCU shall provide at least two data communication ports for PC computer, modem and/or printer connection. MCU shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or Operator's Terminals.
 - .3 The Processor shall execute programmable logic control (Direct Digital or Closed Loop Process Control) of associated HVAC equipment without interacting with any other Processor or Operator Workstation.
 - .4 Basic functional requirements to include scanning of digital/analog input, digital change of state (alarm) monitoring, analog input (alarm) monitoring, on-off digital control with programmable logic, analog control using programmable logic (including PID) with adjustable dead bands and deviation alarms, control of HVAC systems, as specified under sequence of operation instructions.
 - .5 Provide a designated MCU with a 28.8 kbps auto call/auto receive modem to communicate with remote operator workstations on an intermittent basis via telephone lines.
- .2 Each MCU shall have sufficient capacity for its assigned D1, D0, A1, A0 points as indicated on the DDC Input/Output Point Schedules. Unless noted on the Input/Output Point Schedule or approved by the Departmental Representative, all points associated with one mechanical system shall be connected directly to the same MCU.

- .3 Unless noted or approved by the Departmental Representative, provide a minimum of one Master Control Unit (MCU) for mechanical room.
- .4 Minimum addressable memory shall be sufficient to support all performance and technical specifications. All operating system, executive, application, subroutines, and other configuration definition software, shall reside in non-volatile memory such as EPROM. All control description logic, application functions and operating data or software shall reside in battery backed RAM 72 hours or EPROM and hence modifiable on-line through the operator panel or remote operators interface. Complete Ram Memory must be downline loadable from Operator Workstation.
- .5 Include an uninterruptible clock, with an accuracy of ± 5 seconds per month and capable of deriving month/day/hour/min./seconds. Rechargeable batteries to provide a minimum of 72 hours of operation in the case of power failure.
- .6 Integrated on-line diagnostics: each MCU panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment. The MCUs shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Diagnostic LEDs for power, communication and processor shall be provided at each MCU.
- .7 Surge and transient protection: isolation shall be provided at all network terminations, as well as all field point termination to suppress inducted voltage transients consistent with IEEE Standard 587.
- .8 Electrical noise protection: operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m.

2.8 MCU SOFTWARE

- .1 The software programs specified shall be provided as an integral part of the Master Control Units and shall not be dependent upon any higher level computer for execution. Software shall include but not be limited to operating systems executive, control description logic, energy management and totalization. The MCU software shall also support the operator interface functions specified in OWS software.
- .2 Programming:
 - .1 Control description logic shall be written in general control type or high level language. The operator shall, at his discretion, be able to alter the operating parameters on-line from the MCU or OWS to tune a control loop.
 - .2 Any change to the program shall be performed on-line.
 - .3 Control description logic will have access to values or status of all points available to the controller including global or common values, allowing cascading and interlocking control.
 - .4 The MCU shall have the ability to perform the following pre-tested control algorithms:
 - .1 Two Position Control.
 - .2 Proportional Control.

- .3 Proportional plus Integral Control.
 - .4 PID Control.
 - .5 Automatic Control Loop Tuning.
 - .5 Equipment cycling protection: control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
 - .6 Heavy equipment delays: the system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads. Motors of 15 kW and larger shall be included in the program.
 - .7 Fire shut-down: fans under the control of EMCS shall shut-down when a fire alarm signal is received by the EMCS.
 - .8 Power fail shut-down: in the event of the loss of normal power, there shall be an orderly shutdown of all MCUs to prevent the loss of database or operating system software.
 - .9 Automatic restart: upon the resumption of normal power, as determined by the emergency power transfer switches or fire alarm panel, the automatic restart program shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
- .3 MCU panels shall have the ability to perform any or all of the following energy management routines:
- .1 Auto Start/Stop Scheduling.
 - .2 Optimal Start/stop.
 - .3 Temperature Reset.
 - .4 Economizer Control.
 - .5 Peak Demand Limiting.
- .4 Totalization:
- .1 Runtime totalization: MCU panels shall automatically accumulate and store runtime hours for binary input and output points.
 - .2 Analog/pulse totalization: MCU panels shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
 - .3 Event totalization: MCU panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

2.9 LOCAL CONTROL UNITS (LCU)

- .1 The Local Control Unit is to be a standalone DDC controller with the following characteristics:
 - .1 LCU shall incorporate a programmable microprocessor, non-volatile program memory, random access memory, power supplies and appropriate communication interfaces as required to perform specified functions.
 - .2 LCU shall incorporate a communication interface port for communication to the Master Control Unit (MCU).
 - .3 LCU shall execute it's logic and control (Direct Digital or Closed Loop Process

- Control) of associated equipment without interacting with any other Processor.
- .4 Basic functional requirements to include scanning of digital/analog inputs, digital change of state (alarm) monitoring, analog input (alarm) monitoring, on-off digital control with configurable logic, analog control using configurable logic (including PID) with adjustable dead bands and deviation alarms, control of HVAC systems, specified under sequence of operation instructions.
 - .2 Minimum addressable memory shall be sufficient to support all performance and technical specifications. All operating system, executive, application, subroutine, and other configuration definition software, shall reside in non-volatile memory such as EPROM. All control description logic, applicable functions and operating data shall reside in battery backed RAM 72 hours or EEPROM and hence modifiable on-line through the operator panel or remote operator interface. All operating data must be downline loadable from Operator Workstations.
 - .3 Each LCU shall have sufficient capacity for its assigned D1, D0, A1, A0 points as indicated on the DDC Input/Output Point Schedules. All points associated with one mechanical system shall be connected directly to the same LCU.
 - .4 The LCU shall include as a minimum 2 interface ports for connection of MCU controller and local computer terminal.
 - .5 In the event of loss of communications with, or failure of the MCU, this controller shall continue to perform control of the associated equipment. Controllers that use defaults or fail to open or closed position will not be acceptable.
 - .6 Unless noted otherwise, LCUs shall not be used to control any major mechanical equipment. LCUs shall be used to control packaged and distributed equipment such as packaged air handling units, radiation, and exhaust fans, and multi-zone VAV boxes.

2.10 LCU SOFTWARE

- .1 Software shall include but not be limited to definitions and operating systems executive, communications, control description logic, operator interface.
- .2 Control description logic shall be written in general control type or high level language.
- .3 Control description logic shall have access to values or status of all points available to the controller including global or common values, allowing cascading and interlocking control.
- .4 Software to be generic and configurable from computer terminal or to be downloaded from operator workstations.

2.11 TERMINAL CONTROL UNITS (TCU)

- .1 Each Terminal Control Unit (TCU) is to be a microprocessor-based standalone DDC controller with the following characteristics:
 - .1 Hardware and firmware are configured to control a specific type of terminal

- equipment such as conventional single zone VAV box or fan powered VAV box.
- .2 The controller shall incorporate a communication interface port for communication to the Master Control Unit (MCU).
 - .3 Each TCU shall have sufficient capacity and memory to support its operating system, data bases and specified functional requirements under sequence of operation instructions.
- .2 Each TCU shall support multiple modes of operation including Day/Weekly Schedules, Occupied/Unoccupied Mode, and Override Mode.
 - .3 Any Operator Workstation (OWS) connected to the communication network shall be able to access all information including sensor values, operating status, setpoints, on/off schedules, alarm limits and other operating parameters of each TCU. Operator at OWS connected to the network shall be able to make setpoint adjustments, assign high and low alarm limits and make programming changes.
 - .4 Powerfail Protection: all system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration will not require reprogramming the DDC controller.

2.12 TEMPERATURE SENSORS AND TRANSMITTERS

- .1 General: temperature sensors shall be RTD platinum type, unless otherwise noted.
- .2 Temperature sensors shall be of the following types.
 - .1 Space RTD: suitable for wall mounting, with protective guard.
 - .2 Duct point RTD: suitable for insertion into air ducts at any angle, insertion length of 460 mm unless otherwise as noted on schedule or drawings.
 - .3 Immersion RTD: Spring loaded construction with compression fitting for 20 mm NPT well mounting. Lengths of 100 mm or 150 mm unless otherwise noted.
 - .4 Mixed Air Averaging RTD: continuous filament with probe length of 6000 mm minimum. Maximum 6 m² cross section area per sensor. Probe to be bent, at field installation time, to a minimum radius of 100 mm at any point along the probe length without degradation in performance.
 - .5 Outdoor RTD: complete with non-corroding shield designed to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, probe length of 100-150 mm.
- .3 Provide each sensor with a temperature transmitter having the following minimum specifications:
 - .1 Output signal of 4-20 mA into maximum of 500 ohm load.
 - .2 Combined nonlinearity, repeatability and hysteresis effects not to exceed $\pm 0.5\%$ of full scale output.
 - .3 Integral, zero and span adjustments.
 - .4 Temperature effect of $\pm 1.0\%$ full scale or less.
- .4 Range of sensors to suit application and to be submitted with shop drawings.

2.13 HUMIDITY SENSORS AND TRANSMITTERS

- .1 Provide humidity sensors with the following minimum specifications:
 - .1 Operating range: 10-90% RH.
 - .2 Operating temperature: 0°C to 60°C.
 - .3 Accuracy: $\pm 2\%$ RH at 25°C.
 - .4 Response time: 60 seconds from 90% to 10% RH.
- .2 Provide transmitters for all supplied relative humidity sensors with the following minimum specifications:
 - .1 Output signal of 4-20 mA or 0 to 10 VDC.
 - .2 Maximum output linearity error of $\pm 1.0\%$ of full scale output.
 - .3 Integral zero and span adjustments.
 - .4 Temperature effect of $\pm 1.0\%$ full scale or less.
 - .5 Drift: not to exceed 1% over 12 months.

2.14 AIR SYSTEM STATIC PRESSURE SENSORS AND TRANSMITTERS

- .1 Sensors shall meet the following:
 - .1 Multipoint element with self-averaging manifold.
 - .2 Maximum pressure loss: 160 Pa at 10 m/s. (air stream manifold).
 - .3 Accuracy: $\pm 1\%$ of actual duct static pressure.
- .2 Provide each sensor with a transmitter to meet the following requirements:
 - .1 Output signal: 4-20 mA linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed 150% of duct static pressure at maximum flow.
 - .3 Accuracy: $\pm 1.0\%$ of full scale.
 - .4 Repeatability: within 0.5% of output.
 - .5 Linearity: within 1.5% of span.
 - .6 Deadband or hysteresis: 0.1% of span.
 - .7 External exposed zero and span adjustment.
 - .8 Range: 0 to 125 Pa static pressure downstream of VAV boxes and 0 to 373 Pa static pressure upstream of VAV boxes, unless otherwise noted.

2.15 AIR SYSTEM VELOCITY SENSOR/ TRANSMITTER

- .1 Sensors shall meet the following requirements:
 - .1 Multipoint static and total pressure sensing element with self-averaging manifold, and with integral air equalizer and straightener section.
 - .2 Maximum pressure loss: 37 Pa at 10 m/s.
 - .3 Accuracy: $\pm 1\%$ of actual duct velocity.
- .2 Provide each sensor with a transmitter to meet the following requirements:
 - .1 Output signal: 4-20 mA or 0-10VDC linear into 500 ohm maximum load.
 - .2 Calibrated span: not to exceed 25% of duct static pressure at maximum flow.
 - .3 Accuracy: $\pm 0.4\%$ of span.
 - .4 Repeatability: within 0.1% of output.
 - .5 Linearity: within 0.5% of span.
 - .6 Deadband or hysteresis: 0.1% of span.

- .7 External exposed zero and span adjustment.
- .8 Air velocity range: 1 m/s to 10 m/s at 15°C.

2.16 PRESSURE/CURRENT TRANSMITTERS

- .1 Provide pressure-to-current transmitters having the following minimum specifications:
 - .1 Internal materials of the transducer suitable for continuous contact with industrial standard instrument air, compressed air, water or steam as applicable.
 - .2 Output signal of 4-20 mA into a maximum of 500 ohm load.
 - .3 Output variations of less than 0.2% full scale for supply voltage variations of $\pm 10\%$.
 - .4 Combined nonlinearity, repeatability and hysteresis effects not to exceed $\pm 0.5\%$ of full scale output over entire range.
 - .5 Integral zero and span adjustment.
 - .6 Temperature effect of $\pm 1.5\%$ full scale/50°C or less.
 - .7 Output short circuit and open circuit protection.
 - .8 Over-pressure input protection to a minimum of twice rated input.
 - .9 Pressure ranges to suit application.

2.17 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Provide differential pressure transmitters having the following minimum specifications:
 - .1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, glycol, or steam as applicable.
 - .2 Output signal of 4-20 mA into maximum of 500 ohm load.
 - .3 Output variation of less than 0.2% full scale for supply voltage variations of $\pm 10\%$.
 - .4 Combined nonlinearity repeatability and hysteresis effects not to exceed $\pm 0.5\%$ of full scale output over entire range.
 - .5 External exposed integral zero and span adjustment.
 - .6 Temperature effect of $\pm 1.5\%$ full scale/50°C or less.
 - .7 Output short circuit and open circuit protection.
 - .8 Over-pressure input protection to a minimum of twice rated input.
 - .9 Differential Pressure ranges to suit application.

2.18 PRESSURE SWITCHES

- .1 Provide pressure or differential pressure switches for ranges as indicated on point schedule.
- .2 Pressure sensing elements shall be bourdon tube, bellows or diaphragm type.
- .3 Adjustable setpoint and differential.
- .4 Pressure switches shall be snap action type rated at 120 volts, 15 amps AC or 24 volts DC.
- .5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.

2.19 **TEMPERATURE SWITCHES**

- .1 Provide High/Low temperature switches for ranges as indicated on point schedule.
- .2 Temperature sensing element shall be liquid, vapour or bimetallic type.
- .3 Adjustable setpoint and differential.
- .4 Snap action type rated at 120 Volts, 15 amps or 24 V DC as required.
- .5 Sensors shall operate automatically and reset automatically. Sensors used for freeze detection or fire detection shall be manually reset type.
- .6 Temperature switches shall be of the following types:
 - .1 General Purpose Duct type: suitable for insertion into air ducts, insertion length of 457 mm.
 - .2 Thermowell type: with compression fitting for 20 mm NPT well mounting, length of 100 mm. Immersion wells shall be stainless steel.
 - .3 Freeze detection type: continuous element with insertion length of 6000 mm minimum, suitable for duct mounting to detect the coldest temperature in any 30 mm section.
- .7 Temperature accuracy shall be $\pm 1^{\circ}\text{C}$.

2.20 **CURRENT/PNEUMATIC TRANSDUCERS**

- .1 Provide current to pneumatic transducers having the following minimum specifications:
 - .1 Input range of 4-20 mA or 0 to 10 VDC as suitable for interfacing with the FID digital-to-analog converter output subsystem.
 - .2 Directly proportioned output range of 20-104 kPa.
 - .3 Dustproof housing or panel mounted.
 - .4 Internal materials of the converter suitable for continuous contact with industrial standard instrument air.
 - .5 Combined nonlinearity, repeatability and hysteresis effects not to exceed +2% of full scale over the entire range.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect of +2.0% full scale or less.
 - .8 Maximum regulated supply pressure of 138 kPa or less.
 - .9 Provide air gauge on outlet.
 - .10 Air consumption: 0.008 scfm at 103 KPa supply.

2.21 **CONTROL RELAYS**

- .1 Contacts rated at 5 amps at 120 V AC.
- .2 Relays to be plug in type with termination base.

2.22 **CURRENT TRANSDUCER**

- .1 Provide current transducers with range to match load being metered.
- .2 Current transducers shall measure line current and produce a proportional signal in one of the following ranges.
 - .1 4-20 mA dc.
 - .2 0-1 V dc.
 - .3 0-10 V dc.
 - .4 0-20 V dc.

2.23 CURRENT SENSING RELAY

- .1 Provide adjustable current-operated solid-state relays with integral zero leakage LED for switching AC or DC circuits.
- .2 The contacts shall close when the current level sensed by the internal current transformer exceeds the trip point set by the multi-turn adjustment.
- .3 Range of monitored AC current to suit application and to be submitted with shop drawings.

2.24 CONTROL DAMPERS

- .1 Construction: Blades shall not exceed 200 mm wide or 1250 mm long. Modular maximum size 1250 mm wide x 1500 mm high. Multiple sections to have stiffening mullions and jack shafts.
- .2 Materials:
 - .1 Frame: 2.3 mm (13 gauge) galvanized sheet steel.
 - .2 Blades: two sheets 0.5 mm (22 gauge) or 1.6 mm (16 gauge) galvanized steel.
 - .3 Bearings: oil impregnated sintered bronze. Provide additional thrust bearings for vertical blades.
 - .4 Linkage and shafts: zinc plated steel.
 - .5 Seals: Replaceable neoprene seals or stain-less steel spring on sides, top and bottom of frame and along all blade edges and blade ends.
- .3 Performance:
 - .1 50 L/s/m² maximum allowable leakage against 1000 Pa static pressure.
 - .2 Temperature range: minus 50°C to 100°C.

2.25 DAMPER OPERATORS ELECTRONIC

- .1 Provide direct coupled type electronic proportional damper operators where indicated or required.
- .2 Spring return for "fail-safe" in Normally Open or Normally Closed position where required.
- .3 Size operators to control dampers against maximum pressure or dynamic closing pressure whichever is greater.

- .4 For modulating services, provide feedback circuit to indicate actuator position.
- .5 Power Requirements 12 VA maximum at 24 V AC.
- .6 Input signal: 2 to 10 VDC or 4 to 20 mA.

2.26 CONTROL VALVES

- .1 Provide control valves as shown on drawings or listed on valve schedule.
- .2 Valves 50 mm and smaller to be bronze with screw end connections. Valve 62 mm and larger to be cast iron with flanged end connections.
- .3 All trim to be 316 SST.
- .4 Valves to provide tight shut-off. Maximum leakage of 0.5% of rated flow.
- .5 Valves to be Normally Open, Normally Closed 2-way or 3-way as shown.
- .6 Valves to have linear or equal percentage flow characteristics as indicated.
- .7 Rangeability of valves to be minimum 50:1.
- .8 Sizing Criteria:
 - .1 Two-position service: Line size.
 - .2 Two-way modulating service: Pressure drop shall be equal to twice the pressure drop through heat exchanger (load), 50% of the pressure difference between supply and return mains, or 35 kPa, whichever is greater.
 - .3 Three-way modulating service: Pressure drop equal to twice the pressure drop through the coil exchanger (load), 35 kPa maximum.

2.27 ELECTRONIC VALVE ACTUATORS

- .1 Provide Electronic Valve Proportional Actuators with spring return to normal positions indicated.
- .2 Construction to be steel , cast iron or cast aluminum.
- .3 For modulating services, provide feedback circuit to indicate actuator position.
- .4 Control Voltage: 0-20 V DC or 24 V AC.
- .5 Positioning time: nominal 60 seconds.

2.28 ELECTRONIC RADIATION OR TERMINAL REHEAT CONTROL VALVE

- .1 Provide small electronic control valve of size 15 mm or 20 mm as indicated on drawing.
- .2 Valves shall be bronze with screw end connections. Stainless steel trim.

- .3 Valves to have linear or equal percentage flow characteristics.
- .4 Rangeability of size 15 mm valves to be 50:1 and 20 mm valves to be 100:1.
- .5 Running time at 60 Hz to be 125 seconds.
- .6 Control voltage: 24 VAC floating (3 position) control signal to control the valve.

2.29 ROUND ZONE CONTROL DAMPERS

- .1 Provide round zone control dampers on the ducts to the individual air outlets for the multi-zone VAV boxes as shown on the drawings.
- .2 Damper shall be of the butterfly type consisting of circular blade mounted to a shaft. Inside frame surface shall be clean and smooth with no blade stops or similar inward projects.
- .3 Frames shall include rolled stiffener beads to allow easy sealing of spiral ductwork joints. Damper frame and blade shall be fabricated from 1.6 mm galvanized steel.
- .4 Sizing Criteria: Velocity shall not be less than 4.6 m/s at design airflow.

2.30 THREE POINT FLOATING ELECTRONIC ACTUATORS

- .1 Use of three point floating actuators shall be limited to zone control dampers, radiation or terminal reheat control valves.
- .2 Provide tri-state outputs from DDC controllers (two coordinated binary outputs) for control of actuators.
- .3 Control algorithms shall run the three point floating actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.31 VAV BOX DDC ROOM THERMOSTATS

- .1 Provide wall mounted DDC room thermostats where indicated on the drawings.
- .2 DDC stat shall be digital controller complete with tamper resistant white plastic cover and back plate, temperature sensing element, LED/digital readout, and control buttons.
- .3 Temperature sensing element shall be RTD 1,000 OHM at 21°C or thermistor 10,000 OHM at 25°C, range 4°C to 37°C.
- .4 Digital readout shall display current space temperature and current setpoint.
- .5 Control buttons shall be provided for setpoint adjustment within the range of 20°C to 26°C (adjustable at OWS) and for override control of occupied and unoccupied modes within the limits set at OWS.

- .6 Provide signal transmission wiring and terminals or jack and connect to TCU of VAV box.

2.32 EXISTING CONTROLS

- .1 Unless noted otherwise or approved by the Departmental Representative in writing, all control devices required for a complete and working EMCS System shall be new and shall be provided by the Contractor.
- .2 The existing control dampers, control valves, sensors and end devices that may be reused are noted on the DDC Input/Output Point Schedules. Within 30 days of contract award the Contractor shall test and inspect for satisfactory operation all existing devices which are permitted to be reused. For those items considered nonfiction, the Contractor shall provide with the report, to support the findings, and obtain the Departmental Representative's instruction.
- .3 The Contractor shall submit written requests to disconnect any controls and to obtain equipment down time. Only after receiving these requests shall such work be allowed to proceed.
- .4 The Contractor shall be held responsible for repair costs due to Contractor negligence or abuse of owner equipment, or failure in reporting defective controls within 30 days of Contract Award.
- .5 Shop drawings shall show all signal levels, pressures, etc., where tying into existing control equipment.
- .6 Where existing controls are not to be reused or not required, they shall be removed and placed in storage for future disposition as directed by the Owner.

2.33 CONDUIT AND WIRE

- .1 Use type FT6 plenum rated cable for low voltage EMCS wiring in ceiling return plenum. Support FT6 cables in ceiling return plenum using Thomas & Betts TY-RAP cable straps and clamps screwed on to ceiling slab. Spacing to be 2M maximum. Do not use ceiling suspension wires for fastening cables. Exact routings shall suit site conditions and shall be to the approval of the Departmental Representative.
- .2 Use EMT conduit for wiring in mechanical, electrical, janitor rooms or equipment rooms.
- .3 Unless noted otherwise, install network cable within building in EMT conduit and install network cable between buildings in buried PVC conduit. The control contractor shall provide conduits with spare capacity not less than 50%.
- .4 Field wiring for each digital input and output shall be No. 20 AWG, stranded twisted pair. For multi-conductor wire having four or more conductors, wire size shall be not less than No. 22 AWG solid copper. Analog input shall be wired with shielded No. 20 AWG, stranded twisted pair, copper wire. Analog output shall be wired with 3 shielded No. 20

AWG stranded twisted copper wires.

- .5 Where conduits pass through fire rated walls or floors, provide schedule 40 steel sleeves filled with fire stopping material and approved sealant around conduits to maintain fire rating integrity.

2.34 RESPONSIBILITY FOR QUANTITIES

- .1 Failure to carry the correct lengths or sizes of conduit or correct types of wire or the correct number of DDC panels is the Contractor's responsibility and shall not be basis for additional charges by the Contractor.

2.35 WIRING IDENTIFICATION

- .1 Provide numbered tape markings on all branch control wiring, and pneumatic tubing.
- .2 At all junction boxes, splitters, cabinets and outlet boxes, maintain identification system.
- .3 Use colour coded wires in communication cables, matched throughout system.
- .4 Identify all power sources at each panel location.

2.36 CONDUIT IDENTIFICATION

- .1 Colour code all Control System conduits.
- .2 Coding to be located on all conduits and cables exposed after completion of construction in all locations including suspended accessible ceilings, tunnels and shafts.
- .3 Coding to be plastic tape or paint at all points where conduit or cable enters wall, ceiling, or floor, and at 15000 mm intervals.
- .4 Coding to be 25 mm wide, and fluorescent orange. Colour to be confirmed by the Contractor with the Departmental Representative at commencement of the project.

2.37 MANUFACTURER'S AND CSA LABELS

- .1 Manufacturers' nameplates and CSA labels to be visible and legible after equipment is installed.

Part 3 EXECUTION

3.1 GENERAL

- .1 All equipment shall be installed in according to manufacturers' published instructions.
- .2 Provide programming for the system and adhere to the sequence of operation specified.

3.2 BUILDING AUTOMATION SYSTEM (BAS) NETWORK ARCHITECTURE

- .1 Building Automation System (BAS) Network Architecture as shown on the Mechanical Drawings.

3.3 DDC INPUT/OUTPUT POINT SCHEDULE

- .1 DDC Input/Output Point Schedule, as shown on the Mechanical Drawings.
- .2 Naming convention: PSPC Standardized Identifiers and Expansions of Building Names, System Names and Point Names shall be used for identification. Identifiers shall be not more than 10 alphanumeric characters, and Expansions shall not more than 40 characters.
- .3 The Application Programs shall be assigned with the specified DDC points as indicated on the DDC Input/Output Schedule. In addition, the Application Program shall be assigned with the following point types:
 - .1 Alarm Program with: all space temperature AI points, all supply air temperature AI points, all supply air and return air humidity AI points, all air filter pressure drop AI points, all supply air static pressure AI points, all AI points of heating water supply and return temperature, all AI points of chilled water supply and return temperature, all DI points of fans and pumps.
 - .2 Auto Start/Stop Program with: all DO points of fans and pumps.
 - .3 Run Time Total Program with: all DO points.
 - .4 Heavy Equipment Delay Program with: all DO points of motors of 15 kw and larger.
 - .5 PID Control Program with: all AO points of control valves (except terminal heating control valves and radiation control valves) and control dampers (except terminal zone control dampers).
 - .6 Analog/PI Total Program with all AI or PI points of water meters and energy meters.
- .4 All DI or DO points assigned with "alarm" and "run time total" programs shall be provided with "critical" and "maintenance" alarms. All AI or AO points assigned with "alarm" program shall be provided with "critical" and "cautionary" alarms.

3.4 INSTALLATION OF SENSORS

- .1 Install sensors in accordance with the manufacturer's recommendations.
- .2 Sensors used in mixing plenums shall be the averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.
- .3 Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 3 m of sensing element for each 1 m² of cross section area.
- .4 All pipe mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat conducting fluid in thermal wells.

- .5 Outdoor air temperature sensors shall be installed on north wall, complete with sun shield at designated location.
- .6 Building static pressure sensors: Pipe the low pressure port of the differential air static pressure sensor to the static pressure port located on the outside of the building through a high volume accumulator. Pipe the high pressure port to a location behind a thermostat cover.
- .7 Supply duct static pressure sensor: Pipe the high pressure tap of the differential air static pressure sensor to the duct using a pitot tube. Pipe the low pressure port to a tee in the high pressure tap tubing of the corresponding building static pressure sensor.

3.5 INSTALLATION OR ACTUATORS

- .1 Install actuators in accordance with the manufacturer's recommendations.
- .2 Electronic dampers: Actuators shall be direct mounted on damper shaft or jackshaft unless shown as a linkage installation. For low leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.
- .3 Electronic Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.6 SEQUENCE OF OPERATION FOR MULTI-ZONE VAV BOXES

- .1 Provide the multi-zone VAV boxes with LCU controllers. The VAV box damper shall be modulated to maintain the duct static pressure setpoint (adjustable from EMCS with initial setpoint of 85 Pa).
- .2 Each individual zone damper shall be modulated to maintain a desired airflow set at the individual DDC thermostat with the occupant adjustable range between 20°C to 26°C (range to be adjustable from EMCS) and a maximum position of 100% (adjustable from EMCS).
- .3 The individual DDC thermostat shall display the current temperature and setpoint, and allow the occupant to make adjustment of the setpoint.
- .4 Optional perimeter radiation or terminal reheat control valve: the individual DDC thermostat shall through the LCU controller to modulate the zone control damper and the zone heating control valve in sequence to maintain the zone heating setpoint (adjustable from EMCs with initial setpoint of 21°C).

3.7 SEQUENCE OF OPERATION FOR CONVENTIONAL SINGLE-ZONE VAV BOXES

- .1 Provide each single-zone VAV boxes with a TCU controller. The VAV box damper shall be controlled within user defined maximum and minimum supply airflow settings.

- .2 The TCU monitors the room temperature sensor and the airflow velocity sensor and modulates the box damper to maintain the desired room temperature setpoint at the room DDC thermostat (adjustable from EMCS).
- .3 Optional perimeter radiation or terminal reheat control valve: the room DDC thermostat shall through the LCU controller to modulate the zone control damper and the zone heating control valve in sequence to maintain the zone heating setpoint (adjustable from EMCS with initial setpoint of 21°C).

END OF SECTION

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (27th Edition), Safety Standard for Electrical Installations.
 - .2 CAN3-C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE 100, The Authoritative Dictionary of IEEE Standards Terms.

1.2 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE 100.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for electrical equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .3 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .4 Submit two (2) copies of 600 x 600 mm minimum size drawings and product data to inspection authorities.
 - .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Certificates:
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such material and equipment to inspection authorities for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.

- .4 Permits and fees: in accordance with Authority having jurisdiction of contract.
- .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
- .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.

1.4 **CLOSEOUT PROCEDURES**

- .1 Submit in accordance with Section 01 77 00 - Closeout Procedures.
- .2 Operation and Maintenance Data: submit operation and maintenance data for electrical equipment for incorporation into manual.
 - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .2 Operating instructions to include following:
 - .3 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .4 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .5 Safety precautions.
 - .6 Procedures to be followed in event of equipment failure.
 - .7 Other items of instruction as recommended by manufacturer of each system or item of equipment.

1.5 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

PART 2 **PRODUCTS**

2.1 **DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

- .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates for control items in English.

2.2 MATERIALS AND EQUIPMENT

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

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Section 26 29 03 - Control Devices except for conduit, wiring and connections below 50 V which are related to control systems as shown on mechanical drawings or specified in mechanical sections.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of Departmental Representative and inspection authorities.
- .2 Decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

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

2.6 EQUIPMENT IDENTIFICATION

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

.2 Sizes as follows:

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

- .2 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per nameplate.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Terminal cabinets and pull boxes: indicate system and voltage.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Pre-paint boxes, couplings and connectors.
- .3 Colours:

Type	Prime	Auxiliary
up to 250 V	Yellow	
Telephone	Green	
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.9 FINISHES

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

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.3 NAMEPLATES AND LABELS

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

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000mm, and information is given before installation.

3.5 MOUNTING HEIGHTS

- .1 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .2 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local Switches: 1100mm
 - .2 Wall Receptacles:
 - .1 General: 450mm (400mm min to bottom of device)
 - .2 Above top of counter or counter splash back: 175mm
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 450mm (400mm min to bottom of device).
 - .5 Wall mounted telephone and interphone outlets: 1100mm.
 - .6 Emergency lights: Not less than 2000mm above finished floor where practical.

3.6 **CO-ORDINATION OF PROTECTIVE DEVICES**

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

3.7 **FIELD QUALITY CONTROL**

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (heating) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and it's controls
 - .4 Motors, heaters and associated control equipment including sequence operation of systems where applicable
 - .5 Systems: Fire alarm system communications.
 - .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Submit test results for consultant's review.

3.8 **SYSTEM STARTUP**

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

3.9 **CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes requirements for selective demolition and removal of electrical, safety, security and communications components including removal of conduit and junction boxes back to electrical panels (source) and incidentals required to complete work described in this Section to ready the site for new construction.

1.2 RELATED REQUIREMENTS

- .1 Section 02 41 19– Selective Interior Demolition

1.3 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures

1.4 DEFINITIONS

- .1 Demolish: Detach items from existing construction and legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .2 Remove: Planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel taking care not to damage adjacent assemblies designated to remain; legally dispose of items off site, unless indicated as removed and salvaged, or removed and reinstalled.
- .3 Remove and Salvage: Detach items from existing construction and deliver them to Departmental Representative ready for reuse.
- .4 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
- .5 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .6 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB s, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Action Submittals: Provide in accordance with Section 01 33 00– Submittal Procedures before starting work of this Section:
 - .1 Construction Waste Management Plan (CWM Plan): Submit plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19 – Waste Management and Disposal.

- .2 Landfill Records: Indicate receipt and acceptance of selective demolition waste and hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.6 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.
- .2 Scheduling: Account for level 8 user's continued occupancy requirements during selective demolition with Section 02 41 19 - Selective Interior Demolition and schedule staged occupancy and worksite activities as a defined in Critical Path in Section 01 32 16 - Construction Progress Schedule - Critical Path Method (CPM).

1.7 QUALITY ASSURANCE

- .1 Regulatory Requirements: Perform work of this Section in accordance with:
 - .1 Federal Workers' Compensation Service
 - .2 Occupational Health and Safety Standards and Programs

1.8 SITE CONDITIONS

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition at time of site examination before tendering.
- .2 Existing Hazardous Substances: Departmental Representative performed a hazardous substances assessment and it is not expected that hazardous substances will be encountered in Work through out the ninth-floor space.
- .3 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform following activities:
 - .1 Refer to Section 01 14 25– Designated Substance Report for directives associated with specific material types.
 - .2 Hazardous substances will be as defined in Hazardous Products Act.
 - .3 Stop work in area of suspected hazardous substances.
 - .4 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb.
 - .5 Hazardous substances will be removed as a change to Work.
 - .6 Proceed only after written instructions have been received from Departmental Representative.

1.9 SALVAGE AND DEBRIS MATERIALS

- .1 Demolished items become Contractor's property and will be removed from Project site; except for items indicated as being reused, salvaged, or otherwise indicated to remain Owners property.
- .2 Carefully remove materials and items designated for salvage and store in a manner to prevent damage or devaluation of materials in accordance with Section 02 41 19 – Selective Interior Demolition.

- .1 Leave main electrical distribution panels in place.
- .2 Leave main telephone terminal backboard in place; panel can be used for temporary construction telephone system for this and subsequent contracts in accordance with Section 01 51 00 – Temporary Utilities, coordinate temporary telephone connections with Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 General Patching and Repair Materials: Refer to Section 02 41 19 - Selective Interior Demolition for listing of patching and repair materials incidental to removal or demolition of components associated with work of this Section.
- .2 Electrical Repair Materials: Use only new materials, CSA or ULC labelled as appropriate and matching components remaining after work associated with components identified for removal or demolition are completed.
- .3 Fire stopping Repair Materials: Use fire stopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire rated performance.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Existing Conditions: Visit site, thoroughly examine and become familiar with conditions that may affect the work of this Section before tendering the Bid; Departmental Representative will not consider claims for extras for work or materials necessary for proper execution and completion of the contract that could have been determined by a site visit.

3.2 PREPARATION

- .1 Protection of Existing Systems to Remain: Protect systems and components indicated to remain in place during selective demolition operations and as follows:
 - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
 - .2 Notify Departmental Representative and cease operations where safety of buildings being demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition work specified in this Section.
 - .3 Prevent debris from blocking drainage inlets.
 - .4 Protect mechanical systems that will remain in operation.
- .2 Protection of Building Occupants: Sequence demolition work so that interference with the use of the building by the Owner and users is minimized and as follows:
 - .1 Prevent debris from endangering safe access to and egress from occupied buildings.

- .2 Notify Departmental Representative and cease operations where safety of occupants appears to be endangered and await additional instructions before resuming demolition work specified in this Section.

3.3 **EXECUTION**

- .1 Demolition: Coordinate requirements of this Section with information contained in Section 02 41 19 - Selective Interior Demolition and as follows:
 - .1 Disconnect electrical circuits; maintain electrical service and main distribution panels as is, ready for subsequent Work.
 - .2 Remove existing luminaires, electrical devices and equipment including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
 - .3 Disconnect and remove existing fire alarm system components including associated conduits, boxes, wiring, and similar items unless specifically noted otherwise.
 - .4 Disconnect and remove communication systems including associated conduits, boxes, cabling, and similar items unless specifically noted otherwise.
 - .5 Disconnect and remove telephone outlets, associated conduit, cabling and sub terminal backboards and related accessories; maintain telephone service and main terminal backboard as is.
 - .6 Perform demolition work in a neat and workmanlike manner:
 - .1 Remove tools or equipment after completion of work, and leave site clean and ready for subsequent renovation work.
 - .2 Repair and restore damages caused as a result of work of this Section to match existing materials and finishes.
 - .7 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
 - .8 Grind off conduits and make flush with surface of concrete where conduits are cast into concrete; seal open ends of conduit with silicone sealant and leave in place.
 - .9 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

3.4 **CLOSEOUT ACTIVITIES**

- .1 Demolition Waste Disposal: Arrange for legal disposal and remove demolished materials to accredited provincial landfill site or alternative disposal site (recycle centre) except where explicitly noted otherwise for materials being salvaged for re use in new construction in accordance with Section 01 74 19– Waste Management and Disposal.
- .2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances in accordance with requirements of Section 01 14 25 – Designated Substance Report and Section 01 41 19 – Selective Interior Demolition.

END OF SECTION

PART 1 **GENERAL**

1.1 **REFERENCE STANDARDS**

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.18.3-12(R2017), Conduit, Tubing and Cable Fittings (Tri-national Standard, with ANCE NMX-J-017 and UL514B)
 - .2 CAN/CSA-C22.2 No.65-18, Wire Connectors (Tri-National Standard with UL 486A-486B).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2-1961, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

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

1.3 **CLOSEOUT PROCEDURES**

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

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

PART 2 **PRODUCTS**

2.1 **MATERIALS**

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:
 - .1 Connector body and stud clamp for conductors copper.
 - .2 Clamp for copper conductors.
 - .3 Bolts for copper conductors.
 - .4 Sized for conductors as required.

PART 3 **EXECUTION**

3.1 **EXAMINATION**

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

3.2 **INSTALLATION**

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

3.3 **CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

PART 1 PRODUCTS

1.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Non Jacketted.

1.2 TECK 90 CABLE

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Cross-linked polyethylene XLPE.
 - .2 Rating, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: aluminum interlocking.
- .6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .7 Fastenings:
 - .1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 900 mm centers.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .8 Connectors:
 - .1 Watertight, approved for TECK cable.

1.3 ARMOURED CABLE

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

PART 2 EXECUTION

2.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform insulation tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

2.2 GENERAL CABLE INSTALLATION

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.

2.3 INSTALLATION OF BUILDING WIRES

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

2.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)

- .1 Group cables wherever possible on channels.
- .2 Install cable exposed, securely supported by straps.

2.5 INSTALLATION OF ARMoured CABLE

- .1 Group cables wherever possible on channels.

END OF SECTION

PART 1 GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

1.2 CLOSEOUT SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

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

PART 2 PRODUCTS

2.1 EQUIPMENT

- .1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.
- .2 Insulated grounding conductors: green, copper conductors, size as indicated.

PART 3 EXECUTION

3.1 EXAMINATION

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

- .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .2 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed Departmental Representative.

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, control panels, distribution panels, electric heaters, etc.

3.4 FIELD QUALITY CONTROL

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

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

1.2 DELIVERY, STORAGE AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT CHANNELS

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

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 **INSTALLATION**

- .1 Secure surface mounted equipment with screws or bolts with washer standoffs (6 mm gap).
- .2 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .3 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
- .4 For surface mounting of two or more conduits use channels at 900 mm on centre spacing.
- .5 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .6 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .7 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .8 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.3 **CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1, 27th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer s printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 JUNCTION AND PULL BOXES

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

2.2 CABINETS

- .1 Construction: welded sheet steel hinged door, latch and catch

Part 3 Execution

3.1 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.2 IDENTIFICATION

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

END OF SECTION

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA International)
- .2 CSA C22.1-18, Ontario Electrical Code, Part 1, 27th Edition.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit samples for floor box in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

PART 2 PRODUCTS

2.1 OUTLET AND CONDUIT BOXES GENERAL

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

2.2 GALVANIZED STEEL OUTLET BOXES

- .1 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 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 duplex receptacles. Minimum depth: 73mm for receptacles and communication outlets.

2.4 **CONDUIT BOXES**

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

2.5 **FITTINGS - GENERAL**

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

PART 3 **EXECUTION**

3.1 **INSTALLATION**

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

END OF SECTION

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2 No. 18.1-13(R2018) Metal Outlet Boxes, etc.
 - .2 CSA C22.2 No. 56-17, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
 - .3 CSA C22.2 No. 83.2-07 (R2017), Electrical Metallic Tubing-Steel.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

PART 2 PRODUCTS

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.

2.2 CONDUITS

- .1 Electrical Metallic Tubing (EMT): to CSA C22.2 No. 83.1, with couplings.
- .2 Rigid Metal Conduit: to CSA C22.2 No. 45.1
- .3 Flexible Metal Conduit: to CSA C22.2 No. 56, Aluminum Liquidtight Flexible Metal.

2.3 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA-C22.2 No. 18.1, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for NPS 1 25 mm and larger conduits.

2.4 **FISH CORD**

- .1 Polypropylene.

PART 3 **EXECUTION**

3.1 **MANUFACTURER'S INSTRUCTIONS**

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

3.2 **INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.
- .3 Minimum conduit size for lighting and power circuits: 21 mm NPS 3/4.
- .4 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .5 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .6 Dry conduits out before installing wire.
- .7 Install fishcords in empty conduits

3.3 **SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Group conduits wherever possible on surface channels.

3.4 **CONDUITS IN DAMP LOCATIONS**

- .1 Duct seal conduits to prevent water and condensation from entering raceway.

3.5 **CONDUITS CONCEALED**

- .1 Use EMT conduits with compression couplings.

3.6 **CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

- .3 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

PART 1 **GENERAL**

1.1 **REFERENCE STANDARDS**

- .1 CSA Group (CSA)
 - .1 **CAN/CSA C22.1 No.126.1-17**, Metal Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 **NEMA VE 1-2017**, Metal Cable Tray Systems.
 - .2 **NEMA VE 2-2013**, Cable Tray Installation Guidelines.

1.2 **ACTION AND INFORMATIONAL SUBMITTALS**

- .3 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .4 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .5 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .6 Show actual cable tray installation details and suspension system.

1.3 **WASTE MANAGEMENT AND DISPOSAL**

- .7 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

PART 2 **PRODUCTS**

2.1 **CABLE TRAY**

- .8 Cable trays and fittings: to NEMA VE 1 and **CAN/CSA C22.1 No.126.1**.
- .9 Ladder type, Class C1 to **CAN/CSA C22.2 No.126.1** or to match existing cable traying class.
- .10 Trays: to match existing 610mm wide with depth of 152mm.
- .11 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reducers where required, manufactured accessories for cable tray supplied.
 - .1 Radii on fittings: 610mm minimum.
- .12 Ground cable trays with #2 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.
- .13 Fire stop system at penetrations of fire separations in accordance with Section 07 84 00 - Fire Stopping.

2.2 **SUPPORTS**

- .14 Provide splices, supports for a continuously grounded system as required.

PART 3 EXECUTION

3.1 INSTALLATION

- .15 Install complete cable tray system in accordance with **NEMA VE 2**.
- .16 Support cable tray on both sides.
- .17 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

END OF SECTION

Part 1 GENERAL

1.1 SPECIAL REQUIREMENTS

- .1 This project requires a special enhanced electrical commissioning.
- .2 One of the commissioning requirements is that the Electrical Contractor must provide full assistance to the independent System Commissioning Administrator (SCA) hired by the Contractor to coordinate and organize all Pre-Commissioning Testing, Commissioning Testing, and O&M Training. More information on roles and responsibilities of the SCA is provided in Section 01 91 13 and Mechanical Contractor must refer to the above Section.
- .3 A total of 4% of the electrical construction price will be held back by PSPC for unfinished commissioning work.

1.2 RELATED SECTIONS

- .1 Section 01 78 00 - Closeout Submittals.
- .2 Section 01 79 00 – Demonstration and Training.
- .3 Section 01 79 00.13 – Demonstration and Training – Building Commissioning.
- .4 Section 01 91 13 – General Commissioning Requirements.
- .5 Section 23 08 00 – Mechanical Commissioning.
- .6 Section 01 91 13.16 – Commissioning Forms
- .7 Section 20, 21,22,23 & 25 – Mechanical Specification for Fire Protection, Plumbing, HVAC and Integrated Automation.
- .8 Section 01 26, 27 & 28 – Electrical Specification for Lighting and Power Systems, Security System Structured Cabling, Audio Visual, Security System, Access Control and Fire Alarm Systems.

1.3 COMMISSIONING PROCESS

- .1 "Commissioning" for this project is defined as a planned program of activities which enhance quality management and information transfer that extends throughout all stages of project delivery.
- .2 Commissioning activities shall include the standard activities and the enhanced activities which are traditionally not provided by the design and construction industry and which are defined in this document.

1.4 REFERENCE STANDARDS

- .1 The most stringent requirements of the following commissioning standards and guidelines shall apply:
 - .1 CSA C282-15: Emergency Electrical Power Supply for Buildings.
 - .2 CSA C22.1-18: Canadian Electrical Code.

- .3 CAN/ULC-S536-97: Standard for the Inspection and Testing of Fire Alarm Systems.
- .4 CAN/ULC-S537-97: Standard for the Verification of Fire Alarm Systems.
- .5 CAN/ULC-60839-11-1: Alarm and Security Systems.
- .6 CSA Z320-11 (2016), Building Commissioning.

1.5 ROLES AND RESPONSIBILITIES

- .1 The key members of the commissioning team include the Contractor, the Consultant, and the PSPC Commissioning Manager (or its representative).
 - .1 It is the Electrical Contractor's responsibility to engage a qualified independent System Commissioning Administrator (SCA) to represent the Contractor including the Sub-Contractors. The SCA shall be responsible for carrying out the Contractor's commissioning activities under the direction of the Consultant.
 - .2 The PSPC Commissioning Manager (or its representative) will be assisted by other project team members for providing an overview of the commissioning activities. The PSPC Commissioning Manager is the final Authority responsible to approve the completion of Commissioning process performed by the Contractor for this project.
 - .3 The Electrical Contractor and its sub-trades shall fully co-operate and assist the PSPC Commissioning Manager (or its representative), SCA and Consultant in performing the system performance verification process and document review throughout the construction, commissioning and operation phases of the project.
- .2 The Electrical Contractor is responsible for the following standard commissioning activities and enhanced commissioning activities during project construction, commissioning and operation phases.
 - .1 Construction Phase:
 - .1 Review Commissioning Plan submitted by the SCA and assist in complying with the requirements.
 - .2 Submit Commissioning Schedule in line with master Construction Schedule.
 - .3 Participate in all commissioning meetings with the sub-trades as required.
 - .4 Submit shop drawings.
 - .5 Conduct startup tests and submit test reports.
 - .6 Perform all required tests and submit reports.
 - .7 Complete equipment and devices Installation Checklists.
 - .2 Commissioning Phase:
 - .1 Participate in all commissioning meetings with the sub-trades as required.
 - .2 Arrange for the suppliers and third-party agencies to inspect all relevant electrical systems installation and testing.
 - .3 Arrange for local authority inspection to obtain approval for all relevant system installation and operation.
 - .4 Conduct Functional Performance Testing under direction from the SCA.

- .5 Demonstrate system operation to Consultant Commissioning Manager and PSPC Commissioning Manager.
- .6 Submit Maintenance Manuals (formerly called O&M Manuals).
- .7 Schedule and Conduct O&M training and submit training documentation.
- .8 Promptly rectify all deficiencies identified by the SCA and Consultants documented in Commissioning Issues Log throughout the commissioning process.
- .9 Submit Commissioning Records of all Systems.
- .3 Contractor's Responsibilities during Operation Phase:
 - .1 Participate in commissioning meetings with the sub-trades as required.
 - .2 Promptly rectify all deficiencies identified by the SCA and Consultants.
 - .3 Provide specified inspection and maintenance services during warranty period.
 - .4 Provide warranty inspection and service reports for review.
- .3 The Consultant and Consultant's Commissioning Manager will carry out the following activities related to the Construction and Commissioning process:
 - .1 Review and approve shop drawings.
 - .2 Review and inspect installation, and prepare construction deficiencies report.
 - .3 Review and approve System Startup Verification Testing.
 - .4 Review and approve System Functional Testing Reports.
 - .5 Witness functional performance of System Operations after the Contractor's SCA has completed their verification.
 - .6 Review commissioning documentation submitted by the Contractor and SCA.
 - .7 Review and approve Maintenance Manuals.
 - .8 Review and approve "As-Built" drawings and specifications.
 - .9 Review Contractor's O&M training schedule and approve training documentation submitted by Contractor.
 - .10 Review and approve post-acceptance fine-tuning and warranty services report.
- .4 The PSPC Commissioning Manager (or its representative) will carry out the following commissioning activities related to the Contractor and the Consultant as required:
 - .1 Provide Commissioning Oversight of the commissioning process.
 - .2 Witness Functional Performance Testing conducted by the Contractor at their discretion and review test reports as required.
 - .3 Review O&M training conducted by the Contractor as required.
 - .4 Review commissioning documentation submitted by the Contractor and Consultant, as required.
 - .5 Witness the post-acceptance commissioning testing conducted by the Contractor and review test reports, as required.

1.6 SCHEDULING

- .1 Within 15 working days of Contract Award, the Contractor shall submit bar chart commissioning schedules indicating anticipated date of start, duration, and date of completion for the following key activities:

- .1 Scheduling Commissioning Meetings.
 - .2 Submission of Shop Drawings.
 - .3 Pre-startup installation inspections and tests.
 - .4 System and Equipment Startup and Verification.
 - .5 Functional Performance Test.
 - .6 O&M manuals.
 - .7 "As-Built" drawings and specifications.
 - .8 O&M Training.
- .2 A bar chart commissioning schedule shall be prepared for each component, equipment, sub-system, system and integrated system to be commissioned as listed under paragraph 1.10.
- .3 The Commissioning shall be carried out to meet the approved project schedule.

1.7 CONTRACTOR'S COMMISSIONING DOCUMENTATION

- .1 The Mechanical Contractor's Commissioning Documentation shall include the following:
- .1 Commissioning Schedule.
 - .2 Minutes of commissioning meetings.
 - .3 Shop drawings and Product Information (PI) Report forms.
 - .4 Installation inspection and test reports.
 - .5 Megger and Grounding Test Reports.
 - .6 Startup Checklists.
 - .7 Fire Alarm Verification Report.
 - .8 Product Information (PI) Report forms.
 - .9 Commissioning Deficiencies/Issues Log.
 - .10 "As-Built" drawings and specifications.
 - .11 Maintenance Manuals.
 - .12 O&M Training Schedule.
 - .13 O&M Training Report.

1.8 PRE-COMMISSIONING TESTING - STARTUPS

- .1 Requirements of Pre-commissioning Verification: range of checks and tests to determine that all components, equipment, systems, and interfaces between systems (e.g. emergency, fire, and life safety) operate in accordance with contact documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.
- .2 The Startup Checklists and PI Report forms shall be completed by the Contractor and verified by the Consultant.
- .3 A few sample commissioning forms are provided in Section 01 91 13.16 for reference.

1.9 COMMISSIONING TESTING

- .1 Commissioning Testing shall include System Operation Demonstration and Functional Performance Testing of mechanical systems. Test each system independently and then in unison with integrated systems.
- .2 Functional Performance Testing (FPT) shall determine if the electrical system is providing the required functionality in accordance with the finalized design intent. If any identified performance deficiencies need to be corrected, the tests shall be repeated after corrective work is carried out, and this process shall continue until acceptable performance is achieved.
- .3 The Functional Performance Tests forms shall be created and completed by the SCA and verified by the Consultant's Commissioning Manager and PSPC Commissioning Manager (or its representative).

1.10 EXTENT OF COMMISSIONING

- .1 Systems to be commissioned with the comprehensive commissioning to include:
 - .1 Lighting and Power Systems.
 - .2 Fire Alarm System.
 - .3 Security and Access Control System.
 - .4 Audio Visual System.
 - .5 Structured Cabling.
 - .6 Interface portion of the associated mechanical and other building systems.

1.11 MAINTENANCE MANUALS

- .1 Electrical Contractor shall submit Maintenance Manuals for electrical equipment and systems.
- .2 Maintenance Manuals shall initially be submitted to the Consultants, Owner and SCA for review. Final submission of Maintenance Manuals shall occur once all comments from the reviewers are attended by the Contractor.
- .3 Refer to other relevant Sections for further requirements on Maintenance Manuals.

1.12 O&M TRAINING

- .1 The Electrical Contractor shall provide qualified training instructors to conduct O&M training.
- .2 Refer to Section 01 79 00 and 01 79 00.13 for detailed requirements on O&M training.

1.13 UNFINISHED COMMISSIONING WORK

- .1 Prior to the "Interim Certificate of Completion" a total of 4% of the mechanical construction price will be held back by PSPC Project Manager until the acceptable Functional Performance Testing, O&M Training, and commissioning documentation have been completed.

1.14 ADDITIONAL COMMISSIONING REQUIREMENTS

- .1 Refer to other specification sections for additional commissioning requirements.

Part 2 PRODUCTS

2.1 NOT USED

- .1 Not used.

Part 3 EXECUTION

3.1 FUNCTIONAL TESTING AND ACCEPTANCE

- .1 Functional Performance Testing for a specific piece of equipment or system shall not be executed until the start-up process for that equipment or system has been completed and the start-up report is submitted for review and acceptance.
- .2 The SCA shall submit the completed functional test sheet to PSPC Commissioning Manager (or its representatives) and Consultant Commissioning Manager for review and approval.
- .3 Performance of the Systems Operation shall be demonstrated to the Consultant team for acceptance.
- .4 The Corrections or Deficiencies identified during the tests and recorded in Commissioning Deficiencies/Issues Log by SCA shall be promptly rectified by the Electrical Contractor.
- .5 The Electrical Contractor shall retest the equipment/system operation once the identified deficiencies are resolved as necessary. After functionality of all required systems are verified and demonstrated with no deficiencies identified, the functional testing activities would be considered as completed for review and acceptance.

END OF SECTION

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (27th Edition), Safety Standard for Electrical Installations.
 - .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE 100, The Authoritative Dictionary of IEEE Standards Terms.

1.2 DEFINITIONS

- .1 LCS: The term 'Lighting Control System' is defined as the interconnected set of hardware and software components that collectively serve to regulate the illumination levels of an interior and/or exterior space. The components that comprise the LCS are sub-categorized into four groups: LCS input devices, LCS end devices, LCS control equipment and LCS software and integration
- .2 DALI: Digital Addressable Lighting Interface used to transmit data to and from LCS input devices, LCS end devices and control equipment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for lighting control equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Complete list of all parts needed to install the digital addressable LCS.
- .3 Shop drawings:
 - .1 Floor Plans: Location, orientation and coverage area of each sensor, group designations and other specific design symbols and designations as required to define the installation, location and configuration of all control devices.
 - .2 Address Drawing: Reflected ceiling plan and floor plans, showing data-bus-connected devices, address for each device and device groups. The plans shall be based on construction plans, using the same legend, symbols and schedules.
 - .3 Point List and Data Bus Load: Summary list of all control devices, sensors, LED drivers and other loads connected to each data bus and total connected load for each data bus. Include percentage of rated connected load and device addresses.
 - .4 Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with drawings and block diagram. Differentiate between manufacturer- installed and field-installed wiring.

- .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .6 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other sections
 - .1 Show interconnecting signal and control wiring, as well as, interface devices that prove compatibility of inputs and outputs
- .7 Field quality-control reports.
- .8 Sample Warranty: For manufacturer's special warranty
- .9 Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

1.4 CLOSEOUT PROCEDURES

- .1 Submit in accordance with Section 01 77 00 - Closeout Procedures.
- .2 Operation and Maintenance Data: submit operation and maintenance data for lighting control equipment for incorporation into manual.
 - .1 Describe system features, operation and architecture in electronic and printed documentation. Include user account information, network access information and technical support contact information. All project-specific documentation shall be made available on a password protected section of the manufacturer's website, upon request of the end user.
 - .2 Software and Firmware Operational Documentation.
 - .1 Software operating and upgrade manuals
 - .2 Program Software Backup: On magnetic media or compact disk, complete with data files
 - .3 Device address list
 - .4 Printout of software application and graphic screens

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store products in manufacturer's unopened packaging until ready for installation.
 - .2 Include installation, programming and maintenance instructions.
 - .3 Do not install equipment until the following conditions can be maintained in spaces to receive equipment.
 - .1 Ambient Temperature:
 - .1 LCS: 0° C to 40° C (32° F to 104° F).
 - .2 System computer: 10° C to 35° C (50° F to 90° F).

- .3 Relative humidity: Maximum 90%, non-condensing
- .4 LCS must be protected from dust during installation.
- .5 Do not install products under environmental conditions outside manufacturer's absolute limits.
- .6 Do not install sensors until building is operating at ambient temperature and humidity ranges that are consistent with those intended for buildings ultimate use.

1.6 **WARRANTY**

- .1 Manufacturer's Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
 - .1 Warranty Periods:
 - .1 A limited three (3) year warranty on all other hardware components of the LCS designed.
 - .2 A limited one (1) year warranty on the Lighting Management Software.

PART 2 **PRODUCTS**

2.1 **SYSTEM DESCRIPTION**

- .1 Operation: Input signal from digital signal sources switch or dim DALI devices associated with LED drivers and other LCS end devices.
 - .1 Each device and relay is connected to a digital data bus.
 - .2 Each DALI device and relay has a digital address and be operated by a digital signal.
 - .3 Each device or relay can be assigned to any or all of 16 available groups connected to a single data bus.
 - .4 Each LED driver may have as many as 16 preset lighting levels or scenes. Scenes can be programmed to LED drivers and may be applied to groups.
- .2 Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application.
- .3 Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- .4 Comply with protocol described in IEC 60929, Annexes E and G, for DALI lighting control devices, wiring and computer hardware and software.
- .5 Comply with UL 916.
- .6 Comply with UL 924.

2.2 **PERFORMANCE REQUIREMENTS**

- .1 DALI Requirements:
 - .1 Components: Individually addressable devices (such as LED drivers, relays, dimmers and switches) that are operated from digital signals received through a DALI-compliant bus, from data-entry and retrieval devices (such as PCs,

personal digital assistants, hand-held infrared programming devices, wired Ethernet hubs, wireless IEEE 802.11 hubs). Devices also report status to data-entry and retrieval devices through the bus.

- .2 Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component shall be automatically isolated and not affect global system functions.

.2 System Requirements

- .1 Emergency Default: The LCS and lighting end devices must revert to a safe and acceptable default state in the event of a loss of the DALI bus situation. In order for the default state to be considered safe and acceptable, it must meet the following specifications:
 - .2 Loss of Power to Lighting Relays: All relays being used for lighting control must default to the closed (On) position the instant that power is lost to their corresponding lighting circuit. Relays must remain in the closed (On) state until the supply of power is resumed, at which point all relays are to continue to remain in the closed (On) position until commanded otherwise.
 - a. Loss of Power to the Lighting Control Panels: All lighting control panels are to be supplied with power from non-emergency circuits. In the event that power is lost to the lighting control panel, all of the lighting relays and led drivers that are connected to it shall revert to the full power (On) state and remain in this state until power is restored and they are commanded otherwise.
 - b. Loss of Power to Emergency Circuits: In the event that power is lost to the emergency circuits, all lighting relays that are supplied by emergency fixtures shall automatically revert to the default closed (On) position. When backup power is activated, all relays that are supplied by emergency fixtures shall be in the closed (On) state and are to remain in this state until commanded otherwise. All led drivers that are supplied by emergency circuits shall revert to the full power state and remain in this state the instant that backup power is activated until commanded otherwise.
 - c. Tamper Proof Settings: The default settings (or any other settings that pertain to the operation of the LCS during emergency conditions) of all lighting control equipment, DALI led drivers and lighting relays shall not be capable of being modified through either a manual or software provision by the user of the LCS.
 - d. UL 924 listed components: The default settings (or any other settings that pertain to the operation of the LCS during emergency conditions) of UL 924 listed components shall not be capable of being modified either manually or via software by the user, person responsible for commissioning or the manufacturer.
2. Central Control: All operating parameters of the LCS shall be configured from a central point of access through a web browser.
3. Remote Access: All operating parameters of the LCS shall be configurable from any computing device with a web browser and an internet browser.
4. User Access: The end user shall be capable of applying administrative rules to

- restrict the access privileges of each user. Access restrictions shall be applicable to the set of fixtures as well as the feature set available for those fixtures.
5. System Clock: The time clock of the LCS shall be synchronized to internet standard time.
 6. Power Failure: The lighting system shall resume operation after a power outage to the state that it would have been in if the power outage had never occurred.
 7. Loss of Communication: DALI devices shall operate at a user-specified level in the event that communication is lost to the control panel.
 8. Time Scheduling: The daily power consumption cycle of each fixture shall be regulated by a programmable scheduling routine.
 9. Daylight Harvesting: The lighting system shall adjust light levels in response to varying ambient light levels in order to maintain a constant, user-specified light level at desk height. Ambient light levels shall be read from a network of daylight sensors that are distributed throughout areas that are candidates for daylight harvesting. Intelligent algorithms shall be used to minimize the number of sensors required.
 - a. Daylight Sensor Groupings: The set of light fixtures that are controlled by a given daylight sensor can span multiple DALI communication busses, shall be configurable through software and shall not require any manual wiring to modify. The system shall allow for light fixtures to be added or removed from given daylight sensor group through web software.
 - .3 Daylight Sensor Settings: All settings that govern the behavior of a given daylight sensor shall be adjustable through web software and shall not require any physical adjustment to the sensor itself.
 - .4 Gradient Dimming: A single daylight sensor working in conjunction with lighting software shall be capable of providing separate control for up to 16 groups of light fixtures. Each group of light fixtures can have unique settings, including the lighting set point, so that location-specific conditions can be accommodated by a single sensor. Gradient dimming will allow for the row of light fixtures closest to the window to dim more than the next closest row of light fixtures (the third closest row dims more than the second closest row and so on for the 4th, 5th...16th rows) even though all rows are controlled by the same single sensor.
 - .5 Electronic Enable/Disable: The daylight sensor shall be enabled and disabled through software in order to manage its operation on a scheduled daily basis.
 - .3 Personal Control: Users shall customize the lighting levels in their own workspace. Building Management can apply restrictions to the range of lighting levels that can be programmed by each occupant to ensure conservation target are met. Access is provided from any computer or hand-held device that is connected to the internet. The light level of each fixture shall be controllable from 0-100%, in increments of 1%, for a specified duration of time.
 - .1 Number of Simultaneous Users: The system shall accommodate a minimum of five hundred (500) simultaneous web users.

- .2 Support Web Browsers: Microsoft Internet Explorer 11 or higher, Google Chrome 40 or higher.
- .4 Occupancy Detection: The system shall reduce the power consumption in vacant areas by reading the status of a network of low voltage occupancy sensors.
 - .1 DALI Occupancy Sensor Wiring: DALI capable occupancy sensors shall be wired directly to the two-wire DALI communication bus.
 - .2 Low Voltage Occupancy Sensor Wiring: Low voltage occupancy sensors shall be wired to the DALI Powerpack as defined by the sensor type. This permits the Low Voltage Occupancy Sensor to obtain an individual DALI address.
 - .3 Occupancy Sensor Groupings: The set of light fixtures that are controlled by a given occupancy sensor can span multiple DALI communication buses, shall be configurable through software and shall not require any manual wiring. The system shall allow for light fixtures to be added or removed from given occupancy sensor group through web software.
 - .4 Occupancy Sensor Settings: All settings that govern the behavior of a given occupancy sensor shall be adjustable through web software and shall not require any physical adjustment to the sensor itself.
 - .5 Occupancy Sensor Levels: Each occupancy sensor shall have a total of five (5) programmable lighting levels. These levels are defined as follows:
 - .1 Occupied Level: The Occupied Level represents the light level that fixtures will be commanded to when occupancy is detected. Light levels will remain at the Occupied Level until occupancy is no longer detected.
 - .2 Transition Levels: Transition Levels provide a gradual change in light levels when occupancy is no longer detected. Three (3) Transition Levels, each of which can be programmed with different light levels and timer values shall be provided.
 - .3 Vacancy Level: The Vacancy Level represents the light level that fixtures will be commanded to when occupancy is no longer being detected and all Transition Levels have expired.
 - .4 Electronic Enable/Disable: The occupancy sensor shall be enabled and disabled through software in order to manage its operation on a scheduled daily basis.
- .5 Monitoring: The operational status of all system hardware and software components shall be routinely checked. Faults with led drivers and every other component of the system shall be automatically detected and electronic notifications shall be distributed. These notifications clearly illustrate the location of the device on the floor plan and the time that the fault was detected.
- .6 Reporting: The energy consumption of the lighting system shall be viewed, tracked and recorded. Data shall be charted according to user-defined zones, which can be as small as an individual fixture or as large as a portfolio of buildings. Savings shall be presented in terms of energy, dollars and greenhouse gas emissions (if requested). The data presented is a computed value and does not require the installation of additional hardware.

Alternatively, this software can be integrated with a physical metering system to present revenue grade energy measurements.

- .7 Partitioning: The system shall allow users to define a space as a partitioned space. Users can define partitioned areas with up to four (4) sub-areas per partitioned area with specific control strategy for each sub-area. When the partitions/dividers are open, the space is used as one large room. When the partitions/dividers are close, each sub-area has a dedicated lighting control.
- .8 Load Shedding: The system shall allow the building manager to apply a customized load shed reduction level to select devices. The system shall allow users to lock certain devices so that the light levels cannot be manipulated or overridden by users. Loading shedding shall be triggered via a maintained contact closure signal from an emergency system, PLC or certified OpenADR device.
- .9 Off-Hour Access: The system shall only activate the set of lights required by an occupant to perform their work during the off-hour time period. The system shall avoid turning on an entire quadrant or floor for when only an office, hallway and washroom are required. These lights can be activated in several ways, including a pass card, phone system or web software. Cleaning staff are accommodated by a programmed turn-on and shut-down sequence, which illuminates their work area in successive fashion.
- .10 Zoning: The system shall be capable of configuring zones via software and avert the need to re-wire certain power distribution circuitry and lighting equipment as tenancy patterns change.
- .11 Multi-Building Control: The LCS shall be capable of connecting to an off-site datacenter so that it can be operated as part of a multiple building control network.
 - .1 Data Consolidation: Buildings operating on the multiple building networks shall have all information consolidated to a single report and view on the web interface. This allows for the total energy consumed by all buildings to be displayed in a single graph rather than one graph for each building. Information relating to the all reporting and monitoring functions (as described in this specification) shall be consolidated in this manner.
- .12 Override Management: The system shall be capable of handling several different commands targeted at the same fixture in a manner that is logical, pre-defined and acceptable to the end customer.
- .13 Graphical User Interface: The visual interface of the software shall import the floor plan design file in DXF or DWG format. All lighting fixtures, sensors and other components of the lighting system contained in the floor plan design file shall be recognized by the software and rendered into interactive objects on the graphical user interface.

2.3 INTEGRATION

- .1 Network Convergence
 - .1 The LCS shall transmit data on the same Ethernet Communication Network used for computers, VOIP telephones and other IP devices running in the facility.
 - .2 The LCS shall not incur noticeable latencies by running on the unified network.

- .3 The LCS shall operate with the same network hardware used for routing standard TCP/IP data packets.
 - .4 The LCS server shall be either a physical server installed within an IT space or installed on a virtual machine.
 - .5 The LCS shall not communicate using Multi-Cast or Broadcast IP traffic messages.
 - .6 The LCS shall be capable of using either fixed IP addresses or DHCP and hostnames.
 - .7 The LCS shall utilize up to 2048 bit encryption on all Web Server user sessions and third party Web Service communications.
- .2 BAS Integration
- .1 The integration of the LCS and other Building Automation Systems (BAS) shall meet the objectives listed as follows:
 - .1 Provide the ability to communicate with the BAS via BACnet IP
 - .2 Requires only one network connection per system
 - .3 The BMS system shall be able to discover the following objects via the BACnet Interface shall support the following commands:
 - .1 Read device (DALI device) status
 - .2 Read Lamp status
 - .3 Read Light level
 - .4 Read what override is active
 - .5 Send override to a device
 - .6 Set override type (high priority, normal)
 - .7 Set light level
 - .8 Set duration
 - .9 Calling Preset DALI scene
 - .10 Set scene ID
 - .11 Set duration for a scene
 - .12 Set scene level
 - .13 Read lights on/off status for a group of fixtures
 - .14 Send override to a group of fixtures
 - .15 Set light level for a group of fixtures
 - .16 Read ballast status for a group of fixtures
 - .17 Read lamp status for a group of fixtures
 - .18 Read power consumption for a group of fixtures
 - .19 Set Light level for a group of fixtures via scenes
 - .20 Set the priority of the override command sent to a group of fixtures
 - .21 Read occupancy sensor status

- .22 Read daylight sensor reading

- .3 VOIP Telephone System
 - .1 The LCS shall support the following models of VOIP telephones by publishing an application designed specifically for the unique user interface of each phone:
 - .2 Features:
 - .1 The following user features shall be provided through the VOIP telephone system:
 - .1 Dimming control over lights on a group and individual fixture basis.
 - .2 Scene control over lights on a group and individual fixture basis.
 - .3 Tube fault detection.
 - .4 Service report and dispatch.
 - .3 User Access
 - .1 The set of lights controlled by a given VOIP telephone shall be regulated through a user access policy.
 - .2 The user access policy shall allow for each VOIP telephone to control a unique set of light fixtures.
 - .3 Facility managers shall be able to regulate the set and number of fixtures assigned to a given user.
 - .4 The LCS shall link each user to a VOIP telephone based on the unique identifier of the VOIP telephone.
 - .5 The set of lights controlled by a given VOIP telephone shall be regulated based on the access level of the user associated with the unique identifier of the VOIP telephone.
 - .4 Number of Simultaneous User Connections
 - .1 The LCS shall be capable of supporting five thousand (5,000) simultaneous VOIP telephone connections.
 - .2 The LCS shall not incur noticeable latencies when multiple users send commands through the VOIP telephones at the same time.
 - .5 Wiring
 - .1 The LCS shall connect to the VOIP telephone system through a single Ethernet connection point.
 - .2 The LCS and the VOIP telephone system shall exchange data through an XML Web Services Protocol.
 - .6 User Set Up
 - .1 The LCS shall provide a user set up application consisting of a visual interface that is accessible by the supported web browsers to set up each VOIP telephone user.
 - .2 The user set up application shall import the DXF file and provide a visual mechanism to link each user to their respective lighting fixtures.

- .4 XML Integration

- .1 Transmission of data between the LCS and 3rd party systems using Web Services.
- .2 The XML Integration shall publish all key operating parameters of the LCS for the read and write operations required to implement intelligent integration strategies.
- .3 XML Integration can be used for AV integration, Fire, Security and other 3rd party coordination.
- .4 Control: The XML interface shall provide read/write access to all LCS end devices.
- .5 Shade Integration
 - .1 Transmission of data between the LCS and 3rd party shading systems.
 - .2 Shade control shall be available through BACnet IP for compatible shades and contact closure for all other shades.
 - .3 The LCS shall support the following shade commands (Up, Down, Stop, Position, Tilt) based on shade manufacturer and communication protocol. Users shall be able to send these commands via the DALI Wallstation.
 - .4 The LCS shall communicate to multiple shade manufacturers and support contact closure input.

2.4 CONTROLLER/GATEWAYS

- .1 Lighting Control Panels
 - .1 Internal circuitry shall be protected by a fused receptacle.
 - .2 Shall provide Class I/II NEC separation.
 - .3 Lighting Control Panel shall include a Local Controller to host the web-based software application and data.
 - .4 Lighting Control Panel shall include the DALI Bus Controller as an interface between the web-based software application and lighting led drivers, sensors, keypads and low voltage switches.
 - .5 Lighting Control Panel shall provide 2-way communication to software application via an Ethernet protocol.
 - .6 Lighting Control Panel shall provide 2-way communication to lighting led drivers via the DALI protocol.
 - .7 The Lighting Control Panel shall include the required hardware to interface with low voltage analog devices and maintained or momentary digital devices..
 - .8 Lighting Control Panel shall be mounted in a tamper-proof electrical cabinet.
 - .9 The Lighting Control Panel shall allow remote diagnosis of its operational status.
- .2 Local Controllers
 - .1 Each Lighting Control Panel shall have a Local Controller
 - .2 The Local Controller shall:

- .1 Host the control application as well as the user interface to manage the devices connected to the Lighting Control Panel.
 - .2 Have a configurable IP address
 - .3 Support up to 32 distributed DALI buses.
 - .4 Support up to 256 digital and analogue low voltage devices
 - .5 Provide limited interfaces for integration with building management systems and IP telephony:
 - .1 5 Mobile Users,
 - .2 250 BACnet objects,
 - .3 25 VOIP phone connections.
- .3 Central Manager
- .1 The Central Manager shall acts as a system wide historian and global database that holds the system's event journal.
 - .2 The Central Manager shall allow user to manage the lighting system centrally. All changes made from the Central Manager shall automatically replicate to the local controllers connected to the Central Manager.
 - .3 The Central Manager shall be installed within an IT space or installed on a virtual machine.
 - .4 The Central Manager shall provide data security methods for backup and restore capabilities.
- .4 Virtual Central Manager
- .1 The Virtual Central Manager shall be installed on a VMWare® based virtual machine
 - .2 The Virtual Central Manager shall provide the same functional as the Central Manager.
- .5 The DALI Bus Controller (DBC) links the distributed data buses with a USB connection to the Local Controller. The Local Controller provides computer configuration, control, analysis and maintenance. The DBC and Local Controller operate independently and continue to process local inputs and schedules when disconnected from the LAN. The DBC and Local Controller shall provide local intelligence and features including the following:
- .6 Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.
 - .7 Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.
 - .8 Computer Monitoring and Configuration: The DBC and Local Controller shall allow configuration, monitoring and analysis from PCs on the Ethernet LAN.
 - .9 Each data bus shall have the capacity to control 64 addressable devices, using NFPA 70, Class 2 control circuit.

- .1 Each data bus shall have the capacity to control up to 16 groups and scenes.
- .2 LED indicator lights for Ethernet status (link, send and receive), power-on and LAN failure.
- .3 Linking of switch and sensor inputs to relay and LED driver outputs.
- .4 Viewing relay and LED driver output status.
- .5 Controlling relay and LED driver outputs.
- .6 Setting device addresses.
- .7 Assigning switch and sensor inputs and relay and LED driver output modes.
- .10 Allow connection of the following DALI-compliant addressable devices:
 - .1 Integral luminaire switching and dimming ballast and drivers.
 - .2 Switching relays.
 - .3 0-10V dimming modules.
 - .4 Two-wire dimming modules.
 - .5 Occupancy and photoelectric sensors.
 - .6 Low voltage powerpacks.
 - .7 Wallstations for user interface functionality.

2.5 USER INTERFACE

- .1 Workstation:
 - .1 A laptop PC, with Microsoft Windows operating system and access to the web-based LCS management software.
 - .2 Include licenses, documentation and storage media and licensing for a minimum of five (5) concurrent users.
- .2 DALI Wallstations
 - .1 DALI wallstations shall provide continuous dimming control via a DALI connection to a Lighting Control Panel.
 - .2 DALI Wallstation Wiring: DALI wallstations shall not be part of the DALI bus wiring to the Lighting Control Panel.
 - .3 DALI Wallstation Groupings: The set of light fixtures that are controlled by a given button shall be configurable through software and shall not require any manual wiring. The system shall allow for light fixtures to be added or removed from given groups through web software.
 - .4 DALI Wallstation Settings:
 - .1 All settings that govern the behavior of the wallstation buttons shall be adjustable through the Lighting Management Software and shall not require any physical adjustment to the device itself.
 - .2 The buttons behavior shall be programmable using conditional logic off of a state variable such as time of day or partition status.
 - .3 A button shall support three level toggles, i.e. three different Go to level commands.

- .5 Dynamic Duration: All commands sent from the wallstation shall expire after a specified time period. The duration of this time period shall be programmable, based on the time of day that the wallstation is activated. This will allow for the time duration to differ at various times of day. Each keypad can have a different dynamic duration.
- .6 DALI Wallstation Functionality:
 - .1 DALI wallstations shall provide one touch On/Off functionality as well as press and hold dimming.
 - .2 Different groups of lights shall be assigned to different buttons on each wallstation.
 - .3 The same button can be used to control lights and shades
- .3 Low Voltage Wallstations
 - .1 Low voltage wallstations shall provide continuous dimming control via a low voltage connection to a Lighting Control Panel.
 - .2 Low Voltage Wallstation Wiring: Low voltage wallstations shall not be wired to switch the AC power line nor shall they be wired directly to any lighting led drivers or any other lighting end device. Low voltage wallstations shall only be wired to a low voltage lighting control panel through a multi (X) conductor, low voltage cable that meets the following specifications: 16AWG/X, plenum rated, FT6; where X is the number of buttons on the keypad plus one (1).
 - .3 Low Voltage Wallstation Groupings: The set of light fixtures that are controlled by a given button shall be configurable through software and shall not require any manual wiring. The system shall allow for light fixtures to be added or removed from given groups through web software.
 - .4 Low Voltage Wallstation Settings: All settings that govern the behavior of a given wallstation shall be adjustable through web software and shall not require any physical adjustment to the device itself.
 - .5 Dynamic Duration: All commands sent from the wallstation shall expire after a specified time period. The duration of this time period shall be programmable, based on the time of day that the wallstation is activated. This will allow for the time duration to differ at various times of day. Each keypad can have a different dynamic duration.
 - .6 Low Voltage Wallstation Functionality: Low voltage wallstations shall provide one touch On/Off functionality as well as press and hold dimming. Different groups of lights shall be assigned to different buttons on each keypad.
- .4 Touchscreen Controllers
 - .1 Communication: Internet Protocol.
 - .2 Interface: 5.7" resistive touch screen.
 - .3 Connections: wired directly to the lighting control network (or network switch) via a Cat5e Ethernet connection.
 - .4 Power: 24 VDC power supply.
 - .5 Touchscreen Functionality: Touchscreens shall accommodate custom dimming levels and time durations over multiple groups of fixtures. Touchscreen shall also

- be programmable to apply multiple pre-set lighting scenes as defined through the web software.
- .6 Customization: Touchscreens shall have the ability to stream custom graphics or interfaces, depending on user need.
 - .7 Groups and settings: All touchscreen attributes, including fixture groups, scenes and graphical interface, shall be customizable through the software and shall not require rewiring or reprogramming at installed location for required changes.
- .5 Personal Digital Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier. The software shall provide for all DALI-protocol programming commands to be applied to the controller/gateway via a tethered connection.
 - .6 Infrared Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches

2.6 LIGHTING MANAGEMENT SOFTWARE

- .1 Provide system software license that is designed, manufactured and warranted by a single manufacturer.
- .2 Lighting Management Software capabilities:
 - .1 Allows user to program, configure and manage the lighting system from a web browser over a TCP/IP connection, i.e. no software application is required to be installed on a remote client (example: desktop, laptop) to access the Lighting Management Software
 - .1 Support web browser: Microsoft Internet Explorer, Google Chrome
 - .2 Supports multiple platforms and devices: tablet, desktop, laptop, smartphone
 - .3 Optimized for displays of 1024 by 768 pixels or higher
 - .2 Allows manufacturer specialist, end user to:
 - .1 Design the system:
 - .1 Import CAD drawings of the building and automatically identify device types (wallstations, fixture types, etc...)
 - .2 Define schedule profiles
 - .3 Define scenes
 - .4 Define fixture types
 - .5 Configure wallstations buttons
 - .6 Define occupancy/vacancy sensor profiles
 - .7 Define daylighting profiles
 - .8 Define partitioned/sub-areas
 - .9 Define emergency lighting
 - .10 Define Fire alarm
 - .11 Configure shade interface
 - .12 Configure BAS interface

- .2 Startup
 - .1 Provide address to each device
 - .2 Adjust daylighting profile
- .3 Maintain
 - .1 View
 - .2 Monitor the status of each device
 - .3 Energy and Power consumption per building, floor, group of devices, device

2.7 **FIXTURE SWITCHING AND DIMMING**

- .1 Each LED driver or group shall be addressable and shall include On/Off, fade, dimming, scene settings and other standard DALI control functions and are required to meet the sequence of operation.
- .2 LED drivers: Comply with requirements in Section 265100 "Interior Lighting" for LED drivers and the following:
 - .1 Starting Method: Turns On at previously set light level.
 - .2 Dimming Range: 100 to 10 percent of rated lumens, unless otherwise indicated.
 - .3 Input Voltage Range: 108 to 305V.
- .3 0-10V Addressable Dimming Modules (Digital to Analog Converter [DALIDAC])
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Communication Connections: Two wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Power Ratings: Up to 4A Ballast 120/277/347 VAC.
 - .6 Dimming Control: 0-10V, 50 mA max current sink.
 - .7 Mounting: Fixture or conduit (90° elbow and mounting clips included).
 - .8 UL 924 Listed component.
- .4 Addressable Dimming Modules
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Communication Connections: Two wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Power Ratings: Up to 20A, 120 VAC.
 - .6 Dimming Control: Forward phase dimming control for incandescent and magnetic low voltage loads.
 - .7 Mounting: Junction box.

- .8 Control and communication operations of the ballast shall be immune to noise and power disturbances.
- .5 Driver shall meet the following operating parameters:
 - .1 Operating Voltage: 120 to 347 VAC (+5%/-10%) as per application requirements.
 - .2 Protection: End of lamp life and inrush current limiting circuitry.
 - .3 Warranty: Five (5) years.
 - .4 Bi-directional digital communication.
- .6 The ballast shall be wired per manufacturers recommendations.
 - .1 The ballast must be properly grounded to earth ground.
 - .2 The maximum length of blue and red wires shall not exceed three (3) ft.
 - .3 The maximum length of the yellow wires (when needed) shall not exceed four (4) ft.
- .7 Driver shall return the following programmable parameters:
 - .1 Power on level.
 - .2 Short, search and random addresses.
 - .3 Groups 0-7 and 8-15.
 - .4 Scenes 0-15.
 - .5 Minimum and maximum dimming levels.
 - .6 Fade time and fade rate.
 - .7 System and power failure levels.
 - .8 Physical minimum level.
 - .9 Device type.
 - .10 Version number.
- .8 Driver shall return the following status parameters:
 - .1 Actual dim level.
 - .2 Ballast status and tube status.
 - .3 Lamp power On.
 - .4 Limit error.
 - .5 Reset state.
 - .6 Missing short address.
 - .7 Contents of volatile memory.

2.8

SENSORS

- .1 Addressable Multi-Sensors
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.

- .4 Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Sensing Technologies: Occupancy, daylight and temperature.
 - .6 Daylight Sensing Range: 0-400 lux.
 - .7 Daylight Sensing Coverage: Light input within 60° cone.
 - .8 Occupancy Detection Technology: Passive infrared.
 - .9 Occupancy Detection Coverage Area: 600 sq. ft. or 1,200 sq. ft.
 - .10 Occupancy Detection Angle: 360°.
 - .11 Mounting: Junction box or ceiling tile.
 - .12 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span multiple DALI communication buses.
 - .13 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours.
- .2 Low Voltage Occupancy Sensors
- .1 Communication: Low voltage signal.
 - .2 Power: From lighting control panel or DALI Powerpack.
 - .3 Lighting Control Panel Connections: Three (3) wires for power, control and common (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated).
 - .4 DALI Powerpack Connections: Five (5) wires for power, control, common, daylighting and commissioning (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated).
- .3 Occupancy Sensing Technologies: Dual Technology, PIR (Passive Infrared) and/or Ultrasonic technology.
- .1 Occupancy Detection Coverage Area: Options available from 500 sq. ft. or 2,000 sq. ft.
 - .2 Occupancy Detection Angle: 360° or linear.
 - .3 Mounting: Junction box or ceiling tile.
 - .4 Groups: The set of fixtures controlled by a given multi-sensor shall be completely configurable through software and can span multiple DALI communication buses.
 - .5 Timers: All times shall be configurable through the web software and shall not require any manual configuration of settings prior to installation. Timer values can range from 1 second to 24 hours.

2.9 RELAYS

- .1 Relays: Electrically operated, mechanically held single-pole switch, rated 20A at 277V. Short-circuit current rating shall not be less than 5 kA. With pilot light indicating when relay is closed and latched. Control shall be by DALI digital data bus. Relay status shall be displayed when queried by lighting management software.

- .2 Relay Panel: A single enclosure with incoming lighting branch circuits, relays and connection to the DALI digital control network.
 - .1 Barriers to separate low voltage and line voltage components.
 - .2 Directory: Cover mounted, identifying each relay with its device address and naming the load controlled.
- .3 Individually Mounted Relays
 - .1 Enclosure: Standard outlet box or NEMA 250, Type 1, unless otherwise indicated.
 - .2 Directory: Cover mounted, identifying each relay with its device address.
- .4 Addressable Field Relays
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA.
 - .4 Communication Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Power Ratings: Up to 20 A at 347 VAC.
 - .6 Field relays shall be capable of controlling plug loads.
 - .7 Mounting: Junction box.
- .5 Relay Panels
 - .1 Communication: DALI protocol.
 - .2 Power: From the DALI bus.
 - .3 Maximum Current Draw: 3.75 mA (per relay).
 - .4 Communication Connections: Two (2) wires (16/18AWG, FT6, non-twisted, non-shielded, non-polarized and plenum rated) connected to the DALI communication bus.
 - .5 Power Ratings: Up to 20A at 347 VAC (per relay).
 - .6 Relay panels shall be capable of controlling plug loads.
 - .7 Number of Relays: Up to 24 or 48.

2.10 LOW VOLTAGE DEVICES

- .1 Infrared Transceiver and Receiver:
 - .1 Product: IRTR
 - .2 Provide contact closure based on status of the partition wall (open/close) enabling automatic update of the lighting control logic within the partitioned space.

2.11 CONDUCTORS AND CABLE

- .1 Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG

- .2 Class 2 Control Cables: Multi-conductor cable with copper conductors no smaller than No. 18 AWG
- .3 Class 1 Control Cables: Multi-conductor cable with copper conductors no smaller than No. 14 AWG
- .4 Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable.
- .5 Communication wires shall be polarity insensitive and shall not require shielding or twisting. Plenum rated 18 AWG 2 conductor cable shall be sufficient.
- .6 Control wires shall be rated for the voltage of the power supply in order to be capable of being run in the same conduit as power wires.
- .7 Communication wires shall be capable of withstanding connection to the line voltage for an indefinite period of time without incurring any damage.

PART 3 EXECUTION

3.1 WIRING INSTALLATION

- .1 Comply with NECA 1.
- .2 Wiring Method: Install cables in raceways. Conceal raceway and cables, except in unfinished spaces.
 - .1 Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- .3 Wiring Method: Conceal conductors and cables in accessible ceilings and walls where possible.
- .4 Wiring within Enclosures: Bundle, lace and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 IDENTIFICATION

- .1 Identify system components, wiring, cabling, boxes, cabinets and terminals. Comply with identification requirements specified in Section 260553 "Identification for Electrical Systems."
- .2 Identify field-installed conductors, interconnecting wiring and components; install warning signs complying with Section 260553 "Identification for Electrical Systems."
- .3 Identify all ceiling-mounted controls with data bus number and device address.
- .4 Label each device cable within 6 inches (152 mm) of connection to bus power supply or termination block.

3.3 FIELD QUALITY CONTROL

- .1 Acceptance Testing Preparation
 - .1 Test continuity of each circuit.

- .2 Ensure standby voltage across the DALI lines (VDALI) is within the following range: $9.5\text{VDC} < \text{VDALI} < 22.5 \text{ VDC}$, as specified in the DALI protocol.
- .3 Ensure that there is no continuity from one DALI communication line to the other.
- .4 Ensure that there is no continuity from the DALI loop to ground.
- .2 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - .1 Test each bus controller using a portable PC.
 - .2 Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - .3 Correct malfunctioning units on-site where possible and retest to demonstrate compliance; otherwise, replace with new units and retest.
- .3 Field Test Reports
 - .1 Printed list of all points created from actual queries of all addressed control points to include LED drivers, manual controls and sensors.
 - .2 Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages and any other change of value messages.
 - .3 Trend data for all daylight zones covering a period of no less than one week and demonstrating performance consistent with the submitted computer models for those spaces.
- .4 Lighting controls will be considered defective if they do not pass tests and inspections.
- .5 Prepare test and inspection reports, including a certified report that identifies bus controllers and describes query results. Include notation of deficiencies detected, remedial action taken and observations made after remedial action.

3.4 STARTUP AND PROGRAMMING

- .1 Engage a factory-authorized service representative to perform startup service.
 - .1 Complete installation and startup checks according to manufacturer's written instructions.
 - .2 Activate light fixtures and verify that all lamps are operating at 100%.
 - .3 Confirm correct communications wiring, initiate communications between DALI devices and controller/gateways and program the LCS according to approved configuration schedules, time-of-day schedules and input override assignments.
- .2 Startup service shall include the following on-site activities as part of deployment requirements.
 - .1 The commissioning agent shall visit the site on a scheduled basis, as per contract provisions.
 - .2 Wiring and Hardware Review: All wiring connections and electrical equipment included in the scope of the LCS shall be assessed.

- .3 Field Testing: All DALI loop communication connections, sensor connections and Ethernet connections shall be verified in accordance to a specified testing procedure.
- .4 Final Inspection: All of the connections relating to the LCS shall be tested and verified.

3.5 STARTUP AND PROGRAMMING

- .1 Provide factory certified field service engineer to make minimum of three site visits for each major construction phase (parking garage completion, maintenance completion) to ensure proper system installation and operation under following parameters:
 - .1 Qualifications for factory certified field service engineer.
 - .1 Minimum experience of two (2) years training in the electrical/electronic field.
 - .2 Certified by the equipment manufacturer on the system installed.
 - .3 Visit duration shall be suitable to accomplish required tasks.
 - .2 First Visit. (Make first visit prior to installation of wiring).
 - .1 Review:
 - .1 Low voltage wiring requirements.
 - .2 Separation of power and low voltage/data wiring.
 - .3 Wire labeling.
 - .4 Lighting Management Panel locations and installations.
 - .5 Control locations.
 - .6 Computer jack locations.
 - .7 Load circuit wiring.
 - .8 Network wiring requirements.
 - .9 Connections to other equipment.
 - .10 Installer responsibilities.
 - .11 Power panel locations.
 - .2 Systems Integration: LCS manufacturer shall provide a factory certified Field Service Engineer on-site to meet with Owners' Representatives, Project Consultant and other related equipment manufacturers to discuss equipment and integration procedures.
 - .3 Second Visit. (Make second visit upon completion of installation of network LCS).
 - .1 Review:
 - .1 Verify connection of power wiring and load circuits.
 - .2 Verify connection and location of controls.
 - .3 Energize lighting management panels and download system data program.
 - .4 Address devices.

- .5 Verify proper connection of panel links (low voltage/data) and address panel.
- .6 Download system panel data to dimming/switching panels.
- .7 Check dimming panel load types and currents and supervise removal of bypass jumpers.
- .8 Verify system operation control by control.
- .9 Verify proper operation of manufacturers interfacing equipment.
- .10 Verify proper operation of manufacturers supplied PC and installed programs.
- .11 Configure initial groupings of LED drivers for wall controls, daylight sensors and occupant sensors.
- .12 Initial calibration of sensors.
- .13 Obtain sign-off on system functions.
- .2 Tuning: LCS manufacturer shall coordinate an on-site meeting with Commissioning Agent, Owner and Project Consultant to make required lighting adjustments to the system for conformance with the original design intent.
- .4 Third Visit
 - .1 Engage a factory-authorized service representative on-site to train Owner's maintenance personnel to adjust, operate and maintain the control unit and operator interface. Training shall be digitally recorded and provided to the Owner.
 - .2 The end customer shall be trained in the usage of the system within 1 month of completion of the startup process. A second training session shall be scheduled within 6 months of final startup.
 - .3 On-site Walkthrough: LCS manufacturer shall provide a factory certified Field Service Engineer on-site to demonstrate system functionality to the Commissioning Agent and Owner.

3.6 SOFTWARE SERVICE AGREEMENT

- .1 Technical Support: Beginning at substantial completion, service agreement shall include software support for five (5) years.
- .2 Upgrade Service: At substantial completion, update software to latest version. Install and program software upgrades that become available within five (5) years from date of substantial completion. Upgrading software shall include operating system and new or revised licenses for using software.
- .3 Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment, if necessary.

3.7 MAINTENANCE

- .1 Offer renewable service contract on yearly basis, to include parts, factory labor and annual training visits.
- .2 Make service contracts available up to ten (10) years after date of system startup.

3.8 **CLOSEOUT ACTIVITIES**

- .1 Training Visits: LCS manufacturer shall provide two (2) day additional on-site system training to Owners personnel.
- .2 System Optimization Visit: LCS manufacturer shall provide a factory certified Field Service Engineer on-site within 6 months after completion of final construction phase to evaluate system usage and discuss opportunities to make efficiency improvements that will fit with the current use of the facility.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Switches, receptacles, wiring devices, cover plates and their installation.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.42-10(R2015), General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA C22.2 No.42.1-13(R2017), Cover Plates for Flush-Mounted Wiring Devices (Bi-National standard, with UL 514D).
 - .3 CSA C22.2 No.55-15, Special Use Switches.
 - .4 CAN/CSA-C22.2 No.111-18, General-Use Snap Switches (Bi-national standard, with UL 20).

1.3 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit Shop Drawings in accordance with Section 01 33 00.

PART 2 PRODUCTS

2.1 SWITCHES

- .1 20 A, 347 V, single pole, three-way, four-way switches to: CSA C22.2 No.55 and CAN/CSA-C22.2 No.111.
- .2 Manually-operated general purpose ac switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle.
- .3 Toggle operated fully rated for LED drivers, and up to 80% of rated capacity of motor loads.
- .4 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
 - .1 Brown urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.

- .4 Eight back wired entrances, four side wiring screws.
- .5 Triple wipe contacts and riveted grounding contacts.
- .2 Safety type duplex receptacles shall be CSA type 5-15R, 125V, U-ground with the following features:
 - .1 Duplex receptacle T-slot.
 - .2 Heavy duty, one-piece, chromate plated steel mounting strap secured to body of receptacle at both ends.
 - .3 Heavy-duty brown urea molded housing.
 - .4 Break off links for use as split receptacle.
 - .5 Triple wipe constant power pressure contacts with fingers in contact when receptacle is not in use.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Receptacles of one manufacturer throughout project.

2.3 OCCUPANCY SENSOR

- .1 Multi-technology sensor with infrared and ultrasonic technology.
- .2 Ceiling mount or wall mount as indicated.
- .3 360 degree coverage, 2000 sq.ft for ceiling mount.
- .4 180 degree coverage, 500 sq.ft for wall mount.
- .5 White colour housing.
- .6 CUL/US, FCC and nom certified.
- .7 Self-adjusting or User-adjustable settings for sensitivity.
- .8 Delayed off setting from 30 seconds to 30 minutes.
- .9 Capable of handling minimum 1000W LED load at 347V.

2.4 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .4 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
- .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Switches:

- .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 00.
 - .4 Locate light switches on latch side of door.
- .2 Receptacles:
- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 00 as indicated.
 - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .4 Device Identification: 1 Identify all receptacles with self-adhesive marker describing circuit number (i.e. "A-32"). Marker shall be fastened around mounting ears of receptacle.
- .1 Identify all receptacle coverplates with clear self-adhesive Mylar tape with black lettering.

3.2 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA C22.2 No. 5-2016, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, thirteenth edition, and the second edition of NMX-J-266-ANCE).

PART 2 PRODUCTS

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers, to CSA C22.2 No. 5.
- .2 Bolt-on moulded case circuit breaker: quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Circuit breakers to have minimum, 10 KA symmetrical rms interrupting capacity rating.
- .4 Arc fault breakers where called for. Refer to panel schedules.

2.2 THERMAL MAGNETIC BREAKERS DESIGN A

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

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Equipment and installation for ground fault circuit interrupters (GFCI).

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.144.1-16, Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA PG 2.2-2014, Application Guide for Ground Fault Protection Devices for Equipment.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit product data and Shop Drawings.

PART 2 PRODUCTS

2.1 MATERIALS

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to CSA C22.2 No.144.
- .2 Components comprising ground fault protective system to be of same manufacturer.

2.2 GROUND FAULT PROTECTOR UNIT

- .1 Self-contained with 15 A or 20A, 120 V circuit interrupter and duplex receptacle complete with:
 - .1 Solid state ground sensing device.
 - .2 Facility for testing and reset.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Do not ground neutral on load side of ground fault relay.
- .2 Pass phase conductors including neutral through zero sequence transformers.
- .3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.

- .2 Arrange for field testing of ground fault equipment by Contractor before commissioning service.
- .3 Demonstrate simulated ground fault tests.

END OF SECTION

PART 1 GENERAL

1.1 REFERENCES

- .1 Institute of Electrical and Electronics Engineers (IEEE)
 - .1 IEEE C62.41.2-2002, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ASTM International Inc.
 - .1 ASTM F1137/F1137M, Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .3 Canadian Standards Association (CSA International)
- .4 ICES-005 December 2018, Lighting Equipment.
- .5 Underwriters' Laboratories of Canada (ULC)

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Departmental Representative.
 - .3 Photometric data to include:
 - .1 Total input watts.
 - .2 Candela.
 - .3 Distribution zonal lumen summary.
 - .4 Luminaire efficiency.
 - .5 Coefficient of utilization.
 - .6 Lamp type.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00.
 - .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, and cleaning procedures.
- .4 Submit a luminaire (and driver if LED) and lamp shop drawing for each luminaire type.
- .5 For LED fixtures, ensure that each of the specified driver features is specifically shown on shop drawings.
- .6 Provide test reports for LED modules and drivers.

1.3 QUALITY ASSURANCE

- .1 Provide mock-ups in accordance with Section 01 45 00 – Quality Control.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 – Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Disposal and recycling of fluorescent lamps as per local regulations.
- .4 Disposal of old PCB filled ballasts.

1.5 GUARANTEE

- .1 Replace:
 - .1 LED drivers that fail or exceed their original noise level rating within 12 months of Substantial Performance of Work.
 - .2 LED fixtures that fall within 12 months of Substantial Performance of the work.

PART 2 PRODUCTS

2.1 LAMPS

- .1 LED sources to be high power, minimum rated 50,000 hour, white, 3500°k (±500° per full fixture), minimum 80CRI, replaceable modules.
- .2 Refer to fixture detail sheets.

2.2 LED DRIVERS

- .1 Refer to fixture detail sheets.
- .2 347V, 60Hz, Class I, LED drivers.
- .3 Power factor: 90% at full load.
- .4 Total Harmonic Distortion (THD): <10% of full load.
- .5 Complete with integral 9kV surge suppression protection.
- .6 CSA approved and/or ULC listed and labelled.
- .7 Capable of 0-10V dimming where indicated.

2.3 FINISHES

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

2.4 OPTICAL CONTROL DEVICES

- .1 As indicated in detail sheets.

2.5 LUMINARIES

- .1 As indicated in detail sheets.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.
- .3 Provide plaster frame and trim as required, and turn over to trade providing ceiling installation.
- .4 Support luminaires directly from building structure.

3.2 WIRING

- .1 Connect luminaries to lighting circuits:
 - .1 Install flexible or rigid conduit for luminaries as indicated.

3.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires to building structure.
- .2 Trapeze fixture supports.

3.4 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CSA C22.2 No.141-15, Emergency Lighting Equipment.
 - .2 CSA C860-11(R2016), Performance of Internally-Lighted Exit Signs.
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA 101-2018, Life Safety Code.
- .3 International Organization for Standardization (ISO)
 - .1 ISO 3864-1:2011, Graphical symbols - Safety colours and safety signs - Part 1: Design principles for safety signs and safety markings.
 - .2 ISO 7010:2019, Safety colours and safety signs - Registered safety signs.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturers printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit WHMIS SDS - Safety Data Sheets in accordance with Section 01 14 25 – Designated Substance Report and 02 41 19 – Selective Interior Demolition.
 - .1 Instructions: submit manufacturer s installation instructions and special handling criteria, installation sequence, cleaning procedures and

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
- .2 Submit WHMIS SDS – Safety Data Sheets.

Part 2 Products

2.1 SELF-POWERED UNITS

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860.
- .2 Housing: extruded aluminum housing, with satin enamel paint finish.
- .3 Universal Face and back plates: extruded aluminum.
- .4 Lamps: two - 6V 4W LED with minimum life span of 100,000 hours.
- .5 Operation: designed for 100,000 hours of continuous operation without relamping.

- .6 Graphics: Green pictogram and white graphical symbol and directional arrows to ISO 3864-1. Dimensions to ISO 7010.
- .7 Face plate to remain captive for relamping.
- .8 Supply voltage: 347V, ac.
- .9 Output voltage: 6V dc.
- .10 Operating time: 60 minutes minimum.
- .11 Recharge time: 24 hours
- .12 Battery: sealed, maintenance free.
- .13 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .14 Solid state transfer circuit.
- .15 Signal lights: solid state, for 'AC Power ON' and High Charge condition.
- .16 Lamp heads: integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.
 - .1 Lamp type: LED, 6V-4W
- .17 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit.
 - .1 Removable or hinged front panel for easy access to batteries.
- .18 Cabinet: finish: White satin enamel paint finish
- .19 Auxiliary equipment:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Lamp disconnect switch.
 - .4 Test switch.
 - .5 AC/DC output terminal blocks inside cabinet.
 - .6 RFI suppressor.
 - .7 Cord and single twist-lock plug connection for AC power supply.

2.2 DESIGN TYPE (X)

- .1 Universal mounting.
- .2 Universal face with die-cast face plate to remain captive for relamping.
- .3 Arrow: Universal provided with left, right and both directions.

Part 3 Execution

3.1 MANUFACTURER S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install exit lights to manufacturer s recommendations, listing requirements, NFPA 101 standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Lock exit light circuit breaker in on position.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Packaging Waste Management: remove for reuse of packaging materials, pallets, padding, crates, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

PART 1 GENERAL

1.1 REFERENCE STANDARDS

- .1 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2015 (NBC).
- .2 Treasury Board of Canada (TBS), Occupational Safety and Health (OSH)
 - .1 Fire Protection Standard-10.
- .3 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524-19, Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525-16, Audible Signal Devices for Fire Alarm Systems, Including Accessories.
 - .3 CAN/ULC-S536-13, Inspection and Testing of Fire Alarm Systems.
 - .4 CAN/ULC-S537-13, Verification of Fire Alarm Systems.
 - .5 CAN/ULC-S541-16, Speakers for Fire Alarm and Signaling Systems, Including Accessories.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .4 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .5 Product Data:
 - .1 Submit manufacturer's instructions, product literature and data sheets for multiplex fire alarm voice communication speakers and include product characteristics, performance criteria, physical size, finish and limitations.
- .6 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Ontario, Canada.
 - .2 Indicate on shop drawings:
 - .1 Details for devices.
 - .2 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.

1.3 CLOSEOUT PROCEDURES

- .7 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .8 Operation and Maintenance Data: submit operation and maintenance data for fire alarm and voice communication systems for incorporation into manual.
- .9 Include:
 - .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.
 - .4 List of recommended spare parts for system.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .10 Submit maintenance materials in accordance with Section [01 78 00 - Closeout Submittals].
- .11 Extra Stock Materials: submit [2] spare glass rods for manual pull box stations if applicable.

1.5 QUALITY ASSURANCE

- .12 Inspection tests to conform to: CAN/ULC-S536.
- .13 Submit inspection report, to Departmental Representative.

1.02 DELIVERY, STORAGE AND HANDLING

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

2 PRODUCTS

2.01 DESCRIPTION

- .1 Existing fire alarm system serving the building is a Notifier. Provide additional devices and work to extend system to serve renovated areas. Additional devices to be 100% compatible with and of the same manufacturer as per the existing system. Include provision of necessary control panel and annunciator work of existing system to accommodate integration of additional devices.
- .2 Include for and engage Building Owner's existing system manufacturer's authorized technicians to provide and perform required system products and work.
- .3 Verify with existing fire alarm system manufacturer exact requirements needed to provide renovation work. If necessary, visit site with manufacturer to review existing conditions. Confirm and coordinate exact work responsibilities with system vendor. Items of clarification or proposed revisions to documents must be reviewed with Department representative prior to submission.
- .4 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .5 Power supply: to CAN/ULC-S524.
- .6 Audible signal devices: to CAN/ULC-S525.
- .7 Speakers: to CAN/ULC-S541.
- .8 Regulatory requirements:

- .1 System:
 - .1 To TBS Fire Protection Standard.
 - .2 Subject to Fire Commissioner of Canada (FC) approval.
 - .3 Subject to FC inspection for final acceptance.

2.02 AUDIBLE SIGNAL DEVICES

- .1 Speakers:
 - .1 Cone type: recessed 200 mm square ceiling mounted.
 - .1 Fire-retardant, moistureproof.
 - .2 Multiple taps adjustable from 0.375 to 6 W.
 - .3 Frequency response: 200 to 8000 Hz.
 - .4 Output sound level: minimum 90 db at 1 m with 1 W tap.

3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- .1 Install systems to CAN/ULC-S524 and TBS OSH Fire Protection Standard.
- .2 Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors.
- .3 Connect alarm circuits to main control panel.
- .4 Connect signalling circuits to main control panel.
- .5 Install end-of-line devices at end of alarm and signalling circuits.
- .6 Splices are not permitted.
- .7 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes as required by equipment manufacturer.
- .8 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .9 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- .10 Install speakers and connect to speaker circuits.

3.03 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and to CAN/ULC-S537.
- .2 Fire alarm system:
 - .1 Test device and alarm circuit to ensure manual stations, smoke detectors and sprinkler system transmit alarm to control panel and actuate general alarm.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
 - .4 Addressable circuits system style DCLB:
 - .1 Test each conductor on DCLB addressable links for capability of providing 3 or more subsequent alarm signals on line side of single open-circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of 3 signals. Correct imposed fault after completion of each series of tests.
 - .2 Test each conductor on DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of 3 signals. Correct imposed fault after completion of each series of tests.
- .3 Provide final PROM program re-burn for system Departmental Representative incorporating program changes made during construction.

3.04 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.05 MAINTENANCE

- .1 Provide one year's free maintenance with two inspections by manufacturer during warranty period.

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- .1 Provide a design, supply, and installation for an Audio Visual system comprising all of the systems herein. See the Design Brief for a description of the intent of these systems.
- .2 The following systems are described in this document. Systems have been allocated to specific rooms and for specific requirements.
 - .1 Meeting Rooms
 - .2 Multi-Purpose Rooms
 - .3 Conference Room with Video Conferencing
- .3 In addition to the above systems, the specific requirements for programming Control and DSP Systems is described.

1.2 STANDARDS

- .1 Shall follow all applicable Infocomm/Avixa Audio Visual design standards, all applicable BICSI and TIA cabling standards for structure cabling including but not limited to;
- .2 EIA RS-310-C Racks, Panels and Associated Equipment
- .3 CSA C22.1-94, Canadian Electrical Code Part I (current edition, Safety Standard for Electrical Installations)
- .4 CSA Standard T527 94 Grounding and Bonding for Telecommunications in Commercial Buildings
- .5 ISBN 0-240-80286-1 Audio Systems Design and Installation, P. Giddings (Focal Press, 1990)
- .6 Building Industry Consulting Services International (BICSI) Telecom Distribution Methods (TDM) Manual
- .7 ANSI/EIA/TIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications
- .8 Building Industry Consulting Services International (BICSI) Telecom Distribution Methods (TDM) Manual
- .9 TIA/EIA-568-B.1 and TIA/EIA-569-A, Category 6 Cabling Standards
- .10 "Controlling the Temperature Inside Equipment Racks" – Middle Atlantic
- .11 IEEE 802.3af – Wired Ethernet

1.3 ABBREVIATIONS AND ACRONYMS

- .1 LEED®: Leadership in Energy and Environmental Design; www.cagbc.org.
- .2 AV: Audio Visual
- .3 DSP: Digital Signal Processing
- .4 GUI: Graphical User Interface

- .5 IR: Infrared
- .6 PC: Personal Computer
- .7 RF: Radio Frequency
- .8 RU: Rack Unit (1.75" 44.45mm)
- .9 TV: Television
- .10 UI: User Interface

1.4 TECHNICAL SUBMITTALS

- .1 27.41.00 shall be responsible for verify all final screen sizes, speaker and microphone quantities and locations to suit the as built conditions.
- .2 27.41.00 shall submit equipment data sheets (cut-sheets) and accessories for each audio-visual systems specified in Part 2 of this Section. Provide detail connection wiring drawings for each system with cable type, numbering and destinations.
- .3 Shop drawings for each system shall include detailed design drawings of the system equipment layout, performance, dimensions and include wiring diagrams and riser drawings. Where applicable, performance shall include expected signal strength and/or signal losses.
- .4 27.41.00 shall submit heat load, specialized mounting requirements and power requirements for each system. Ventilation and cooling requirements shall also be specified by 27.41.00.
- .5 27.41.00 shall submit sample Touch Panel Layouts for all Rooms.

1.5 DELIVERY, HANDLING AND STORAGE

- .1 27.41.00 shall deliver, store and protect materials in accordance with requirements of Architectural Specification.
- .2 27.41.00 shall maintain packaged materials clean, dry and protected against dampness and intrusion of foreign matter.
- .3 27.41.00 shall be responsible for the removal and disposal of all packaging and construction debris related to the installation of Audio Visual equipment.

1.6 SYSTEM INTEGRATION

- .1 27.41.00 shall be responsible for coordination and integration of the audio-visual (AV) systems with other systems. Division 01 and/or Division 26 shall be responsible for other low voltage systems with the respective specialty subcontractors of each system. Integration shall include but not be limited to the following:
 - .1 Volume/source selection and control of audio/video systems;
 - .2 LED/LCD display controls;
- .2 Where new conduit is to be installed a Division 26 shall be responsible for all electrical conduits, raceways, cable trays, wiremold, AC Power, and back boxes required to support the above systems. 27.41.00 shall coordinate and communicate with the Division 26 to ensure all required systems have been installed day one.

- .3 27.41.00 shall be responsible for all Category UTP twisted pair network cables that shall terminate in an IT closet and any specialty or shielded cables installed between devices or terminating in an AV Rack.

1.7 COORDINATION WITH TRADES

- .1 27.41.00 shall be responsible to conduct site surveys prior to ordering equipment to verify all architectural, structural, electrical, and network requirements with the Departmental Representative.
- .2 27.41.00 shall schedule and coordinate, with Division 01, the delivery of the Audio Visual system with the delivery of the above items.
- .3 27.41.00 shall supply all required back boxes required for DIV 26 Rough-in.
- .4 27.41.00 shall supply all required templates for AV equipment to be installed in tables or surfaces supplied by the furniture vendor.
- .5 27.41.00 shall coordinate all blocking and support systems required for AV Equipment with the Division 01.
- .6 Failure to identify requirements or changes to the requirements prior to ordering equipment will not affect 27.41.00 responsibility to deliver a functional Audio Visual System. The Departmental Representative will not be responsible for changes or additional equipment required for the Audio Visual system as the result of a failure to identify requirements.

1.8 ACCEPTABLE AV SYSTEM CONTRACTORS:

- .1 Only 27.41.00 having the following qualifications shall be approved for providing the specified system and work:
 - .1 Minimum 10 years experience in the AV design and installation industry;
 - .2 Successfully completed at least two similar projects within the last five years with integrated AV systems – provide references and project descriptions;
 - .3 Authorized and trained DSP programmers and installers. 27.41.00 must be authorized to purchase, sell, install and service all equipment specified and/or supplied as an alternate for the specified project. 27.41.00 shall be able to access and supply parts required as a replacement within 24 hours during the warranty period.
 - .4 Authorized and trained Control System programmers and installers – provide certificates in the Control System to be provided. If sub-contractors, please specify.
 - .5 Provide proof of qualifications as part of the shop drawing submission.
27.41.00 shall adhere to industry installation standards as set out by InfoComm and/or NSCA (National Systems Contractors of America) for Audio Visual Systems installation. The Suppliers Company shall hold a minimum of CTS silver.

1.9 AUDIO-VISUAL DESIGN CRITERIA

- .1 General:
 - .1 The general system design and performance requirements are shown on drawings and specified herein and shall be used for pricing. The documents are not intended to be for construction or for full system wiring purposes. The documents do not identify all necessary installation or integration devices.

- .2 The successful 27.41.00 shall be responsible for final construction design and full wiring and integration drawings that identify all necessary components to provide the intent of these documents for full and proper functioning sound and in-house broadcast/video systems that satisfies the requirements of the Departmental Representative.
 - .3 27.41.00 shall be responsible for the coordination of wiring and conduit installations by Division 26 that are directly required for the AV systems.
 - .4 27.41.00 shall be fully responsible for ensuring that all components of the systems are completely compatible for interconnections, projections and displays as an integrated system.
 - .5 With the exception of the Audio Digital Signal Processor (DSP) and the control systems, 27.41.00 shall substitute for approved equivalent as necessary all other equipment and other AV components including cables for that which is acceptable and approved by the Departmental Representative and their representative.
 - .6 Some equipment may become discontinued between the time of tender and installation; therefore it is the responsibility of 27.41.00 to specify and provide the current replacement model.
 - .7 27.41.00 shall specify all analog to digital converters and interface as required for all systems.
 - .8 27.41.00 shall supply shop drawings and product data sheets to the Departmental Representative within 10 business days from award of contract, unless otherwise negotiated. Expect several iterations of the shop drawing review process before final configurations and presets are agreed to.
 - .9 Supply certain product samples to the Departmental Representative as requested within two weeks from request.
 - .10 27.41.00 shall be responsible for the supply and installation of complete system products, system programming, testing and commissioning.
 - .11 Testing and commissioning shall be performed within the presence of the Departmental Representative where requested.
-
- .2 Rooms 9169, 927, 929, 931, 914, 939 & 9211
 - .1 Provide one AV wall-plate which combines Audio, VGA and HDMI signals into one CAT6 output which will be connected to a matching CAT6 receiver/scaler which will distribute the original signals to the TV, via one of the HDMI inputs.
 - .2 Wireless digital media presentation streaming device, with a video resolution of 4K UHD (3640 X 2160 @30Hz) with frame rate of 30 frames per sec. With 1 user presenting on screen, with 1 presentation dongles, wireless sharing from laptops , tablet and smartphone, touch back support and security enhanced security features. One HDMI 1.2 output. Must be compatible with Windows 7/8/8.1/10 32 & 64 bit, macOS 10.14/10.15 (Catalina), Android 9 & 10, iOS 11, 12 & 13. Each plate shall accommodate connections as noted on the drawings. Including for a min of:
 - (x1) HDMI
 - (x1) VGA + audio
 - (x1) Network drop (UTP CAT 6a cable by Division 27)
 - .3 The TVs sizes are noted on the AV drawing AV-100
 - .4 The TV's Audio output will be played through audio optical cable to a powered soundbar,

- .3 Room 9147
 - .1 TV Size as noted on drawing.
 - .2 Wireless digital media presentation streaming device, with a video resolution of 4K UHD (3640 X 2160 @30Hz) with frame rate of 30 frames per sec. With 1 user presenting on screen, with 1 presentation dongles, wireless sharing from laptops , tablet and smartphone, touch back support and security enhanced security features. One HDMI 1.2 output. Must be compatible with Windows 7/8/8.1/10 32 & 64 bit, macOS 10.14/10.15 (Catalina), Android 9 & 10, iOS 11, 12 & 13. Provide the following on Tek Tier Faceplate (provided by furniture vendor):
 - (x1) HDMI
 - (x1) VGA + audio
 - (x1) Network drop (UTP CAT 6a cable by Division 27)

- .4 Rooms 950, 951, 954
 - .1 TV sizes as noted on drawing.
 - .2 Provide one AV wall-plate which combines Audio, VGA and HDMI signals into one CAT6a output which will be connected to a matching CAT6a receiver/scaler which will distribute the original signals to the TV. Each plate shall accommodate connections as noted on the drawings. Including for a min of:
 - (x1) HDMI
 - (x1) VGA + audio
 - (x1) Network drop (UTP CAT 6a cable by others)
 - .3 The TV's Audio output will be played through powered stereo (left & right channels) speakers. The impedance of the speakers shall match the audio output of the TV.
 - .4 Wireless digital media presentation streaming device, with a video resolution of 4K UHD (3640 X 2160 @30Hz) with frame rate of 30 frames per sec. With 1 user presenting on screen, with 1 presentation dongles, wireless sharing from laptops , tablet and smartphone, touch back support and security enhanced security features. One HDMI 1.2 output. Must be compatible with Windows 7/8/8.1/10 32 & 64 bit, macOS 10.14/10.15 (Catalina), Android 9 & 10, iOS 11, 12 & 13. Powered speakers will be used for sound reinforcement, speakers shall be channel oriented to the left and right of the TV, and the speaker wire shall not be visible.
 - .5 The speakers shall be securely mounted on the wall.

- .5 Room 9139
 - .1 Provide one AV wallplate. The plate shall accommodate connections as noted on the drawings. Including for a min of:
 - (x1) HDMI
 - (x1) VGA + audio
 - (x1) Network drop (UTP CAT 6a cable by Division 27)

- .2 Each wall plate shall convert multimedia signals to be transported over twisted pair cable. The plate shall have cable home run back to the local AV rack within the room. The local rack shall have tie lines for digital audio and control system network run back to the central main equipment rack location.
- .3 TV size as noted on drawing.
- .4 Wireless digital media presentation streaming device, with a video resolution of 4K UHD (3640 X 2160 @30Hz) with frame rate of 30 frames per sec. With up to 2 users presenting on screen, with up to 2 presentation dongles, wireless sharing from laptops , tablet and smartphone, touch back support and security enhanced security features. One HDMI 1.2 output. Must be compatible with Windows 7/8/8.1/10 32 & 64 bit, macOS 10.14/10.15 (Catalina), Android 9 & 10, iOS 11, 12 & 13. Provide an AV receiver next to the display, which shall convert information from twisted pair cables back to DATA, HD and standard video signals. The receiver shall be home run back to the identified equipment rack. Refer to AV drawings for additional detail.
- .5 The room shall provide all required functionality and codecs for Skype For Business, Video Conferencing and Audio Conferencing.
- .6 Boardrooms shall be equipped with local AV rack. A digital audio connection from the central audio system shall be connected to each meeting and boardroom audio system.
- .7 Provide loudspeakers recessed within the ceiling as identified on the drawings. Loudspeakers shall carry supporting audio for presentation, other forms of pre-recorded sources, voice reinforcements and background music.
- .8 Within boardrooms, provide a touch screen. The touch panel shall control all AV systems, Video conferencing and audio conferencing.
- .9 Provide DSPs and telephone hybrid to allow for audio conferencing via the AV system. The DSPs shall digitally provide echo and feedback cancelation.
- .10 Sound reinforcement shall be provided using multichannel sound amplifier and speakers.
- .11 Board rooms shall have the ability to display IPTV and content uploaded via the network.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 All equipment supplied under this Specification shall be new and of current manufacture. Used, reconditioned or repaired equipment shall not be acceptable. All equipment supplied shall be capable of meeting or exceeding the published specifications of the manufacturer. At the Departmental Representative's request and at no additional cost to the Departmental Representative, the Supplier shall be prepared to demonstrate, on site, that the equipment supplied meets or exceeds these specifications. To this end, the Supplier shall provide qualified technicians and such test equipment as may be required to demonstrate conformity to the published specifications. All equipment wiring and wiring devices supplied shall meet the requirements of the authority having jurisdiction and shall be a minimum CSA and/or ULC approved. The total work specified herein shall comply strictly to the requirements of the latest edition of the Ontario Building Code or the Canadian Electrical Code, as appropriate. This code and any additional requirements of the Authority having jurisdiction constitute as integral parts of this specification, and in case of conflict, Code shall take precedence over this specification.

2.2 EQUIPMENT

- .1 All equipment and materials supplied shall be new stock, except as indicated.
- .2 All equipment is to be of current manufacture and commercially available off the shelf. Except for required interfaces between subsystems, equipment proposed shall not be prototypes or in the development phase.
- .3 All equipment is to be obtained through manufacturer-authorized distribution channels.

2.3 MICROPHONES

- .1 The microphone ceiling array shall provide complete coverage in a space, either by adding lobes or changing the lobe width. This ensures the sensitivity is within 6 dB in all areas. It is acceptable for lobes to slightly overlap. Ensure that spacing and isolation are adequate to reduce noise and maximize automatic mixing performance. The microphone shall have a minimum of 8 channels and a sampling rate of 48Khz, with a bit depth of 24.

2.4 CLICKSHARE

- .1 The CS-100 is a stand-alone model with an HDMI output, that allows up to 8 users to connect and, with one user sharing at a time. The CS-100 includes the standard ClickShare security features including encryption, login management, https and the possibility to hide the SSID of the Base Unit's wireless network.
- .2 ClickShare CX-30 is fully compatible with Windows, Mac, iOS and Android devices; and it can also be used alongside any unified communications (UC) technology and any brand of AV USB peripherals. Also, ClickShare CX-30 users can benefit from interactive features including moderation, local view of the room display, annotation, blackboarding and touch back support allows users to control the touchscreen in the room.

2.5 DSP

- .1 Digital audio processing includes those devices that convert from analogue to digital and digital to analogue as well as the digital processors.
- .2 All processors shall include graphical PC based software. This software shall be used for programming, real time control, communication and archiving of all software / firmware settings. Local control and interfacing shall be via RS232, USB or Ethernet and remote control and interfacing shall be via Ethernet or RS485.
 - .1 Provide minimum 20% spare inputs and outputs.
 - .2 The equalizer, which is part of the DSP device, must allow for the following:
 - .3 One channel per Loudspeaker Zone
 - .4 Bandwidth adjust from 3 octaves to 1/20 octave
 - .5 Independent channel adjustments

2.6 AMPLIFIERS

- .1 Program amplifiers must be capable of providing 200% of the power required by the loudspeaker.

2.7 CEILING LOUDSPEAKERS

- .1 The transformer, is used, and loudspeaker assembly must meet the following minimum requirements:
- .2 Frequency Response (loudspeaker and transformer) of 100 Hz to 12 kHz, ± 4 dB
- .3 Minimum Dispersion of 90 degrees at 5 kHz.
- .4 Distortion shall be less than 3% at 6 dB down from full output throughout stated frequency response.
- .5 The speakers shall match the impedance of the amplifier for a 70V audio system.

2.8 WALL MOUNT POWERED SPEAKERS

- .1 Powered Speakers shall come with wall mount brackets, shall be black in colour or an approved substitution, brackets shall be the same colour.
- .2 The speakers shall come with mounting brackets.
- .3 The powered speakers shall be 8 ohms.
- .4 They shall have front facing volume control knobs.
- .5 The speakers shall have a minimum wattage of 30 RMS.
- .6 The audio cable shall connect from the rear of the speaker.

2.9 TOUCHSCREEN

- .1 Touchscreen be an integrated capacitive touchscreen, touch overlay will not be accepted.
- .2 Have audio touch feedback.
- .3 The touchscreen shall be connected by POE.
- .4 Wall mounted at location in drawing.
- .5 The touchscreen shall have wall mount bracket, specifically for its model.
- .6 Shall have a screen size of 5 inches.
- .7 Shall be compatible with conferencing system.
- .8 The display shall be customized to suit the conferencing system.

2.10 VIDEO PROCESSING EQUIPMENT

- .1 All video matrix switchers, extenders and cabling components transmitting computer or blu-ray signals are to be HDCP compliant.
- .2 All components are to have EDID management functions.

2.11 DISPLAYS AND MOUNTS

- .1 All displays to be 4K in 16:9 aspect ratio. When content is not native 16:9, e.g. 4:3 format, it is to be displayed in its native aspect ratio with black bars on the side or top/bottom to maintain the proper aspect ratio of the display content. It is not permissible to stretch the image to fill the screen. The display must be setup to automatically reproduce an incoming signal to fill the screen as much as possible without clipping the image.

- .2 Blocking is required in the wall and shall be 10% larger than the display in all directions. Tin blocking is not acceptable, provide plywood blocking.
- .3 All displays that are wall mounted shall have mounts properly rated for the display size.
- .4 The HDMI Receivers and Clickshare shall be mounts behind the display and they shall not be visible, including all related cabling.
- .5 Sound bars shall be mounted directly below the display and connected using an optical cable.
- .6 In rooms where multiple HDMI inputs are available the HDMI transmitters and receivers must switch to the HDMI input that connected into the HDMI input plate.
- .7 The Display shall come with its original wireless remote control and batteries.

2.12 RACKS AND CABINETS

- .1 Supplied Cabinets shall meet the following requirements:
 - .1 The design of the layout and cooling must allow equipment to operate at specified normal operating temperatures.
 - .2 The cabinet rack is free standing it must have minimum of 2" of clear space behind the cabinet and the wall. Electrical, Data and AV wall boxes shall be concealed behind the cabinet. Cabinet must be designed to allow cooling of equipment utilizing low noise fans. Number of RU shall be determined as required to support the Audio Visual equipment.
 - .3 Power and data connections shall be co-located with the AV backbox.
 - .4 All equipment is to be secured into racks, using tamper proof methods.
 - .5 Equipment Cabinets
 - .1 Equipment Enclosures: Mobile furniture style melamine 19-Inch (482.6mm) equipment enclosure.
 - .2 Rack shall be EIA compliant 19" (482.6mm) mobile furniture equipment rack.
 - .3 Overall dimensions of the rack shall be 48.95" (1243mm) height x 27.3" (693mm) width x 28.25" (718mm) deep.
 - .4 Useable height of The rack shall be 24 rackspaces, useable depth shall be 23.31" (592mm).
 - .5 The rack shall come equipped with two pairs of adjustable steel rack rail with tapped 10-32 mounting holes in universal EIA spacing, black e-coat finish and numbered rack spaces.
 - .6 The rack shall have bolt through 4" (102mm) height casters.
 - .7 The rack shall have 4 casters total, with locking front casters.
 - .8 The rack shall have internal steel bracing.
 - .9 The rack shall be metal and the colour determined by the Departmental Representative.
 - .10 The rack shall have an undersized top.
 - .11 The rack shall include a locking and latching IR friendly tempered glass front door.
 - .12 The rack shall include a locking and latching melamine rear door.
 - .13 The rack shall have rear venting, cable entry and cable spools.

- .14 The rack shall have a 2.375" (60mm) cable grommet on top, that accepts a monitor mount.
- .15 The rack shall contain an internal cable and device management system with all required accessories.
- .16 The rack shall provide a UL Listed load capacity of 350 lbs. mounted in the rack.
- .17 The rack Shall provide a load capacity of 50 lbs (23Kg) on top of the rack.
- .18 The rack shall be UL Listed in the US and Canada.

2.13 Grounding

- .1 The assembled and installed equipment racks shall bear an ESA special inspection label, which will indicate that all electrical equipment and devices have been installed and grounded in a manner that will not present and hazard to operating or maintenance personnel.
- .2 Utilizing standard grounding practices-effectively ground each rack and the associated rack equipment to the building grounding system.
- .3 The electrical continuity of the shield of a line shall be maintained throughout the length of the line. The shield shall be insulated from all metal parts, except at the point of termination at the audio ground bus of the unit involved. The floating ends of the shield shall be terminated by wedge-on collars or with plastic tape.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 27.41.00 shall examine surfaces, substrates, and conditions for compliance with requirements of other sections in which that related work is specified, and determine if surfaces, substrates and conditions affecting performance of the work of this Section are satisfactory. Do not proceed with work of this Section until unsatisfactory conditions have been corrected in a manner acceptable to the Installer. Starting installation constitutes acceptance of surfaces, substrates, and conditions.

3.2 INSTALLATION OF AUDIO-VISUAL SYSTEMS

- .1 27.41.00 shall prepare detailed design/installation drawings and submit to Departmental Representative for review prior to start of work. The submission shall include all documentation as required to identify full system design intent, its operation, included system components, and installation requirements and requirements as specified for sound systems and video systems.
- .2 27.41.00 shall assume where existing walls will not be renovated or demolished the AV cabling shall be free air.
- .3 If required Division 26 shall include with the provision of the system components, the provision of required conduits, boxes, etc., to provide a full operational system to Departmental Standards and to specified requirements.
- .4 Include for wiring in conduit runs (minimum 20 mm) diameter unless otherwise noted) to associated interconnections to the Security System and Fire Alarm System. Allow sufficient slack cabling at end termination box for system connections to respective systems. Unless otherwise noted, camera conduit runs shall be "home runs".

- .5 Provide specified various AV system components to serve the various areas. Program and install systems in accordance with manufacturer's recommendations and previous requirements specified in Part 2.
- .6 Rough-in locations of component (i.e. speakers) and obtain Departmental Representative's approval of locations before final installations. Install devices in accordance with system supplier's instructions.
- .7 General Audio System Performance Criteria:
 - .1 Loudness –An approved sound level meter, set to "C" weighting and "SLOW" meter response shall be used to make this measurement. The audio system shall be able to provide 10 dB of headroom or the ability to produce program peaks of 100 dB. Program peaks shall not produce any type of audible distortion.
 - .2 Coverage Uniformity – Using broad-band pink noise as a program source, media and/or PA audio response through the general listening area shall not vary more than ± 3 dB, as measured with an approved sound level meter set for "A" weighted response.
 - .3 Hum and Noise – With system gain set for 90 dB peak levels from any normal program source, electrical noise shall not exceed 0.2 volts RMS at power amplifier output terminals. Operation of various system controls such as program source, gain control, lighting controls, etc. shall not introduce objectionable noise into the system.
 - .4 Frequency Response – Using accepted and approved 1/3 octave analysis procedures the response of each audio channel will be equalized to provide a "flat" frequency response curve over the frequency spectrum of the specified equipment. It is important that loudspeaker crossover settings and equalization be trimmed to result in the closest possible match between each speaker channel, as measured at a favourable centralized listening position.
 - .5 Signal to Noise Ratio – (Inclusive of crosstalk and hum). Signal to noise ratios shall be measured using an approved sound level meter, set to "linear" weighting and "SLOW" meter response. Unless restricted by the undistorted output level of the system, the overall system S/N ratio shall be greater than 70 dB.
 - .6 Total Harmonic Distortion – With the exception of microphones and speakers, the published THD for any piece of audio equipment in the system shall not exceed 0.1% over a 20 Hz to 20 kHz bandwidth.
- .8 Include costs for and arrange for system manufacturer's authorized representative (27.41.00) to perform final equipment connections, system programming, testing and adjustments.
- .9 Provide ceiling mounting speaker assemblies complete with backboxes and grilles in locations as shown and/or directed by Departmental Representative. Comply with specified wiring in conduit installation requirements.
- .10 Provide amplifiers, music source units and control unit in rack mount enclosures.
- .11 Provide microphone packages as specified and turn over to Departmental Representative.
- .12 Co-ordinate and perform required connections and wiring of override for emergency paging as needed.
- .13 Install work and equipment in accordance with manufacturer's instructions and integrate to sound system AV controller.

- .14 Provide matrix switchers and projectors and integrate with various AV systems as per drawing details. Install in accordance with manufacturer's instructions. Provide required power supplies, mounting hardware, cabling, patch cables, etc.
- .15 Instruct Departmental Representative on operating and maintenance.
- .16 Do not splice wiring in conduit runs. Where required, make splices in proper junction boxes utilizing terminal strips.
- .17 All audio circuits shall be balanced to ground.
- .18 All conduits containing AV system wiring shall be permanently bonded to a dedicated building ground. All electronic equipment shall exclusively receive its technical ground via the isolated equipment ground conductor run to AC outlets. Comply with manufacturer's grounding instructions.
- .19 All work shall be performed in accordance to the manufacturer's instructions and requirements.
- .20 The integrated systems shall be tested during the installation process so that any problems can be detected and corrected as they occur. Evaluate the following:
 - .1 Safe rigging practices including safety cables.
 - .2 Safe grounding practices - each component is earth grounded through its AC cord, rack rails or both, and not produce audible hum.
 - .3 Hums resulting from ground currents.
 - .4 Proper system polarity.
 - .5 Susceptibility to radio frequency interference.
 - .6 Susceptibility to electromagnetic interference.
 - .7 Proper system gain structure.
 - .8 Consistency and accuracy of coverage.
 - .9 Adequate acoustic gain.
- .21 Confirm the exact requirements and locations of the equipment with the Departmental Representative and the system installers prior to roughing-in.
- .22 Quantities for devices shall be as per the floor plan drawing and not the schematic diagram.
- .23 All cables shall be labelled with self-laminated marking tape-Panduit LJSL5-Y3 labels or equivalent. Identification shall be as follows:
 - At the all racks, the label shall be placed on a visible part of the cable within 12" (305mm) of the termination point for ease of identification after termination.
 - At the 'Outlet', the cables shall be labelled 4" (102mm) from the termination point and shall be visible by removing the outlet cover plate or at the source.
- .24 No Nylon cable ties shall be used. Only Velcro cable ties will be accepted.
- .25 All LED Displays, mounting devices must be installed in accordance with manufacturer specifications and industry standards
- .26 All interconnect wiring must be correctly dressed and labelled

.1 Performance CRITERIA AND ADJUSTMENT

- .1 Adjust the speaker phasing and orientation, If necessary, in order to achieve the systems' maximum performance within the limits of the specified equipment and device capabilities. Any variation or deviation from these criteria must be approved by the Departmental Representative.
- .2 Test the system for sound level capability, uniformity of level with respect to position and uniformity of level with respect to frequency, using approved equipment such as IVIE meter with memory lock feature, IVE-20B noise generator, IVIE-30 real time analyser, B & K 4134 diameter microphone. Record all results for review by the Departmental Representative. Make adjustments as necessary to optimize the system performance, such as adjust the power and phasing and re-aim the speakers as required.

.2 Performance Test and Reports

- .1 After the system is complete and final adjustments have been made, provide the Departmental Representative with all documented test data regarding the performance of the system, as detailed below. Include a listing, by manufacturer and model number of measurements instrumentation, as well as block diagrams and description outlining the measurement procedures.
- .2 All acoustic measurements shall be done with commercially available equipment meeting the appropriate ANSI or IEC Standards for precision sound level meters and filter sets.
- .3 Measurements shall be made in octave or 1/3 octave bands centered on the standard frequencies, as required.
- .4 Submit the test report(s) written certification that the system is complete and meets these specifications and is ready for final inspection.

3.3 SYSTEM TESTING AND COMMISSIONING

- .1 27.41.00 shall provide onsite administration and performance of all required acceptance and commissioning of systems, including testing, adjustments and fine-tuning required to optimize overall system performance and functionality. Include also for provision of required test equipment (spectrum and analyzers, meters, etc.) and personnel on site for all periods of testing and verification work.
- .2 Distribute to the Departmental Representative a full system commissioning report confirming the systems have been tested and optimized in all configurations. The reports shall include infield testing of the harmonic distribution and coverage of all areas complete with supporting test results.
- .3 Distribute to the Departmental Representative, a project deficiency list prior to scheduling final commissioning and acceptance.
- .4 All commissioning and deficiency reports shall be signed off by 27.41.00 Project Manager, prior to issuance to the Departmental Representative.
- .5 After the Departmental Representative has received and reviewed the reports on all system testing, commissioning and deficiencies, a final commissioning and acceptance session will be conducted by 27.41.00, and the Departmental Representative(s).
 - .1 During the final commissioning and acceptance session, 27.41.00 may also be required to repeat any portion or portions of the testing.

- .2 Acceptance by the Departmental Representative in writing shall denote substantial performance, unless otherwise defined in Division 1.
- .3 If the system does not fulfill all aspects of this Document, make any adjustments, or any other changes required, bringing the installation into conformance with the Bid Documents.
- .4 Prior to final acceptance, after notifying the Departmental Representative, the Departmental Representative may require use of the system for testing or other purposes. 27.41.00 shall not waive any responsibility because of this temporary use of the system and it shall not be construed as evidence of acceptance.
- .5 27.41.00 shall provide a minimum of one year warranty and onsite service for their work. See instruction to bidders and bid forms for additional warranty and maintenance requirements.

3.4 AS BUILT DRAWINGS

- .1 Preliminary as-built drawings and specifications shall be submitted to the Departmental Representative for approval prior to final submission
- .2 Upon approval, the as-built drawing must be included in the final submission, including all manuals, appropriate programs both in hard copy and electronic format
- .3 As built drawings shall include the following:
 - .1 Audio
 - .2 Video
 - .3 Control
 - .4 System function
 - .5 Control Program (Compiled and non-compiled versions)
 - .6 Touch Panel Layouts
 - .7 DSP Program (Compiled and non-compiled versions)
- .4 At the conclusion of this project, 27.41.00 shall provide "as-built" drawings and specifications showing all details of the construction. These as built drawings may closely resemble the shop drawings previously submitted, but will include all details of changes or variances that were necessary during the construction period to accommodate site conditions, or other Departmental Representative requested and approved modifications.
- .5 Upon completion of the installation following commissioning of the system, the supplier shall provide an operating manual for review by the Departmental Representative. The manual shall be bound in a heavy-duty ring type binder, which shall be clearly labelled and contain a complete index and plan pockets. A soft copy of the manual shall include the following items:
 - .1 Table of contents
 - .2 Complete bill of materials (BOM), including all updates and changes (made by change order) or other conditions
 - .3 As-built drawing set and as built specifications manual
 - .4 System Operation Manual including:
 - .1 Step by step Power Up/Down procedure to follow
 - .2 Detailed operating instructions for each system

- .3 Screen Capture touch Screen pages with instructions
 - .5 Technical manuals for each component (or descriptions for each unit type of equipment if manual is not available)
 - .6 Compiled & non-compiled program files & code for control system
 - .7 Intellectual property disclaimer regarding transfer of ownership of the compiled & non-compiled program files & code to the Departmental Representative.
 - .8 Preventative maintenance procedure, including; cleaning of system components, replacing filters, lamps etc..
 - .9 System restore-detailed information on how to restore the system after a system crash.
 - .10 Contact information (including info for service &warranty repairs)
- .6 Prior to the final submission, 27.41.00 shall submit a draft copy of the as built drawings, specifications and system manual to the Departmental Representative for review.
- 1. No later than twenty (20) working days following the commissioning of the system, 27.41.00 shall provide three bound sets of the as-builts drawings. The drawings shall have clearly labelled cover page and table of contents. Three sets shall be provided to all Departmental Representative.

3.5 Training

- 1. 27.41.00 shall provide (4) four onsite training sessions, pertaining to the operations and routing/preventative maintenance of the scope of work, of not less than (2) two hours each to representatives named by the Departmental Representative. This training shall occur at a time that is acceptable by both parties.
- 2. A training syllabus must be supplied to the Departmental Representative for approval, prior to the commencement of the training.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

- .1 Refer to Section 28 12 01 Access Control General Requirements.

1.2 SCHEDULE

- .1 Refer to Section 28 12 01 Access Control General Requirements.

1.3 DEFINITIONS

- .1 Refer to Section 28 12 01 Access Control General Requirements.

1.4 DESIGN PERFORMANCE REQUIREMENTS

- .1 This document provides the minimum performance criteria for the components and sub-systems comprising a complete Security System cabling.
 - .2 General Scope
 - .1 This document defines the cabling system and sub system components to include cable, termination hardware, supporting hardware, and miscellany required to provide a complete system supporting the Security System.
 - .2 The intent of this document is to provide all pertinent information to include, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system. Supply all items required for a complete system if not identified in this specification.
 - .3 Product specifications, general design considerations, and installation guidelines are provided in this written document. Meet or exceed all performance requirements for the cabling system described in this document.
 - .4 Cabling shall include the following systems:
 - .1 Access Control System
 - .2 Electrified Door Hardware
 - .5 The work shall include the installation of the following:
 - .1 Category 6 patch cords
 - .2 Telecommunications grounding and bonding hardware
 - .3 Cable terminations onto patch panels and insulation displacement connectors (IDC)
 - .4 Labelling
 - .5 Testing of all Security System cabling;
 - .6 Cable management hardware
 - .7 Cable troughs in LAN room.
 - .8 Conduits in LAN room and at doors
 - .9 As-built Plan Holders
 - .6 The work shall involve identification, design, and installation for the following:
 - .1 Horizontal Access Control System Cabling.
 - .2 Access Control Cabling
 - .3 Door Hardware Cabling
 - .3 System Description
-

- .1 Horizontal cabling
 - .1 All cables shall be in protective conduit provided by Division 26
 - .2 All conduits shall be with a maximum conduit fill rate that does not exceed 40%.
 - .3 All cables shall comply with manufacturer recommended cable types.

Part 2 Products

2.1 INSTALLATION OF PRODUCTS

- .1 Be fully responsible for the ultimate design and implementation of the full system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints.
- .2 The Security Cabling System shall use matched components from a single manufacturer.
- .3 Comply with manufacturer's instructions and recommendations so as to meet the requirements of the specifications.

2.2 CABLE MANAGEMENT

- .1 Horizontal Cable Management
 - .1 To effectively manage patch cords and patch panels, cable management bars shall be used.
 - .2 Vertical Cable Management
 - .1 A Vertical Cable Management System (VCM) shall be provided by the Department Representative for effective management of patch cords from network equipment and patch panels on equipment cabinets.
 - .2 Vertical management channel shall be provided by the Departmental Representative.
 - .3 Network Terminations / Patch Panel
 - .1 All equipment racks and patch panels shall be provided by the Departmental Representative.
 - .2 All Network Terminations shall be coordinated with the Departmental Representative.
 - .4 Patch Cords, Cross-Connect Wire and Pigtails
 - .1 General
 - .1 All required patch cords shall be provided by Division 27.
 - .2 All Security System patch cables shall be colored white
 - .5 Equipment Cabinets
 - .1 Equipment cabinets shall be supplied by the Departmental Representative.
 - .6 Uninterruptible Power Supply (UPS)
 - .1 UPS power for each equipment cabinet containing security PoE, Network Switches shall be supplied and installed by the Departmental Representative.
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2.3 GROUNDING AND BONDING

- .1 Provide grounding & bonding in accordance with good industry practices and in accordance with codes and standards.

2.4 PLYWOOD BACKBOARD

- .1 Fire retardant plywood panels in the LAN room shall be supplied, installed and Fire retardant painted by the by Section 06 10 00 and Section 09 21 16.
- .2 Fire Stop System
- .3 Coordinate with section 07 84 00
- .4 All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped.

2.5 LABELS

- .1 General
 - .1 All identifier labels shall be of a size, color, and contrast to be readily visible by those maintaining the system.
 - .2 All components of the cabling system shall be numbered including the following components:
 - .1 Backbone and horizontal cabling
 - .2 Outlet faceplates
 - .3 Patch cables
 - .4 Patch panel ports
 - .5 Equipment Terminal ports
 - .2 Labels should be resistant to environmental conditions likely to be encountered where they are installed, such as moisture or heat, and should be designed to have a useful life equal or greater to that of the component labelled.
 - .3 Where possible, industrial grade adhesive should be used on labels.
 - .4 Device labels shall be installed on the exterior of all devices, when possible. Device labels may be installed on the interior of a device at the primary access point.
 - .5 Patch Panel, Cable and Conduit Labels
 - .1 Labels shall use black lettering on a white background.
 - .2 To maximize legibility, all labels shall be printed or generated by an Departmental Representative approved labeling device and shall not be written by hand.
 - .3 Hand-written labels are only acceptable on a temporary basis during installation.
 - .4 Labels shall be able to withstand high and low temperatures without detaching.
 - .5 Labels in exterior spaces shall be able to withstand extended submersion.
 - .6 Labels shall be self-adhesive type.
 - .7 The minimum font sizes are defined below:
 - .1 Patch Panel and cables: Arial 10 point or as per Departmental Representative approved standard

2.6 IDENTIFICATION LOG

- .1 Cable Identification Log shall be recorded in Excel.
- .2 A hard and soft copy Cable Identification Log is to be handed over to the Departmental Representative within 30 days of substantial completion.

2.7 CABLE TESTING AND SYSTEM CERTIFICATION

- .1 The cabling system will require 100% cable testing and verification.
- .2 Verify each cable and document results on a cable testing sheet which shall form part of the electronic and hard copy documentation supplied at the end of the installation. The testing sheets will list the detailed performance test measurements as requested and as required to prove compliance with the referenced standards. Submit a sample of test sheet with shop drawings to Departmental Representative.
- .3 Compliance with manufacturer's testing and certification procedures will be mandatory.

2.8 MISCELLANEOUS EQUIPMENT

- .1 Provide all necessary screws, anchors, clamps, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the equipment.

2.9 SPECIAL EQUIPMENT AND TOOLS

- .1 Furnish any special installation equipment or tools necessary to properly complete the System.

Part 3 Execution

3.1 GENERAL

- .1 The cabling system shall be installed in accordance with manufacturer's recommendations and best industry practices.
 - .2 All cables placed in cable tray shall have slack placed where expansion joints occur.
 - .3 Where wires run through holes or conduit, they shall be protected by suitable grommets
 - .4 Wires and cables external to equipment and enclosures shall be run in conduit. PVC conduit may be used underground. Where free movement of equipment is required, flexible conduit shall be employed. Once installed in the conduit, all cable shall be tested for continuity, insulation breakdown (skinning) and ground faults.
 - .5 Provide additional conduits and raceways where required, provide blank stainless-steel cover plates for back boxes that are not being used
 - .6 Wires and cables shall be located so that inductive and capacitive effects do not degrade system operation
 - .7 For non-network related cables all wires shall be terminated by soldering or by the use of solder-less terminals. Crimp lug terminals shall only be used on stranded wire. For devices utilizing solid wire, the solid wire shall be soldered to the terminal and the soldered portion insulated.
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- .8 Terminal and connecting blocks shall be of the screw type. As a minimum, all terminal blocks shall have 20% spare capacity. A barrier shall separate each termination. No more than two terminal lugs shall be clamped under each terminal screw. Solder, wire wrap and pressure termination type terminal blocks shall only be used with prior approval and where the need for this type of device has been demonstrated. No more than one wire may be connected to each terminal, except in permanent daisy chaining requirements.
- .9 Terminal lugs shall be suitably electroplated or treated by commercially acceptable methods to ensure good electrical contact and prevent corrosion
- .10 No more than one wire shall be connected to each pin of a cable connector unless that pin has been designed to accept more than one wire. All strands of the wires shall fit into the pin receptacle. All cable connectors shall be field replaceable. Provision shall be made to fix the cable connector covers to a chassis or to each other by means of screws
- .11 Verify that critical dimensions are correct and conditions are acceptable. Proceed with installation only after unsatisfactory conditions have been coordinated.
- .12 Prior to commencement of Work, examine current site conditions and inform the Departmental Representative of any unusual existing conditions that may affect Work.

3.2 WORK AREA

- .1 Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" (305mm) slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls.
- .2 Do leave 10' (3m) of slack, be neatly coiled and stored in the ceiling above each drop location.
- .3 Prevent undue stress and strain on connectors and cables;
- .4 Allow easy disconnection of equipment;
- .5 Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.

3.3 HORIZONTAL DISTRIBUTION CABLE INSTALLATION

- .1 All access control cabling shall be installed in conduit.
- .2 A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be co-installed with all cable installed in any conduit.
- .3 Cable raceway shall not be filled greater than the maximum fill for the raceway type or 40%.
- .4 Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points that are within secure enclosures and are not permitted inside the conduit.
- .5 Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.
- .6 The cable's minimum bend radius and maximum pulling tension shall not be exceeded. Refer to manufacturer's requirements.
- .7 Cables shall not be attached to or rest on liquid carrying pipes and electrical conduits.

- .8 Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- .9 Cable supports must be installed every 4-5 feet at an irregular interval. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- .10 Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, install appropriate carriers to support the cabling.
- .11 Do not install cables under such strain as to require tying to supports.
- .12 All cables are to be installed in a neatly-dressed manner to their point of termination.
- .13 Obtain and follow the manufacturers' installation instructions for products for correct termination and wire management of cables on respective products.
- .14 Cable routing is to avoid crossovers and congestion at all times.
- .15 All Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

3.4 HORIZONTAL CABLE TERMINATIONS – CABINETS / ENCLOSURES

- .1 All horizontal cable shall be installed per manufacturer instructions to ensure a manufacturer certified solution.
- .2 Neatly dress cables to their respective patch panel and within the cabinet with cable management using Velcro cable ties and/or rack cable management loops. Cables shall not be bundled outside of a rack but shall be loose and random in cable tray.
- .3 Provide identification labels for each cable.

3.5 CABLE AND EQUIPMENT LABELLING

- .1 Functional or alpha-numerical mechanically printed labelling shall be installed on all equipment. All visible wires and cables typically accessed for service shall be labelled at both ends. As well, all connecting strips, terminal blocks, plugs and sockets shall be labelled. The marking on the labels shall be consistent with the As-Built Drawings and Specifications.
- .2 All cables shall be labeled at all termination points, junction box and pull box locations. Install permanently wrapped cable identification labels produced by a portable label maker that utilizes a thermal transfer printer with black on white vinyl self-adhesive labels approved by the Departmental Representative.
- .3 Equipment Enclosure: Printed label shall be placed on lower left side of the door (hinge side). Printed label text shall include panel name and circuit number. Printed labels shall be clear polypropylene with adhesive back designed for exterior applications. Label text shall be 4.8 mm (3/16") high, black and shall be applied to the label by a thermal transfer printer.
- .4 Labeling inside security panels shall be easily identifiable and shall not be concealed behind cable management or tie warps.

3.6 CABLE CONTAINMENT

- .1 Cable exits shall be strictly controlled such that additional cables can be easily and neatly added to trays and raceways in the future.
- .2 Cable shall be installed to use the minimum of the raceway width.
- .3 Loose laid cables shall not be permitted.
- .4 Conduits shall not exceed a fill ratio of 40% to allow for future installation of cables.
- .5 Cables shall enter and exit conduit such that complete separation between power compartments is maintained.
- .6 The number of cables in each conduit shall be controlled to allow for future cable installation and to stay within the manufacturer's maximum allowable cable pulling tension.

3.7 GROUNDING AND BONDING

- .1 Be responsible for grounding of all cabinets, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the communications rooms. These shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

3.8 SEPARATION FROM SOURCES OF ELECTROMAGNETIC INTERFERENCE (EMI)

- .1 All cables shall be separated from sources of electromagnetic radiation.

3.9 FIRE STOP SYSTEM

- .1 Coordinate with Section 07 84 00

3.10 TESTING AND ACCEPTANCE

- .1 General
 - .1 All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions.
 - .2 All pairs of each installed cable shall be verified prior to system acceptance.
 - .3 Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
 - .4 Any cable not passing the testing procedure shall be replaced expeditiously and in its entirety. No splicing will be permitted in the repair of any defective cable.
 - .5 Produce a test report based on the cable schedules. The report should indicate for each cable, when it was tested successfully and the technician that performed the test. Division 28 must sign the report, prior to submission for the Departmental Representatives approval.

3.11 AS-BUILT DOCUMENTATION

- .1 Provide copies of all test results in both hard and soft copies.
 - .2 All cables, patch panel ports and outlet ports with the corresponding communications room number shall be recorded in Excel spread sheets for submittal.
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3.12 PROTECTION

.1 Refer to Section 28 12 01 Access Control General Requirements.

3.13 CLEAN UP

.1 Refer to Section 01 74 00 Cleaning

3.14 CONTRACT CLOSEOUT

.1 Refer to Section 28 12 01 Access Control General Requirements.

END OF SECTION

Part 1 General

1.1 REQUIREMENTS

- .1 Refer to Section 28 12 01 Access Control General Requirements.

1.2 DEFINITIONS

- .1 Refer to Section 28 12 01 Access Control General Requirements.
- .2 Design Requirements
- .3 General Scope
 - .1 This document defines the Access Control System to include field devices, termination hardware, supporting hardware, locking hardware and miscellany required to provide a complete system. The intent of this document is to provide all pertinent information to supply the equipment, labor, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete operational and functional system. Propose in their bid any and all items required for a complete system if not identified in this specification.
 - .2 Be responsible for the entire scope specified herein.
 - .3 Supply and install a fully functional Kantech Access Control System that is integrated to electrified door hardware and Departmental Representative's existing Kantech Central Control Computer System.
 - .4 Be responsible for the procurement, detailed design, installation, terminations, programming, configuration, integration, testing and demonstrating system functionality.
 - .5 Install all required cabling, connectors, door hardware, software, hardware and software updates, hardware and software upgrades and licenses to allow for the required functionality under this specification.
 - .6 Provide at all times sufficient competent trained labor, materials, and equipment to properly carry on construction work and insure completion of each part in accordance with the Work Schedule.
 - .7 Provide necessary labor, Certified technicians and material to comply with manufacturer's requirements and applicable standards and codes for grounding of devices.
 - .8 Equipment shall be installed as per manufacturer recommendations or as otherwise noted in this specification and specification drawings.
 - .9 Be responsible for the safe keeping and protection of the system equipment until the system is fully accepted by the Departmental Representative after the commissioning process.
 - .10 Coordinate all Work with the Departmental Representative and applicable trades on site.
 - .11 Coordinate all Work regarding the network and IP addressing schemes with the Departmental Representative.
 - .12 Equipment and material shall be UL, CSA or ULc certified. Where there is no existing rating to equipment specified, obtain special prior written approval from the Departmental Representative
 - .13 Warrant the completed Access Control System including all equipment/hardware, software and documentation. Maintain the Access Control System in compliance with manufacturer specified preventative maintenance schedule during the project installation period.

- .14 Preventive and corrective maintenance performed by another maintenance provider other than the installer, after or during warranty period shall not void warranty on labor, hardware or software provided.
- .15 System testing shall follow the testing, commissioning and Certificate of Acceptance process outlined in Section 28 00 00.
- .16 All card readers and operator controls shall be installed between 800-1200MM above Fixed floor level to meet CSA-B651-18 –Accessible design for the built environment.
- .4 System Description
 - .1 Supply. Install and Configure the Access Control System as described in this specification and as shown on the specification and drawings.
 - .2 The Access Control System shall be capable of expansion to additional card access portals and monitoring points. The system shall be remotely operated, monitored and configured by the Departmental Representatives existing Kantech central server solution.
 - .3 The Access Control System shall be installed based on Kantech KT-400 control panels installed in Kantech enclosures as shown on the drawings.
 - .4 Connectivity from the KT-400 panels to the existing system Central Server Solution at the remote security office will be based on Ethernet IP based protocols over the IP network provided by the Departmental Representative.
- .5 Access Control System Deployment
 - .1 The Access Control System shall consist of card readers compatible with existing card format deployed by the Departmental Representative, door contacts, REX devices and monitoring devices integrated to the door hardware, and electronic locking devices necessary to provide a fully automated and monitored system to control authorized pedestrian traffic in and out of controlled doors of the facility.
 - .2 The conduit installation from the doors to the LAN room shall be provided by Section 26 and shall be consistent with the specification drawings and all norms and regulations applicable. In the event the proposed pathway becomes infeasible source an alternative route and propose to the Departmental Representative for approval. Alternative routing of pathways shall not incur any additional costs to the project.
 - .3 The Access Control System shall be configured by the Departmental Representative's existing Kantech central server solution.
 - .4 The Access Control System shall consist of the elements in the quantities specified in the drawings and schedules.
 - .1 For card reader door locations, supply and install all necessary field devices as shown on the Security drawings including, but not limited to:
 - .1 Card Readers
 - .2 Request to Exit Motion Detectors or REX switch
 - .3 Concealed Door Contact
 - .4 Local Audio/Visual Alarms if indicated on drawings
 - .5 Door hardware
 - .2 Supply and install all necessary Control Equipment including, Transformers, Power supply units with as shown on the drawings:
 - .1 Equipment shall not carry any logos or text without prior formal approval from the Departmental Representative.
- .6 Portal Definition

- .1 Common Portal Functions
 - .1 The below functions are general to all portal's where applicable, and unless otherwise stated within the respective portal sub-sections.
 - .1 Valid Access Trigger – The following are valid triggers which shunt the door alarms, and allow proper access through the respective portal.
 - .1 Valid Access Card swiped
 - .2 Request to Exit Motion Detector or Pushbutton
 - .3 Remote access granted.
 - .2 Invalid Card Reader Swipe
 - .1 Upon presentation of an invalid access card, the card reader shall provide an audio/visual indication of the invalid access attempt.
 - .3 Door Forced Open Alarm
 - .1 In the event that the Door Position Switch or Lock Status Switch activate without a Valid Access Trigger, generate a “Door Forced Open” alarm at the access control head end and activate the local annunciator.
 - .2 Local annunciator shall remain active until door is closed and a valid access card is swiped. Alarm can also be reset by the operator remotely from the Central control system.
 - .4 Door Held Open Alarm
 - .1 Door not closed during shunt time will activate “Door Held Open” indication in the Central control system, activate local annunciator and pop up cameras in the area on security monitors through integration. The system should have the ability to keep the local annunciator active until door is closed and a valid card is swiped. Alarm can also be reset by the operator remotely from the Central control system.
 - .7 Equipment Rooms
 - .1 Provide cable troughs, conduit, and emergency power circuits for Panel configurations, as shown on the drawings Cable troughs shall be grounded to earth ground.
 - .2 All enclosures shall be mounted on fire rated plywood supplied and installed by Section 06 and Section 09.
 - .3 Access Control equipment, cable troughs, conduit, emergency power circuits, and power supplies shall be wall mounted as per specification drawings and manufacturer's specifications. In the event the proposed layout becomes physically or technically infeasible, propose alternative layout to the Departmental Representative for approval. Alternate equipment layout, cabling, and conduit shall not incur any additional costs to the project.
 - .4 Provide temperature sensor alarm unit to monitor temperature within the LAN room and connect into the Access Control System for remote temperature alarm monitoring.
 - .5 Prior to start of installation of any equipment remove all water, dirt and debris of any kind from the room. Keep LAN room clean and free of dust at all times during the installation.
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- .8 Communications Backbone
 - .1 IP backbone and Infrastructure shall be supplied by the Departmental Representative.
- .9 Security Network
 - .1 Ensure that all IP addressing schemes used on the security network are coordinated and approved by the Departmental Representative prior to implementation.
 - .2 The IP addressing, labeling, and terminating scheme shall be communicated by the departmental Representative at the time of installation
- .10 Monitoring & Control Locations
 - .1 Access Control Server
 - .1 The access control system components installed shall be configured, operated and maintained by the existing Kantech infrastructure, operational at the Central Security Control.
 - .2 Coordinate with the Departmental Representative to configure and test the functionality of the installed system.
- .11 Third Party Interfaces
 - .1 All third-party interfaces shall be directly supported by the individual system manufacturer(s). "Middleware" created and deployed by a 3rd party is not acceptable and shall not be used on this project.
- .12 Network Time Protocol
 - .1 The Access Control System shall be maintained with NTP time. The NTP master clock Link, shall be by the Departmental Representative.
- .13 Power
 - .1 Refer to Section 28 00 00 General Security System Requirements.
- .14 Labelled Fire Doors and Frames
 - .1 In no instance shall any labelled fire door or frame be cut, penetrated, drilled or modified in any way that has not been designated as requiring such in the security drawings.
 - .2 Any labelled fire door or frame which will require modification to meet the system specifications must be immediately brought to the attention of the Departmental Representative.
 - .3 Be responsible for replacing any labelled fire door or frame that is modified, without written approval from the Departmental Representative.

1.3 SUBMITTALS

- .1 Refer to Section 28 00 00 General Security System Requirements.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Refer to Section 01 74 19 Waste Management and Disposal

1.5 WARRANTY

- .1 Refer to Section 28 00 00 General Security System Requirements.
-

Part 2 Products

2.1 GENERAL REQUIREMENTS

- .1 Be fully responsible for the ultimate design and implementation of the system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints.

2.2 TECHNICAL REQUIREMENTS – FIELD DEVICES

- .1 Electronic Locking Devices
 - .1 In locations requiring door hardware such as electric lock Sets, Electromagnetic locks, electric strikes, power transfer hinges, door cords or electrified panic hardware, these units shall be supplied, by Section 08-71-00. Coordinate all requirements for each card access controlled door with the Section 08-71-00
 - .2 Fire release of electromagnetic lock permits and installations if required shall be coordinated with the Departmental Representative.
 - .2 Door Position Switches
 - .1 Supply and install door position switches for all card access controlled doors, in consultation with the Departmental Representative.
 - .2 Door position switches shall be Interlogix / Sentrol 1078 type or similar concealed discrete devices unless otherwise noted and shall not be integral to other devices such as strikes, maglocks, etc.
 - .3 The maximum diameter for the concealed contact and magnet shall be 26mm.
 - .4 All End Of Line resistors shall be installed at the door contact.
 - .5 Frame mounted magnetic door contacts, hinge mounted plunger type switches, are not acceptable.
 - .3 Card Readers
 - .1 Departmental Representative approved card readers compatible with the security standards set for Access Cards, shall be installed on all access controlled doors.
 - .4 Tamper Alarms
 - .1 All security equipment cabinets (ACS and system power supply cabinets) shall be equipped with sensors, which detect and remotely annunciate their opening.
 - .2 All communication and alarm device cabling at the door and between the DGP and the door shall be supervised to detect and remotely annunciate "open", "high impedance", "low impedance", and "short" conditions. The end of line supervision device shall be installed as close as possible to the monitored security device at the end of the line.
 - .5 Request to Exit Motion Detector
 - .1 Requests to exit motion detectors shall be installed for hands free exit.
 - .1 Request to Exit Motion (REX) detectors shall be an infrared exit detector for access control applications suitable for mounting in a single gang box above doorways.
 - .1 For electric strike applications the REX shall shunt the door contact only, where applicable, for the programmed activation duration but shall not energize the electric strike, or unlock door.
 - .2 Request to exit motion detector case color should be confirmed with the Departmental Representative.
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- .6 Request to Exit
 - .1 Request to exit Wave to Exit devices shall be used at locations if shown on the drawings.
 - .1 Request to exit wave to exit devices shall be equipped with a heavy-duty tamper resistant Double Pole Double Throw contacts (DPDT).
 - .2 Back plate shall be a minimum ¼" (6.35mm) thick brushed aluminum.
- .7 Edge Device Environmental Requirements
 - .1 System shall be capable of operating within the temperature range of +4°C to +50°C (+40°F to +122°F).
 - .2 Outdoor edge devices should have an Ingress Protection Rating of IP67 minimum. Outdoor devices shall be capable of operating within the temperature range of -40°C to +50°C (-40°F to +122°F).

2.3 TECHNICAL REQUIREMENTS – LAN ROOM.

- .1 Be responsible for the ultimate design and implementation of the system topology (physical and logical) best suited for the project, given identified and recognized physical infrastructure and constraints.
- .2 Distributed Processing Unit (DPU)
 - .1 General
 - .1 The DPU shall be Departmental Representative approved controllers with enclosures.
 - .2 The DPU serves as the data collection and communications interface between the System Central Server and the various field devices such as card readers, alarm inputs and control outputs.
 - .3 All Access Control functionality shall be contained in the DPU and its accessories. DPUs shall communicate to the Central Server Via Departmental Representative supplied communication network via standard TCP/IP protocols.
 - .2 Power Requirements
 - .1 Each Kantech panel shall accept AC power input through an ULc/CSA approved transformer and generate appropriate voltage levels for on-board DPU. All power output to external devices shall be current limited by the DPU.
 - .2 Each panel shall contain Battery backup for a minimum of 6 hours.
 - .3 All power supplies shall be hard wired into source 110 VAC power. Plug in transformers are not acceptable.
 - .3 System Enclosure
 - .1 The panels shall be housed in a locking steel enclosure, suitable for wall mounting. All cabinet locks shall be keyed alike. The cabinet shall be suitably sized to allow installation of the DPU and associated field wiring. A single, Normally Closed (NC) tamper switch shall be incorporated into the door to monitor tampering.
 - .4 Regulatory Approvals
 - .1 Regulatory Approvals - FCC Part 15, CE, UL 294, and UL 1076. UL 1076 shall be applied only to the overall system as required. All power supplies shall be UL, ULc or CSA approved.
 - .5 Communication Services

- .1 A set of Communications Services shall be provided to facilitate encrypted communication between the System Server and DPU. The service shall also allow configuration of communication ports and shall handle all data encryption and communication protocol specifics.
- .6 Communications
 - .1 The network system shall be designed to support advanced distributed network architectures, whereas DPUs do not need to be home-run wired back to the System database server. DPUs shall be wired at any point on the Local Area Network (LAN)/Wide Area Network (WAN) via industry standard Ethernet utilizing the TCP/IP protocol. DPUs shall be able to communicate back to the System database server through industry standard network switches and routers and shall not be required to reside on the same subnet as the System Server. Any activity or event within the DPU network shall be routed to any client workstation(s) on the network, regardless of the DPU that handles the activity. The System Server shall manage any message routing issues, thus isolating the subsystem applications from network-specific communication details.
 - .2 The Distributed Processing Unit to System Server communication shall include TLS authentication and encryption.
 - .3 Upon losing and then restoring communications between the DPU and the System Server, database synchronization between the System Server database and the local database in each Controller shall be fast and efficient. When communications are restored, database synchronization shall occur immediately and without System Operator intervention. Any changes made to the System Server database while the DPU was off-line shall also be simultaneously downloaded to all required DPU databases.
- .7 Offline / Online Reporting
 - .1 The system shall provide a mechanism to report activities to the System Server for display, reporting and archiving. If a System Server is not currently connected to the cluster of controllers, the activity reports will be buffered until the System Server reconnects to the cluster. Should the user-configured, activity buffer limit be exceeded before the System Server reconnects, the first in first out rule shall apply.
- .8 Access Control
 - .1 One of the ACS's primary purposes shall be to provide access control. The ACS shall be able to make access granted or denied decisions, define access levels, and set time zones and holidays. An input or output linkage feature shall allow linking of monitor zone points to output control points within Distributed Processing Units (DPUs). The ACS shall support features such as area control (two-man control, hard, soft, and timed anti-pass back), database segmentation, and time zone or holiday overrides if and when required in the future.
- .9 Alarm Monitoring

- .1 The remote KT-400 panels shall be monitored to provide information about the time and location of alarms, along with its priority to the Central control server. The main Alarm Monitoring window must be able to sort pending and/or insert new alarms based on any of the following attributes: priority, date or time, alarm description, Distributed Processing Unit, Card Reader, Input Control Module, asset name, or cardholder. Date or time sorts must be System Operator selectable to be either ascending or descending and must have the option of displaying the seconds of the minute in which the alarm arrived into the ACS.
- .10 Credential Management
 - .1 All credentials shall be managed and issued by the Central Control Server from the Departmental Representative's Security office.
- .11 Remote Access Level Management
 - .1 The ACS shall include a seamlessly integrated remote access level management module. The remote access level module shall allow the Departmental Representative managers to assign and remove access levels to and from cardholders in the existing ACS database. All transactions relating to the adding and/or removal of access levels shall be recorded complete with a time and date stamp and the System Operator who made the change.
- .12 System Administration
 - .1 System Administrative tasks such as defining client workstations and System Operator permissions set-up, access groups, time zones, reports, maps, etc. shall be provided from the Central Control workstations, on the network.
- .13 Graphical Map Creation
 - .1 Provide drawings showing all access controlled doors for Graphical Map Creation by the System Administrators.
 - .2 The drawings should provide physical floor layout of field devices including all monitored doors and access control portals,

2.4 ACS CONFIGURATION

- .1 Provide all information including up loadable floor plan drawings with all access control devices shown, as required by the Central Control Server Administrators to configure and make operational the installed devices.
- .2 Coordinate and test all door devices with the remote administrators to meet each door functionality requirement.

2.5 INTEGRATION

- .1 Refer to Section 28 05 45 System Integration and Interconnection

Part 3 Execution

3.1 GENERAL

- .1 Programming
 - .1 Include all associated costs to assist Central System administrators to program the system and ensure all configuration and naming conventions are approved by the Departmental Representative.

- .2 Attend pre-installation meetings as required with the Departmental Representative to identify the specifics of the system configuration and programming.
- .3 Be responsible to document all decided on software configuration parameters and submit for approval.
- .4 Include all approved software configuration parameters in final revisions of the shop drawings.
- .5 Be responsible to ensure final programming configuration and system documentation match the newest door numbers to be provided by the Departmental Representative.

3.2 MECHANICAL AND ELECTRICAL REQUIREMENTS

- .1 Refer to Section 28 12 01 Access Control General Requirements.

3.3 COMMISSIONING

- .1 Refer to Section 28 12 01 Access Control General Requirements.

3.4 DOCUMENTATION

- .1 Refer to Section 28 12 01 Access Control General Requirements.

END OF SECTION

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- .1 National Building Code of Canada 2015
- .2 Ontario Building Code 2012
- .3 CSA-B651-18 –Accessible design for the built environment
- .4 Ontario Fire Code 2015
- .5 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th edition) Safety Standard for Electrical Installations.
- .6 UL 294- Edition 7 - 2018 -Standard for Access Control System Units.
- .7 CSA C282:19 Emergency Electrical Power Supply for Buildings.
- .8 ANSI/TIA -568-B.1-3
- .9 BICSI Telecommunications Distribution Methods Manual – 14th Edition
- .10 American Society for Testing Materials (ASTM).
- .11 Institute of Electrical and Electronic Engineers (IEEE).
- .12 Manufacturer's installation and specification manuals latest issue.
- .13 All applicable Provincial regulations respecting Health and safety.
- .14 National Fire Code of Canada (NFC)
- .15 National Fire Protection Association (NFPA)
- .16 City of Toronto Fire Department

1.1 **SUMMARY**

- .1 Section Includes:
 - .2 Definitions
 - .3 Schedule
 - .4 General requirements
 - .5 Related requirements:
 - .6 Documentation
 - .7 Submittals
 - .8 Training
-

.9 Warranty

1.2 DEFINITIONS

- .1 ACS – Access Control System
- .2 CAT 6 - Category 6 data cable
- .3 COTS – Commercial Off the Shelf Software
- .4 DGP – Data Gathering Panel
- .5 DPU – Distributed Processing Unit
- .6 EIA – Electronic Industries Alliance
- .7 IP – Internet Protocol
- .8 LAN – Local Area Network
- .9 PoE – Power over Ethernet
- .10 RAM – Random Access Memory
- .11 REX – Request to Exit Motion Detector
- .12 RXP – Request to Exit Push Button
- .13 UTP – Unshielded Twisted Pair
- .14 UPS – Uninterruptible Power Supply

1.3 SCHEDULE

- .1 The Departmental Representative Designated Security Services Provider, Convergent Technologies hereinafter referred to as the Section 28 shall confirm the ability to meet the identified scope and the project completion date.

1.4 GENERAL REQUIREMENTS

- .1 Provide a comprehensive, security solution based on all the requirements encompassed within this document. A solution with a well-defined architecture and which includes a comprehensive plan for continuing service and support. Engineer and propose a solution that best meets stated requirements using industry best practices.
 - .2 This specification outlines the requirements for system installation, configuration, integration, operation, products, components and materials.
 - .3 This document details the required submittals, testing procedures and installation procedures for all parts of the system.
 - .4 Hold current certification for the proposed solutions for this project. Must be in good standing with the manufacturer and must have all up to date certifications.
 - .5 Provide documentation for all systems as detailed in this specification.
 - .6 System components to comply with all relevant requirements of CSA, ULc or UL.
 - .7 Coordinate all work with the Departmental Representative as well as with other Sections working on site.
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- .8 Examine all project documents to determine whether there are any impediments to the installation of a fully functioning and operational system. At the time of bidding the provide written notification to the Departmental Representative of any omission, irregularities, errors, or ambiguities. Failure to supply notification shall not relieve the responsibilities for providing a fully functional and operational system at the bid Price. Price.
- .9 Include in the bid all required labour and material to integrate the system outlined in these documents to the Departmental Representative's existing Kantech Central Security Control Centre. This includes configuration of the existing system with new access levels, floor plans and access control devices for real time display and control of all access controlled doors,

1.5 DOCUMENTS

- .1 In the case of discrepancies or conflicts between the Drawings and Specifications, the Documents will govern in order specified in the "General Conditions", however, when the scale and date of the Drawings are the same, or when the discrepancy exists within the Documents, include the costliest arrangement.
- .2 The Security drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. The drawings are intended to convey the scope of work and do not show architectural and structural details. The locations of materials and equipment shown may be altered, when reviewed and accepted by the Departmental Representative to meet requirements of the material and/or equipment, other equipment and systems being installed in the building. The work shall be installed in such a manner as to avoid conflicts between other systems and architectural features. Provide all fittings, offsets, transformations, and similar items required as a result of obstructions and other architectural or structural details not shown on the Security drawings.
- .3 Shall be responsible for reviewing Drawings, Schedules, and Specification requirements of the Security Systems prior to commencing and confirm exact scope of work.

1.6 SUBMITTALS

- .1 Along the course of design and implementation the submit to the Departmental Representative; shop drawings, as-built documentation, and other supporting documents. Provide a schedule for the following document submissions within one-week of award, for review and approval by the Departmental Representative. All submittals shall be in accordance with this Section unless stated otherwise.
- .2 Shop Drawings
 - .1 Each drawing shall include all changes and be upgraded to reflect the latest configuration.
 - .2 The first drawings submitted shall be reviewed for conformance to the requirements herein. Once approval is given, the approved drawing shall be used as the standard, and prepare subsequent drawings to a quality equal to or better than the approved standard.
 - .3 Each drawing prepared and submitted for review shall have in the lower right-hand corner, just above the title block, a five-inch square blank space in which the Departmental Representative may indicate the action taken.
 - .4 Shop drawings shall be prepared and submitted in the native (editable) electronic format (.vsd, .dwg, .xls, .rvt .doc) All documents produced shall be property of the Departmental Representative, Section 28, shall have no rights over the entire documentation package or any parts of the documentation package.
 - .5 All Shop Drawings must be submitted as follows:

- .1 Cover Sheet - Job Name, Date
 - .2 Table of Contents with following columns
 - .1 Device Name
 - .2 Model #
 - .3 Symbol Name on Drawings
 - .3 All Shop drawings shall include as a minimum:
 - .1 Details necessary for the procurement, installation, maintenance, and repair of all components or facilities equipment provided.
 - .2 List of equipment to be installed organized by location and including the part number and the manufacturer.
 - .3 Manufacturer specification sheet for each new piece of equipment. Each sheet should clearly identify the particular model number of the hardware being provided. Where such information is not provided, at the discretion of the Departmental Representative, the most expensive option will be assumed.
 - .4 Wiring diagrams for each location.
 - .5 Point allocation tables for each control panel
 - .6 Termination point on IT patch panel.
 - .7 Detailed System Architecture Diagrams
 - .8 Software configuration parameters.
 - .4 Testing and commissioning plan
 - .1 Safety Plan
 - .2 Software Materials Licenses
 - .3 Operator Manuals and Procedures
 - .4 System Administrator's Manuals and Procedures
 - .5 Operator/Maintenance Manuals
 - .6 Testing procedures for each functional module.
 - .6 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted. Submit minimum three (3) copies of shop drawings unless otherwise directed by Departmental Representative. Confirm exact quantity with Departmental Representative.
 - .7 The Departmental Representative will review shop drawings and will indicate his review status by stamping shop drawing copies as follows:
 - .8 "REVIEWED" or "REVIEWED AS NOTED" - If the Departmental Representative's review of shop drawing is final, the Departmental Representative will stamp the shop drawing "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked).
 - .9 "RETURNED FOR CORRECTION" If the Departmental Representative's review of shop drawing is not final, the Departmental Representative will stamp the shop drawing "RETURNED FOR CORRECTION", mark the submission with his comments, and return the submission. Revise the shop drawing in accordance with the Departmental Representative's notations and resubmit.
 - .10 It is understood that the following is to be read in conjunction with the wording on the Departmental Representative's shop drawing review stamp applied to each and every shop drawing submitted:
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- .1 "THIS REVIEW BY THE DEPARTMENTAL REPRESENTATIVE IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH THE GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT THE DEPARTMENTAL REPRESENTATIVE APPROVES THE DETAIL DESIGN INHERENT IN THE SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH SECTION 28, AND SUCH REVIEW DOES NOT RELIEVE THE RESPONSIBILITY FOR ERRORS OR OMISSIONS IN THE SHOP DRAWINGS OR OF RESPONSIBILITY FOR MEETING ALL REQUIREMENTS OF THE DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT THE JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF THE WORK OF ALL SUBTRADES".

1.7 SECURITY SYSTEMS TESTING PROCEDURE

- .1 General: Overall testing algorithm shall consist of three phases per system and final Integrated Test(s) of all subsystems.
 - .1 Field devices (Field Layer).
 - .2 Termination equipment (Distribution Layer).
 - .3 Monitoring locations, integrated system functionality – within the system (Core Layer).
 - .2 Exact testing schedule on day by day basis (including exact list of devices that should be tested during allocated time) should be submitted two weeks prior to commencement of testing.
 - .3 The test shall be conducted according to the following algorithm:
 - .1 Verify prerequisites
 - .2 Verify presence of all required witnesses of the test in accordance with the Specification.
 - .3 Verify presence of a test plan, test description.
 - .4 Verify presence of all test forms and checklists for proper test recording and documenting.
 - .5 Verify presence of all test objects: field devices, panels, racks, equipment, components, cables, hardware, software, programming devices, AC power, etc.
 - .6 Verify presence of programming and/or configuration settings, manufacturer's recommended test procedures for every device, predetermined parameter ranges and expected test results. This information may vary and depends on the actual location of testing and commissioning activity.
 - .7 Shop and Record Drawings(s).
 - .8 Programming/configuration settings.
 - .9 Conduct the Test
 - .10 Verify record drawings with the site location and the testing package.
 - .11 Verify programming sheets with active settings(s).
 - .12 Verify installation, workmanship, wiring, cabling, grounding & shielding,
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- .13 Verify functionality.
 - .14 Document the Test
 - .15 Complete all test forms and checklists.
 - .16 Record all required and applicable information.
 - .17 Compare obtained test results with expected results.
 - .18 Provide test report.
- .4 Dealing with Deficiencies
- .1 Identify deficiencies and record them in a system's log.
 - .2 Deficiencies should be treated on an individual basis, Remediation and correction to be confirmed and approved by the Departmental Representative.
 - .3 Each deficiency should be corrected in a prompt manner. All deficiencies shall be identified with proper correction schedule, dates, responsible parties, and names.

1.8 WARRANTY

- .1 Shall warrant the completed solution including all equipment, device software, device firmware, documentation and latent defects delivered shall perform in accordance with and conform to all applicable standards, requirements, specifications, descriptions, and other requirements included in their proposal and shall be without defects in materials, workmanship and design. The warranty shall commence upon Certificate of Completion as defined by the Departmental Representative.
- .2 Expose, and assign to the Departmental Representative, any manufacturer's warranties. Include for 12-month all-inclusive parts and labor with 12-month warranty as part of the bid amount. Also, include software, Firmware, maintenance for a period of 12 months.
- .3 As a minimum during the warranty period and at no extra cost to the Departmental Representative, include a guaranteed response time of two (2) hours for a major system failure and eight (8) hours for a minor system failure on a 24 hour per day, 7 days per week basis. A major system failure shall be defined as the failure of any operator controls as well as any system controller, processor or communication link which renders more than 10% of a specific security subsystem or systems inoperative. A minor system failure shall be defined as the failure of a single security device such as a card reader, egress device etc.
- .4 As part of the submission, provide a complete list of recommended spare parts which should be held in the facility as well as a list of parts available on premises for fast system repairs and/or replacements.

1.9 LICENSE FEES

- .1 Provide licenses for every edge device added and remote central control computer systems that would require licenses.
 - .2 All firmware and software shall be guaranteed for up to five (5) years, during which period any patches, bug fixes or related upgrades shall be implemented without additional cost to the Departmental Representative.
 - .3 All software and firmware delivered shall become the property of the Departmental Representative. The Departmental Representative's right to use all software and firmware delivered for this project shall not expire, regardless of other upgrade and warranty arrangements agreed with the Departmental Representative.
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Part 2 Products

2.1 INSTALLATION OF PRODUCTS

- .1 Comply with manufacturer's instructions and recommendations so as to meet the requirements of the specification in all respects with regards to performance and functionality. Anchor each product securely in place, accurately located, coordinated and aligned with other Sections. Conflicts between the manufacturer's instructions and the Specification shall be promptly brought to the attention of the Departmental Representative prior to the initiation of any related Work.
- .2 Installation shall comply with all applicable norms and regulations, Departmental Representative standards and Base Building standards.
- .3 Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration,
- .4 Thoroughly clean areas and spaces where work is performed or used as access to work. Remove completely, paint, mortar, oils, putty and items of similar nature. Thoroughly clean piping, conduit and similar features before painting or other finishing is applied. Restore all surfaces to their original condition.
- .5 Termination equipment is to be mounted according to manufacturer's instructions unless specified otherwise.
- .6 Ensure that all services in the immediate areas of the installation are protected against damage or interference.

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle products in accordance with the manufacturer's recommendations, using means and methods that will prevent damage, deterioration and loss, including theft. Materials delivered to the Project site shall be stored and protected to effectively prevent theft or damage from weather or physical abuse, either deliberate or inadvertent.
 - .2 The Departmental Representative assumes no responsibility or liability for the loss by theft, vandalism, or burglary of material or equipment stored on or at the Project site.
 - .3 Materials shall be received, receipted and stored by Section 28.
 - .4 Access to the Project site for on and off-loading of all material, structures and equipment shall be coordinated with and approved by the Departmental Representative.
 - .5 Before any Work is started, coordinate with the Departmental Representative, use of areas for staging and storage or materials and equipment.
 - .6 Keep all route and site areas free and clean at all times of any dirt, debris or other material resulting from operation.
 - .7 Schedule delivery to minimize long-term storage at the site and to prevent overcrowding of construction spaces.
 - .8 Coordinate delivery with installation time to ensure minimize holding time for items that are flammable, hazardous, easily damaged or sensitive to deterioration, theft and other losses.
 - .9 Deliver products to the site in manufacturer's original sealed containers or other packaging system, complete with Safety Data Sheets (SDS), labels and instruction for handling, storing, unpacking, protecting and installing.
 - .10 Inspect products upon delivery, ensure that products are undamaged and properly protected.
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- .11 Store products at the site in a manner that will facilitate inspection and measurement of quantity or counting of units.
- .12 Store heavy materials away from the Project structure in a manner that will not endanger the construction.
- .13 Store products subject to damage by the elements above ground, under cover in a weather-tight enclosure, with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instruction.

2.3 DAMAGE TO PROPERTY

- .1 Damage done to property, including equipment, base buildings, etc. during the course of installation or testing shall be made good. Any damage whatsoever during installation or testing of equipment supplied shall result in that equipment being replaced by new undamaged equipment.

Part 3 Execution

3.1 GENERAL

- .1 Working Conditions
 - .1 The Work shall be scheduled to avoid and/or minimize the impact on business operations. Portions of the Work including portions of the inspection of the Work will be required to be performed outside regular working hours.
 - .2 The Departmental Representative's Security Regulations shall be followed at all times during the performance of the Work.
 - .3 Obtain any and all permits required to carry out work.
 - .2 Examination
 - .1 Verify that critical dimensions are correct and conditions are acceptable. Proceed with installation only after unsatisfactory conditions have been coordinated.
 - .2 Prior to commencement of Work, examine current site conditions and inform the Departmental Representative of any unusual existing conditions that may affect Work
 - .3 Preparation
 - .1 Cooperate and coordinate with the Departmental Representative for the location of all mechanical, plumbing, electrical rights-of-way and access/egress to any area required to remain accessible for maintenance and removal of equipment or related components.
 - .2 Coordinate with the Departmental Representative, the overall project schedule, the equipment and layout in relation to the facility, work aisle or equipment removal paths and drive aisles to avoid any conflicts.
 - .4 Workmanship
 - .1 All work shall be performed by manufacturer trained and certified technicians, to standards and best practices as governed by the reference standards mentioned earlier.
 - .2 Equipment shall be mounted in accordance with manufacturer's recommended or supplied hardware and fasteners.
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- .3 Cabling shall be mounted in accordance with manufacturer's recommended or supplied hardware and fasteners.
- .5 Installation
 - .1 Be responsible for the installation of all the equipment, units, sub-systems, and components at the required locations in order to meet all requirements specified in this document, drawings and as per all applicable standards.
 - .2 Provide all installation materials, accessories, special equipment, services, personnel team, test equipment and tools required for installation.
 - .3 Ensure that installation workmanship complies with the best industry quality standard levels.
 - .4 Be responsible for the shipment, on site storage, transportation, installation, testing, commissioning of all material and equipment.
 - .5 Any spare part/s supplied within the scope of this project, but used to replace faulty item/s during the installation, testing and commissioning phases shall be replaced by free of charge, within thirty (30) days.
 - .6 Specify the estimated periods, personnel requirement and include costs for the installation of the equipment. The cost of travel, accommodation and subsistence, as well as any related insurance costs for the duration of the installation.
 - .7 At least 10 working days (10) days prior to installation, submit for approval to the Departmental Representative a detailed site installation plan. The plan shall contain all necessary information required to install the equipment and integrate it for operation.
 - .8 The installation plan shall be updated to reflect changes made to the equipment layout, cabling drawings, installation instructions and test procedures during the installation. A marked-up installation plan shall be provided.
 - .9 Final As-Built documents shall be provided within 15 days after completion.
- .6 Cutting and Patching
 - .1 All cutting and patching shall be performed by trades specializing in this type of work and in consultation with the Departmental Representative
 - .2 Any walls, ceiling, windows, finishes and doors damaged during the course of the Work shall be made good to the Departmental Representative's satisfaction.

3.2 MECHANICAL AND ELECTRICAL REQUIREMENTS

- .1 Wire and Cable
 - .2 Supply and install all specified wire and cable, as well as additional conduit extensions or relocations, necessary to achieve the specified security system.
- .2 Replaceable Parts
 - .1 Parts and components that may require replacing or removal for servicing shall not be affixed by rivets, welds, metal tags on other similar means that would prevent ready removal.
- .3 Materials

- .1 Materials used in installations shall be selected with due regard to environment, the intended use, durability, safety, retention of appearance and avoidance of corrosion or other chemical effects. The use of wood, natural rubber, toxic materials and other materials capable of supporting fungus or insects is not allowed. The use of electrical tape or masking tape is prohibited.

3.3 COMMISSIONING

- .1 Project Schedule
 - .1 Upon award, submit a complete project schedule with identified milestones.
 - .2 The schedule shall include the scheduled commencement date for each major activity, the duration of each activity, the proposed sequence of activities, dependencies between internal activities and milestone, dependencies between external activities and milestones, identification of the critical path and related milestones.
 - .3 The schedule shall be progressively updated as the work progresses and enable the Departmental Representative to readily identify activities by location or resources.
 - .4 The schedule shall clearly identify completion dates and shall clearly identify schedule contingencies, free floats and critical path.
 - .5 The schedule information shall be sufficiently detailed to enable integration of all interface activities by the Departmental Representative.
 - .6 Develop and submit to the Departmental Representative for approval, project design review and audit Schedule.
 - .7 Submit, on a weekly basis, a progress report to the Departmental Representative including percentage complete and deliverables of scheduled work. Reports shall provide comparison of actual progress versus baseline and in accordance with the WBS and report any variation from the master schedule. Progress reporting shall include as a minimum:
 - .1 Summary of changes since the prior schedule;
 - .2 Actual dates for activities started during the period;
 - .3 Actual dates for activities completed during the period;
 - .4 Actual human resource allocation during the period;
 - .5 Estimate of percent complete for activities in progress;
 - .6 Duration for remaining activities;
 - .7 Activities behind schedule;
 - .8 Critical path;
 - .9 Deliverables.
 - .2 Acceptance Test Procedures
 - .1 Prior to on-site testing, prepare and submit two (2) copies of the Acceptance Test Procedures (ATP) for review by the Departmental Representative.
 - .2 The ATP shall be approved when all issues and comments identified by the Departmental Representative have been satisfactorily addressed.
 - .3 Upon approval of the ATP forward the documented results to the Departmental Representative.
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- .3 Site Acceptance Tests (SAT)
 - .1 After a review of the preliminary tests as outlined in the ATP, a Site Acceptance Test date shall be established. A date will not be established until all equipment is available for testing. The Departmental Representative shall be entitled to witness testing on the agreed date.
 - .2 Demonstrate that all components of the Security System equipment are compliant to the technical specification and requirements. All deficiencies identified shall be corrected by prior to the Final System Acceptance phase.
 - .3 Perform all operational and performance tests in the presence of the Departmental Representative. In addition, the Departmental Representative shall perform a visual and mechanical inspection of the installation.
- .4 Final System Acceptance (FSA)
 - .1 After successful completion of the SAT, submit to the Departmental Representative a final deficiency list.
 - .2 Correct all deficiencies and notify the Departmental Representative, when all on-site work is completed.
 - .3 The Departmental Representative will conduct a final acceptance of the work only when all requirements of this specification have been fulfilled, the hand over report has been received and all noted deficiencies have been corrected.
 - .4 The Departmental Representative will perform spot checks to verify that all deficiencies have been corrected.
 - .5 Upon verifying that all the deficiencies have been corrected, the Departmental Representative will issue a letter of Technical Acceptance signifying that the equipment has been accepted. Final Certificate of Acceptance shall be given when all the terms of this section have been met.

3.4 TRAINING

- .1 Additional Administrator and Operator training that is required for the new installation shall be provided.

3.5 DOCUMENTATION

- .1 The Final Documentation Phase of the project begins upon approval of the Shop Drawings. This phase contains three (3) major milestones:
 - .1 Operator Manual Approval
 - .2 Maintenance Manual Approval
 - .3 As-built & Turnover Documentation Approval
 - .2 Prepare and submit two (2) hard and soft copies of the Operator and Maintenance Manuals for review by the Departmental Representative within one (1) month of Shop Drawing Approval. Manuals shall be approved when all comments have been satisfactorily addressed.
 - .3 Deliver two (2) hard and soft copies of each manual within one (1) month of receiving Operator and Maintenance Manual approval from the Departmental Representative.
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- .4 Prepare and submit one (1) hard and soft copies of the As-built Drawings, Specifications and Turnover Documentation for review by the Departmental Representative within one (1) week of on-site commissioning. As-built and Turnover Documentation, Drawings and Specifications shall be taken to site for accuracy verification against the installation. The As-built Drawings, specifications and Turnover Documentation will be approved by the Departmental Representative when all comments have been satisfactorily addressed.
- .5 Deliver two (2) hard and soft copies sets of revised As-built Drawings, Specifications and Turnover Documentation within one (1) month of receiving approval from the Departmental Representative.
- .6 Final documentation soft copies shall be prepared and submitted in the native (editable) electronic format (.vsd, .dwg, .xls, .doc). All documents produced shall be property of the Departmental Representative.
- .7 Final As-built Drawings, Specifications and Turnover Documentation shall consist of the following as a minimum:

Continued Next Page

1. Equipment List	
Shall Include as a Minimum:	Description
Devices	All Supplied Equipment with Manufacturer Part Numbers, Model Number & Serial Number and Quantity in Communications Room
Components	Removable Components that makeup the device (example: slotted cards) Showing Part Number, Model Number & Serial Number
Manufacturers	Manufacturer of the Device and the Components that makeup the Device (Include contact name, address, phone, email, website)
Section 28	Company supplying, the Component or Device (Include contact name, address, phone, email, website)
Distributors	Distributor or Manufacturers Rep. Include contact name, address, phone, email.
2. Final Revision As-Builds & Shop Drawings	
Shall Include as a minimum:	Description and revision date.
Interconnect Diagrams	Detailed drawing showing connection of devices with patch panel port numbers
Equipment Layouts	Riser diagrams indicating location of equipment along with IP stack, and system addressing information
Electrical Schematics	all associated electrical panel and breaker numbers for all powered equipment.
Wiring Diagrams	Detailed drawing depicting exact terminations and components as installed.
Point Allocation Table	Very specific showing all termination points for all devices, components. Shows what is connected to each terminal on each device.
Architectural drawings.	Floor plans that show all device locations
3. Software	
Shall Include as a Minimum:	Description
Installed software List	For each supplied device including operating system. Show current software
Equipment OS / Firmware version	For each supplied device in "Equipment List".
Application CD's, DVD's or USB drives	For each application noted in "Installed Software List"
Configuration	All Software Configuration Parameters presented in excel spread sheets (alarming tables, equipment addressing etc....)
Registrations	Software Registration numbers, codes and forms supplied by the manufacturer for each supplied device noted in "Equipment List".
4. Manuals	
Shall Include as a Minimum:	Title and Description
Manufacturer Equipment Manuals	Published by the Manufacturer
Manufacturer Operation Manuals	Published by the Manufacturer
Manufacturer Service Manuals	Published by the Manufacturer
Manufacturer Maintenance Manuals	Published by the Manufacturer
Equipment Keys, Codes and passwords	All keys, Password and Codes including Installer, Master and Admin Codes.
5. Warranties	
Shall Include as a Minimum:	Description
Vendor Installation warranties	Include start date and end date, Service Level, Response times
Vendor equipment warranties	Include start date and end date
Software warranties	5 years on software and Firmware and all required updates
Hardware Warranties	12 Months parts and labor minimum
Manufacturing Warranties	12 Months parts and labor minimum
All Codes and Passwords used on the system	User Names and Passwords on software and devices, including installer codes
IP Address schedule	Schedule of IP's Used on every device on the system and their location
6. Checklist / Commissioning Forms	
Shall Include as a minimum:	Description
Inspection Checklist	Inspection reports.
Verification Checklist	Test Verifications
Integration Checklist	Real time display of Access events, door held open and forced open alarms

3.6

PROTECTION

- .1 After installing clean-finished surfaces, touch up shop-applied finishes as required to restore damaged area.

- .2 Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, which ensure equipment is without damage or deterioration at the time of Initial Acceptance.

3.7 CLEAN UP

- .1 Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where work has been completed unless designated for storage.
- .2 Clean up all areas around system equipment and ensure that internal equipment component area is free from debris.
- .3 Remove protective coverings from accessories and components.
- .4 Adjust all components for correct function.
- .5 Clean housings and system components, free from marks, packing tape, and finger prints, in accordance with manufacturer's written cleaning recommendations.
- .6 Clean all components free from dirt and fingerprints.

3.8 CLOSEOUT

- .1 Testing of the system shall be 100% passed before the issuance of the Certificate of Acceptance
- .2 Even though the equipment shall be inspected and accepted, the issuance of Certificate of Completion and Project Closeout shall not occur before all obligations are completed including delivery of digital "as-built" drawings, specifications, software/ firmware versions, and the Operations and Maintenance manual.

END OF SECTION