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New showcase layout on the 4th floor**

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Volume 2 :

Mechanical and Electrical Technical Specifications

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STANTEC

375 Boulevard Roland-Therrien
Longueuil, Québec
J4H 4A6
Tél: (514) 281-1010



1.2 - MECHANICAL



Stantec Consulting Ltd.
Michel Hallis-Springuel, Eng.
Mechanical
OIQ No: 5027497



Stantec Consulting Ltd.
Aboubakeur Bensikhelifa, Eng.
Commissioning
OIQ No: 140616



Stantec Consulting Ltd.
Alain Higgins, Eng.
Automatic Regulation
OIQ No: 33962

1.3 – ELECTRICAL



Stantec Consulting Ltd
Alexandre Manseau-Nguyen, Eng.
Electrical
OIQ No: 5020736

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ELECTRICAL

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END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 21 13 13 - Wet Pipe Sprinkler Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit related manufacturer's instructions, printed product literature, and data sheets.
- .3 Shop Drawings:
 - .1 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of supports and anchor bolts.
 - .2 Manufacturer to certify current model production.
 - .3 Certification of compliance to applicable Codes.
 - .2 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.
- .5 As-Built drawings:
 - .1 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
 - .2 Submit to Departmental Representative for approval and make corrections as directed.
 - .3 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.

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 RELATED REQUIREMENTS**

- .1 Section 21 05 00 - Common Work Results for Fire Suppression.
- .2 Section 23 05 48.16 - Seismic Restraint Systems (SRS) - Type 2 Buildings.

1.2 REFERENCE STANDARDS

- .1 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .2 National Fire Prevention Association (NFPA).
 - .1 NFPA 13-2007, Standard for the Installation of Sprinkler Systems.
- .3 Underwriter's Laboratories of Canada (ULC).
 - .1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Shop Drawings:
 - .1 Installation drawings must be stamped and signed by professional engineer registered or licensed in the Province of Quebec.
 - .2 Shop drawings must indicate the following:
 - .1 Materials;
 - .2 Finishes;
 - .3 Method of anchorage;
 - .4 Number of anchors;
 - .5 Supports;
 - .6 Reinforcement;
 - .7 Assembly details;
 - .8 Accessories.
- .4 Samples:
 - .1 On demand, submit samples of following:
 - .1 Each type of sprinkler head.

- .5 Test Reports:
 - .1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
- .6 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .7 Manufacturers' Instructions:
 - .1 Provide manufacturer's installation instructions.
- .8 Field Quality Control Submittals:
 - .1 Manufacturer's Field Reports: Manufacturer's field reports specified.
- .9 Sustainable Design Submittals:
 - .1 LEED Canada Submittals: In accordance with Section 01 35 21 - LEED Requirements.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals in accordance with ANSI/NFPA 20.
- .2 Manufacturer's catalogue Data, including specific model, type, and size for:
 - .1 Pipe and fittings.
 - .2 Sprinkler heads.
 - .3 Pipe hangers and supports.
 - .4 Mechanical couplings.
 - .5 Other related elements.
- .3 Drawings:
 - .1 Sprinkler heads and piping system layout.
 - .1 Prepare 760 mm by 1,050 mm detail working drawings of system layout in accordance with NFPA 13, "Working Drawings (Plans)".
 - .2 Show data essential for proper installation of each system.
 - .3 Show details, plan view, elevations, and sections of systems supply and piping.
 - .4 When applicable, show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point-to-point electrical wiring diagrams.
 - .2 Electrical wiring diagrams.
- .4 Field Test Reports:
 - .1 Preliminary tests on piping system.

- .5 Records:
 - .1 "As-built" drawings of each system.
 - .1 After completion, but before final acceptance, submit complete set of "As-built" drawings of each system for record purposes.
 - .2 Submit 760 mm by 1,050 mm drawings on reproducible Mylar film with title block similar to full size contract drawings.
 - .6 Operation and Maintenance Manuals:
 - .1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for aboveground piping and other documentation for incorporation into manual in accordance with NFPA 13.

1.5 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, for quality assurance and traceability.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide spare sprinklers and tools in accordance with NFPA 13.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with manufacturer's written instructions and with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Storage and Protection:
 - .1 Store materials indoors in dry location.
 - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.
- .4 Packaging Waste Management: Remove for recycling, in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products**2.1 DESIGN REQUIREMENTS**

- .1 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.
- .2 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.
- .3 Design systems for earthquake protection for buildings in seismic zones 3 and 4, and only essential and high-risk buildings in seismic zone 2.
- .4 Unless otherwise specified on the drawings, all new pipe sizes shall reflect the existing pipe design for the same risk.
- .5 Arrangement of sprinklers: In accordance with ANSI / NFPA 13 and according to the instructions of the authorities concerned.

2.2 ABOVE GROUND PIPING SYSTEMS

- .1 Provide fittings for changes in direction of piping and for connections.
 - .1 Make changes in piping sizes through tapered reducing pipe fittings.
- .2 Conceal piping in areas with suspended ceiling.

2.3 PIPE, FITTINGS AND VALVES

- .1 Pipes:
 - .1 Pipes NPS 2 or less:
 - .1 Black steel, Schedule 40, grooved or threaded, complying with NFPA 13 and ASTM A-53 or ASTM A-135 Standards.
 - .2 Pipes NPS 2 ½ and over:
 - .1 Black steel, Schedule 10, roll grooved, complying with NFPA 13 and ASTM A-135 Standards.
 - .2 Black steel, Schedule 40, roll grooved, for piping located inside the service tunnel, between East block and Central block mechanical rooms, complying with ASTM A-53. Piping must be shop painted before installation.
 - .3 Acceptable products: Allied; Bull Moose; Wheatland.
- .2 Fittings and couplings as per NFPA 13 Standard:
 - .1 Fittings and couplings up to NPS 2:
 - .1 Fittings and joints, rigid, provided by same manufacturer.
 - .2 Fittings, screwed with teflon tape, to ASTM A-47M, grade 32510.
 - .3 Joints for pipes with grooved ends, standard coupling to CSA B242 and ANSI/API Spec 5L.
 - .4 Fittings with grooved ends, to ASTM A-536, grade 65-45-12.

- .2 Fittings and couplings NPS 2½ and over:
 - .1 Joints and fittings, rigid, provided by the same manufacturer.
 - .2 Fittings and welded flanges, to CSA W47.1 and CSA W47.1S1.
 - .3 Joints for pipes with grooved ends, standard couplings, to CSA B242 and ANSI B-3620 (API-5L).
 - .4 Fittings with grooved ends, to ASTM A-536, grade 65-45-12.

2.4 SPRINKLER HEADS

- .1 General: To NFPA 13 and ULC listed for fire services.
- .2 Sprinkler Head Type:
 - .1 Semi-recessed pendant sprinklers, with semi-recessed escutcheon, quick response, with frangible bulb, "K" factor of 5.6:
 - .1 Acceptable products:
 - .1 Viking Microfast, model M, VK-302 and E-1 escutcheon;
 - .2 Victaulic, style V2708;
 - .3 Tyco, model TY3231.
 - .3 Sidewall Sprinklers:
 - .1 Sidewall sprinklers, quick response, with frangible bulb, "K" factor of 5.6:
 - .1 Acceptable products:
 - .1 Viking Microfast, model M, VK-305;
 - .2 Victaulic, style V2710;
 - .3 Tyco, model TY3331.
 - .2 Release element of each head to be at 68°C, as existing heads.
 - .3 Provide polished chromium-plated pendant sprinklers below suspended ceilings.
 - .4 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.
 - .5 Deflector: Not more than 75 mm below suspended ceilings.
 - .6 Ceiling plates: Not more than 25 mm deep.
 - .7 Ceiling cups: Not permitted.

2.5 ESCUTCHEON PLATES

- .1 Provide one-piece type metal plates for piping passing through ceilings and walls in exposed spaces.
- .2 Provide polished chromium-plated finish on copper alloy plates in finished spaces.
- .3 Provide paint finish on metal plates in unfinished spaces.

Part 3 Execution**3.1 MANUFACTURER'S INSTRUCTIONS**

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

3.2 INSTALLATION

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

3.3 PIPE INSTALLATION

- .1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.
- .2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.
- .3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.
- .4 Inspect piping before placing into position.

3.4 FIELD QUALITY CONTROL

- .1 Site Test, Inspection:
 - .1 Perform test to determine compliance with specified requirements in presence of Departmental Representative.
 - .2 Test, inspect, and approve piping before covering or concealing.
 - .3 Preliminary Tests:
 - .1 Hydrostatically test each system at 200 psig for a 2-hour period with no leakage or reduction in pressure.
 - .2 Flush piping with potable water in accordance with NFPA 13.
 - .3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.
 - .4 Test alarms and other devices.
 - .5 When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13.
 - .4 Formal Tests and Inspections:
 - .1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.
 - .2 Submit written request for formal inspection at least 15 days prior to inspection date.
 - .3 Repeat required tests as directed.

- .4 Correct defects and make additional tests until systems comply with contract requirements.
- .5 Furnish instruments, appliances, and personnel for tests.
- .6 Authority of Jurisdiction will witness formal tests and approve systems before they are accepted.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools, and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Sections 01 74 19 - Waste Management and Disposal and 01 35 21 - LEED Requirements.

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.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .2 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable Codes.
 - .3 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Fabrication drawings:
 - .1 Prepare and submit fabrication drawings to coordinate the work of the various construction sub-trades. Construction drawings are required for the following work:
 - .1 Ventilation work of all the building.
 - .2 Fire protection work as defined by the documents prepared by Code Consultants Inc.
 - .2 All fabrication drawings shall be prepared with the latest AutoCAD version, presented as DWG and PDF files. Drawings shall be a appropriate scale but no smaller than 1:50.
 - .3 The fabrication drawings shall consist of plans to scale, indicating the position of equipment, ducts, piping, valves, and other fittings with required sections and details, including the dimensions of piping and ducts, openings, anchors, and supports, relative positions with framework, architectural works, and other mechanical and electrical works.
 - .4 Preparation of the drawings:
 - .1 Each sub-trade shall do its own fabrication drawing and coordinate it with other sub-trades.

- .2 The Construction Manager shall be responsible for the coordination of all fabrication drawings of all mechanical and electrical sub-trades which shall provide all the data, drawings, and diagrams necessary for this coordination work.
- .3 The ventilation subcontractor shall prepare a design of its own work with all necessary data and dimensions and incorporate all information provided by the other trades.
- .4 All fabrication drawings shall be submitted for review at the same time.
- .5 Mechanical and electrical contractors shall work in close collaboration to determine the location of their respective works and to avoid clashes.
- .5 Responsibilities:
 - .1 Each subcontractor is directly responsible for the location and exact dimensions of the openings, bases, the location of its equipment, piping and ducts, whether dimensions figure in the structural, architectural or engineering drawings or not.
 - .2 The ventilation subcontractor shall ensure that no clashes are present in the fabrication drawings.
 - .3 No compensation shall be awarded for modifications to the work, for coordination and integration of mechanical and electrical systems with each other.
 - .4 The Departmental Representative's verification of the fabrication drawings is limited to ensuring that the technical requirements appear to be met (FD, grilles, insulation, duct sizing, etc.) The Departmental Representative does not verify the quality of the coordination carried out by the contractors.
- .6 Work in existing conditions:
 - .1 The fabricating drawings shall include the existing mechanical, electrical, structural, and architectural facilities, as well as planned work.
- .5 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit Waste Management Plan highlighting recycling and salvage requirements.

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.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems, including environmental controls.

- .2 Description of systems and their controls.
- .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
- .4 Operation instruction for systems and component.
- .5 Description of actions to be taken in event of equipment failure.
- .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required, and task time.
- .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
 - .1 Departmental Representative will provide one set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems, and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
- .8 "As-built" drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of "As-built" drawings.
 - .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS

BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS
INSTALLED" (Signature of Contractor) (Date).

- .3 Submit to Departmental Representative for approval and make corrections as directed.
- .4 Perform testing, adjusting, and balancing for HVAC using "As-built" drawings.
- .5 Submit completed reproducible "As-built" drawings with Operating and Maintenance Manuals.
- .9 Submit copies of "As-built" drawings for inclusion in final TAB report.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with manufacturer's written instructions and with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location, indoors, and off ground, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 35 21 - LEED Requirements.
- .5 Packaging Waste Management: Remove for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 SYSTEM CLEANING

- .1 Clean interior and exterior of all systems. Vacuum interior of ductwork.

3.3 DEMONSTRATION

- .1 Departmental Representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, troubleshooting, and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .3 Use Operation and Maintenance Manual, "As-built" drawings, and audiovisual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Departmental Representative will record these demonstrations on video tape for future reference, when needed.

3.4 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 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.

3.5 PROTECTION

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

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 05 - Selective Demolition for Electrical.

1.2 REFERENCE STANDARDS

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

1.3 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 items from existing construction including removal of conduit, diffusers, and grilles 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, clean, 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 the Federal Hazardous Products Act (RSC 1985) including latest amendments.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Action Submittals: Provide the following 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 - Construction Waste Management and Disposal.

1.5 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

- .2 Scheduling: Account for Departmental Representative's continued occupancy requirements during selective demolition with schedule staged occupancy and worksite activities as a defined Activity item.

1.6 QUALITY ASSURANCE

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

1.7 SITE CONDITIONS

- .1 Existing Conditions: Condition of materials identified as being salvaged or demolished are based on their observed condition.
- .2 Existing Hazardous Substances: Departmental Representative performed a hazardous substances assessment and it is not expected that hazardous substances will be encountered in the Work.
- .3 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in the Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform the following activities:
 - .1 Hazardous substances will be as defined in the Hazardous Products Act;
 - .2 Stop work in the area of the suspected hazardous substances;
 - .3 Take preventative measures to limit users' and workers' exposure, provide barriers and other safety devices and do not disturb;
 - .4 Hazardous substances will be removed by Contractor under a separate contract or as a change to the Work;
 - .5 Proceed only after written instructions have been received from Departmental Representative.

1.8 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 Departmental Representative's property.

Part 2 Products

2.1 MATERIAL

- .1 HVAC Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section; new materials

are required to meet assembly or system characteristics as existing systems indicated to remain and carry CSA approval labels required by the Authority Having Jurisdiction.

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 Building Occupants: Sequence demolition work so that interference with the use of the building by the Departmental Representative and users is minimized and as follows:
 - .1 Prevent debris from endangering the 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 Removal Demolition: Coordinate requirements of this Section with the following:
 - .1 Disconnect and cap electrical services in accordance with requirements of local Authority Having Jurisdiction;
 - .2 Do not disrupt active or energized utilities without approval of the Departmental Representative;
 - .3 Erect and maintain dust proof and weather tight partitions to prevent the spread of dust and fumes to occupied building areas; remove partitions when complete;
 - .4 Demolish parts of existing building to accommodate new construction and remedial work as indicated;
 - .5 At end of each day's work, leave worksite in safe condition;
 - .6 Perform demolition work in a neat and workmanlike manner:
 - .1 Remove any 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.

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).

- .2 Hazardous Substances Disposal: Arrange for disposal of hazardous substances.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA).
 - .1 CAN/CSA G40.20/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Safety Data Sheets (SDS).
- .3 National Research Council Canada (NRC).
 - .1 National Building Code of Canada 2015 (NBC).

1.2 DEFINITIONS

- .1 Priority Two (P2) Buildings: Buildings in which life safety is of paramount concern. It is not necessary that P2 buildings remain operative during or after earthquake activity.
- .2 SRS: Acronym for Seismic Restraint System.

1.3 DESCRIPTION

- .1 SRS fully integrated into, and compatible with:
 - .1 Noise and vibration controls specified elsewhere.
 - .2 Structural, mechanical, and electrical design of project.
- .2 Systems and equipment not required to be operational during and after seismic event.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury and from moving from normal position.
- .4 Designed by professional engineer specializing in design of SRS and registered in Province of Quebec.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: In accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings: Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Quebec.
- .3 Submit design data including:
 - .1 Full details of design criteria.
 - .2 Working drawings (prepared to same standard of quality and size as documents forming these tender documents), materials lists, schematics, full specifications for components of each SRS to be provided.
 - .3 Design calculations (including restraint loads resulting from seismic forces in accordance with National Building Code, detailed work sheets, tables).

- .4 Separate shop drawings for each SRS and devices for each system, equipment.
- .5 Identification of location of devices.
- .6 Schedules of types of SRS equipment and devices.
- .7 Details of fasteners and attachments to structure, anchorage loadings, and attachment methods.
- .8 Installation procedures and instructions.
- .9 Design calculations including restraint loads to NBC and Supplement.
- .10 Detailed work sheets, simplified tables, and tables. Simplified, conservative assumptions may be acceptable.
- .11 Detailed design of SRS including complete working drawings prepared to same standard of quality and size as Contract Documents, materials lists, design calculations, schematics, and specifications.
- .4 Quality Assurance Submittals: Submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Closeout Submittals:
 - .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling, and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store, and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SRS MANUFACTURER

- .1 SRS from one manufacturer regularly engaged in SRS production.

2.2 GENERAL

- .1 SRS to provide gentle and steady cushioning action and avoid high impact loads.
- .2 SRS to restrain seismic forces in every direction.
- .3 Fasteners and attachment points to resist same load as seismic restraints.
- .4 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .5 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power-driven anchors not permitted.
- .6 Wet-Pipe Sprinkler Systems: Refer to Section 21 13 13 - Wet Pipe Sprinkler Systems.
- .7 Seismic control measures not to interfere with integrity of fire stopping.

2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS

- .1 Floor-Mounted Equipment, Systems:
 - .1 Anchor equipment to equipment supports.
 - .2 Anchor equipment supports to structure.
 - .3 Use size of bolts scheduled in approved shop drawings.
- .2 Suspended Equipment, Systems:
 - .1 Use one or combination of following methods:
 - .1 Install tight to structure;
 - .2 Cross-brace in every direction;
 - .3 Brace back to structure;
 - .4 Slack cable restraint system.
 - .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding, and buckling in axial direction.
 - .3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT

- .1 Floor-Mounted Equipment, Systems:
 - .1 Use one or combination of following methods:
 - .1 Vibration isolators with built-in snubbers;
 - .2 Vibration isolators and separate snubbers;
 - .3 Built-up snubber system approved by Departmental Representative, consisting of structural elements and elastomeric layer.
 - .2 SRS to resist complete isolator unloading.
 - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.

- .4 Cushioning action: Gentle and steady by utilizing elastomeric material or other means to avoid high impact loads.
- .2 Suspended Equipment, Systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system;
 - .2 Brace back to structure via vibration isolators and snubbers.

2.5 SLACK CABLE RESTRAINT SYSTEM (SCS)

- .1 Use elastomer materials or similar to avoid high impact loads and provide gentle and steady cushioning action.
- .2 SCS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods to withstand compressive loading and buckling.

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 Attachment Points and Fasteners:
 - .1 To withstand same maximum load that seismic restraint is to resist and in every direction.
- .2 Slack Cable Systems (SCS):
 - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
 - .2 Use appropriate grommets, shackles, other hardware to ensure alignment of restraints and to avoid bending of cables at connection points.
 - .3 Piping systems: Provide transverse SCS at 10 m spacing maximum, longitudinal SCS at 20 m maximum or as limited by anchor/slack cable performance.
 - .4 Small pipes may be rigidly secured to larger pipes for restraint purposes, but not reverse.
 - .5 Orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), tie back to structure at maximum of 45° to structure.
 - .6 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
 - .7 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.

- .3 Install SRS at least 25 mm from equipment, systems, and services.
- .4 Miscellaneous equipment not vibration-isolated:
 - .1 Bolt through house-keeping pad to structure.
- .5 Co-ordinate connections with other disciplines.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
 - .2 Manufacturer's Field Services: Consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
 - .1 Upon completion of installation.
 - .3 Submit manufacturer's reports to Departmental Representative within 3 days of manufacturer representative's review.
- .2 Inspection and Certification:
 - .1 SRS: inspected and certified by Seismic Engineer upon completion of installation.
 - .2 Provide written report to Departmental Representative with certificate of compliance.
- .3 Commissioning Documentation:
 - .1 Upon completion and acceptance of certification, hand over to Departmental Representative complete set of construction documents, revised to show "As-built" conditions.

3.4 CLEANING

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

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.
- .2 National Fire Protection Association (NFPA).
 - .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data.
- .2 Submittals: In accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product data to include paint colour chips, other products specified in this Section.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.3 QUALITY ASSURANCE

- .1 Quality Assurance Submittals: Submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling, and unloading:
 - .1 Deliver, store, and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store, and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Waste Management and Disposal: Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.
 - .2 Dispose of unused coating and paint material at official hazardous material collections site approved by Departmental Representative.
 - .3 Do not dispose of unused coating or paint material into sewer system, onto ground, or in locations where it will pose health or environmental hazard.

Part 2 Products**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
- .2 Lettering and numbers raised or recessed.
- .3 Information to include, as appropriate:
 - .1 Equipment: Manufacturer's name, model, size, serial number, and capacity.

2.2 SYSTEM NAMEPLATES

- .1 Colours:
 - .1 Hazardous: Red letters, white background.
 - .2 Elsewhere: Black letters, white background (except where required otherwise by applicable Codes).
- .2 Construction:
 - .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned, and machine engraved into core.
- .3 Sizes:
 - .1 Conform to following table:

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

- .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
 - .1 Terminal cabinets, control panels: Use size # 5.
 - .2 Equipment in Mechanical Rooms: Use size # 9.
- .5 Identification for PSPC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in mechanical room:
 - .1 Main identifier: Size #9.
 - .2 Source and Destination identifiers: Size #6.

- .3 Terminal cabinets, control panels: Size #5.
- .3 Equipment elsewhere: Sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this Section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Sprinklers: To NFPA 13.

2.5 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Back, or co-ordinated with base colour to ensure strong contrast.

2.6 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, and sensors with system nameplates specified in this Section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.7 LANGUAGE

- .1 Unless otherwise indicated, identification must be in French.

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 TIMING

- .1 Provide identification only after painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3, except as specified otherwise.
- .2 Identify systems, equipment to conform to PWGSC/PSPC PMSS.

3.4 NAMEPLATES

- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Protection:
 - .1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

- .1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: At not more than 17-m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 At least once in each small room through which piping or ductwork passes.
- .4 On both sides of visual obstruction or where run is difficult to follow.
- .5 On both sides of separations, such as walls, floors, and partitions.
- .6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.
- .7 At beginning and end points of each run and at each piece of equipment in run.
- .8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.6 CLEANING

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

END OF SECTION

Part 1 General**1.1 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of Contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: Performed in accordance with the requirements of Standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .4 Recommendations and suggested practices contained in the TAB Standard: Mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this Contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.2 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads.
- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

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

1.3 EXCEPTIONS

- .1 TAB of systems and equipment regulated by Codes, Standards to satisfaction of Authority Having Jurisdiction.

1.4 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.5 PRE-TAB REVIEW

- .1 Review Contract Documents before project construction is started, confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from Standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports, and fittings.

1.6 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer, unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.7 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.

1.8 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weather-stripping, sealing, and caulking.
 - .3 Pressure, leakage, other tests specified elsewhere Division 23.
 - .4 Provisions for TAB installed and operational.

- .5 Start-up, verification for proper, normal, and safe operation of mechanical and associated electrical and control systems affecting TAB including, but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.

1.9 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: + 5 %, - 5 %.

1.10 ACCURACY TOLERANCES

- .1 Measured values accurate to within ± 2 % of actual values.

1.11 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced Standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

1.12 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit, prior to commencement of TAB:
 - .1 Proposed methodology and procedures for performing TAB if different from referenced Standard.

1.13 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.

1.14 TAB REPORT

.1 Format in accordance with referenced Standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit of electronic file (pdf) of TAB Report to Departmental Representative for verification and approval, in French.

1.15 VERIFICATION

.1 Reported results subject to verification by Departmental Representative.

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

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

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

1.16 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.17 COMPLETION OF TAB

.1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

1.18 AIR SYSTEMS

.1 Standard: TAB to most stringent of TAB Standards of AABC, NEBB, SMACNA, or ASHRAE.

.2 Do TAB of systems, equipment, components, controls: Systems, equipment, components, and controls specified Division 23.

.3 Qualifications: Personnel performing TAB qualified to Standards of AABC and NEBB.

.4 Quality Assurance: Perform TAB under direction of supervisor qualified to Standards of NEBB and AABC.

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

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

1.19 OTHER TAB REQUIREMENTS

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

1.20 POST-OCCUPANCY TAB

- .1 Measure NC levels, air flow patterns, WBT (or %RH), DBT, air velocity, in the occupied zones.
- .2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 Products

2.1 NOT USED

- .1 Not used.

Part 3 Execution

3.1 NOT USED

- .1 Not used.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
 - .1 Material Safety Data Sheets (SDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA).
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 1985.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Test Reports: Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties. Include pressure test information and results as follows:
 - .1 Submit proposed report form and test report format to Departmental Representative for approval at least three weeks before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative;
 - .2 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
 - .3 Include test reports in final TAB report.
 - .4 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .5 Instructions: Submit manufacturer's installation instructions.
 - .6 Manufacturer's field reports specified.

1.3 QUALITY ASSURANCE

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 32 16.19 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.

- .3 Co-ordination with other building subtrades.
- .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

Part 2 Products

2.1 TEST INSTRUMENTS

- .1 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .2 Test Apparatus: Accurate to within $\pm 3\%$ of flow rate and pressure.
- .3 Submit details of test instruments to be used to Departmental Representative at least three weeks before anticipated start date.
- .4 Test Instruments: Calibrated and certificate of calibration deposited with Departmental Representative no more than 10 days before start of tests.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
 - .1 Fittings, branch ducts, tap-ins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on SMACNA HVAC Air Duct Leakage Test Manual.

- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

3.3 SITE TOLERANCES

- .1 System leakage tolerances specified are stated as percentage of total flow rate handled by system. Pro-rate specified system leakage tolerances. Leakage for sections of duct systems: Not to exceed total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates:
 - .1 Small duct systems up to 250 Pa: 2% leakage;
 - .2 VAV box and duct on downstream side of VAV box: 2% leakage.
 - .3 Large low-pressure duct systems up to 500 Pa: 2% leakage.
 - .4 HP duct systems up to 1,000 Pa pressure classification, including upstream side of VAV boxes: One leakage.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

3.4 TESTING

- .1 Test ducts before installation of insulation or other forms of concealment.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals and gaskets.
- .4 Flexible connections to VAV boxes.

3.5 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services.
 - .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
 - .2 Manufacturer's Field Services: Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Once during progress of Work at 50% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
 - .4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.
- .2 Performance Verification:
 - .1 Departmental Representative to witness tests and to verify reported results.

- .2 To be certified by same TAB agency approved by Departmental Representative to undertake TAB on this project.

3.6 CLEANING

- .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).
 - .1 ANSI/ASHRAE/IESNA 90.1-04, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International (ASTM).
 - .1 ASTM B209M-07, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 - .2 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C553-02e1, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .4 ASTM C612-04e1, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .5 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB).
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Green Seal Environmental Standards (GSES).
 - .1 Standard GS-36-00, Commercial Adhesives.
- .5 South Coast Air Quality Management District (SCAQMD), California State.
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.
- .6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .7 Underwriters Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 DEFINITIONS

- .1 For purposes of this Section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .1 Description of equipment giving manufacturer's name, type, model, year, and capacity.
- .3 Samples:
 - .1 Submit for approval: Complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .2 Mount sample on 12-mm plywood board.
 - .3 Affix typewritten label beneath sample indicating service.
- .4 Manufacturers' Instructions:
 - .1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, and cleaning procedures.
- .5 Sustainable Design Submittals:
 - .1 LEED Submittals: In accordance with Section 01 35 21 - LEED Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: Remove for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 FIRE AND SMOKE RATING

- .1 To CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335.
- .2 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).

2.3 JACKETS

- .1 Canvas:
 - .1 220 gm/m²cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: Compatible with insulation.

2.4 ACCESSORIES

- .1 Vapour Retarder Lap Adhesive:
 - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: Hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
 - .1 220 gm/m²cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C921 Standard.
- .5 Outdoor Vapour Retarder Mastic:
 - .1 Vinyl emulsion type acrylic, compatible with insulation.
 - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².
- .6 Tape: self-adhesive, aluminum, plain reinforced, 75 mm wide minimum.
- .7 Contact Adhesive: Quick-setting.
- .8 Canvas Adhesive: Washable.
- .9 Tie Wire: 1.5 mm stainless steel.
- .10 Banding: 19 mm wide, 0.5 mm thick stainless steel.
- .11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face or both faces of insulation.
- .12 Fasteners: 4 mm diameter pins with 35 mm diameter, square clips, length to suit thickness of insulation.

Part 3 Execution**3.1 APPLICATION**

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

3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness, and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use 2 layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: Install at 300 mm on centre in horizontal and vertical directions, minimum 2 rows each side.

3.4 DUCTWORK INSULATION SCHEDULE

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

TIAC CODE	VAPOUR RETARDER	THICKNESS (MM)
Rectangular Warm and Cold Air Ducts	C-1	25
Round Warm and Cold Air Ducts	C-1	25

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools, and equipment.
- .2 Waste Management: Separate waste materials for recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 48.16 - Seismic Restraint Systems (SRS) - Type P2 Buildings.
- .2 Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .3 Section 23 07 13 - Duct Insulation.

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- .2 ASTM International (ASTM).
 - .1 ASTM A480/A480M-12, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
 - .2 ASTM A635/A635M-09b, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
 - .3 ASTM A653/A653M-11, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .4 Green Seal Environmental Standards (GS).
 - .1 GS-36-11, Standard for Adhesives for Commercial Use.
- .5 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - .3 NFPA 96-11, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 IAQ Guideline for Occupied Buildings Under Construction, 2007.
- .7 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards.
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

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 metal ducts and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to Codes and Standards.
- .4 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products**2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

MAXIMUM PRESSURE PA	SMACNA SEAL CLASS
500	B

- .2 Seal Classification:
 - .1 Class B: Longitudinal seams, transverse joints and connections made airtight with tape or sealant combination.

2.2 SEALANT

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: In accordance with Section 07 92 00 - Joint Sealants.
 - .2 Adhesives and sealants: VOC maximum according to GS-36 or SCAQMD Rule 1168.
- .2 General:
 - .1 Tapes and sealants shall conform to CAN/ULC-S109 (tape), NFPA 90A and 90B standards, and have a maximum flame spread of 25 and a smoke index of not more than 50.
 - .2 All sealants must meet LEED criteria (IEQ 4.1) - Low Emitting Materials: Adhesives and Sealants.
- .3 Transverse joints:
 - .1 Round ducts and rectangular ducts with sliding or "S" joints. Operating temperature: -40°C to +116°C.
 - .1 ULC labeled self-adhesive kraft/canvas/aluminum laminated tape.
 - .2 T joints and flanged joints.
 - .1 Tape.
- .4 Longitudinal seams:
 - .1 Round.
 - .1 ULC labeled self-adhesive kraft/canvas/aluminum laminated tape.
 - .2 Rectangular.
 - .1 Tube sealant.
- .5 Miscellaneous:
 - .1 Operating temperature above -7°C (19.4°F).
 - .1 Sealant: Water-based, ULC-certified watertight sealant with a flame spread of not more than 25 and a smoke index of not more than 50, which can be used in an operating temperature range from -7°C (19.4°F) to +93°C (199.4°F).

2.3 TAPE

- .1 Tape: Polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.4 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.5 FITTINGS

- .1 Fabrication: To SMACNA.
- .2 Radiused Elbows:
 - .1 Rectangular: Standard radius.
 - .2 Round: Centreline radius: 1.5 times diameter.
- .3 Mitred Elbows, Rectangular:
 - .1 To 407 mm: With single thickness turning vanes.
 - .2 Over 407 mm: With double thickness turning vanes.
- .4 Branches:
 - .1 Rectangular main and branch: With 45° entry on branch 1.5 times width of duct.
 - .2 Round main and branch: Enter main duct at 45° with conical connection.
 - .3 Provide volume control damper in branch duct near connection to main duct.
 - .4 Main duct branches: With splitter damper.
- .5 Transitions:
 - .1 Diverging: 20° maximum included angle.
 - .2 Converging: 30° maximum included angle.
- .6 Obstruction Deflectors: Maintain full cross-sectional area.
 - .1 Maximum included angles: As for transitions.

2.6 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Coordinate with 07 84 00 - Fire Stopping to ensure fire stopping materials and installation does not distort duct.

2.7 GALVANIZED STEEL

- .1 Lock Forming Quality: To ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, Fabrication and Reinforcement: To SMACNA and ASHRAE.
- .3 Joints: To SMACNA and ASHRAE proprietary manufactured duct joint and flanged duct joint to be a Class A seal.

2.8 HANGERS AND SUPPORTS

- .1 Strap Hangers: Of same material as duct, but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500.
- .2 Hanger Configuration: To ASHRAE and SMACNA.

- .3 Hangers: Galvanized steel angle with galvanized steel rods to SMACNA and ASHRAE, and according to the following table:

DUCT SIZE (mm)	ANGLE SIZE (mm)	ROD SIZE (mm)
up to 750	25 x 25 x 3	6
751 to 1,050	40 x 40 x 3	6
1,051 to 1,500	40 x 40 x 3	10
1,501 to 2,100	50 x 50 x 3	10
2,101 to 2,400	50 x 50 x 5	10
2,401 and over	50 x 50 x 6	10

- .1 Upper hanger attachments:
- .1 For concrete: Manufactured concrete inserts.
 - .2 For steel joist: Steel plate washer.
 - .3 For steel beams: Manufactured beam clamps:

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 metal duct installation in accordance with manufacturer's written instructions.
- .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

- .1 Do work in accordance with ASHRAE, SMACNA, NFPA 90B, and NFPA 90A Standards.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct.
- .3 Install breakaway joints in ductwork on sides of fire separation.
- .4 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .5 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 HANGERS

- .1 Strap Hangers: Install in accordance with SMACNA.
- .2 Angle Hangers: Complete with locking nuts and washers.
- .3 Hanger Spacing: In accordance with as follows:

DUCT SIZE (mm)	SPACING (mm)
To 1,500	3,000
1,501 and over	2,500

3.4 SEALING AND TAPING

- .1 Apply sealant in accordance to manufacturer's recommendations.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.5 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Do leakage tests in sections.
- .4 Make trial leakage tests to demonstrate workmanship.
- .5 Do not install additional ductwork until trial test has been passed.
- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90° elbows.
- .7 Complete test before performance insulation or concealment Work.

3.6 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 recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 48.16 - Seismic Restraint Systems (SRS) - Type P2 Buildings.
- .2 Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .3 Section 23 07 13 - Duct Insulation.

1.2 REFERENCE STANDARDS

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).
- .2 ASTM International (ASTM).
 - .1 ASTM A653/A653M-09b, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. (Metric).
- .3 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .4 Green Seal Environmental Standards (GS).
 - .1 GS-36-11, Standard for Adhesives for Commercial Use.
- .5 Sheet Metal Air Conditioning Contractors National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2005.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 2012.
 - .3 SMACNA IAQ Guideline for Occupied Buildings Under Construction, 2007.
- .6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards.
 - .1 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

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 metal ducts and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to Codes and Standards.

- .4 Sustainable Design Submittals:
 - .1 LEED Canada submittals: in accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, off ground, and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.
 - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: Remove for recycling, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 DUCTWORK

- .1 Material:
 - .1 Galvanized steel with Z90 designation zinc coating lock forming quality: To ASTM A653/A653M.
 - .2 Thickness: To SMACNA.
- .2 Construction: Round and oval.
 - .1 Ducts: Factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
 - .2 Transverse joints up to 900 mm: Slip type with tape and sealants.
 - .3 Transverse joints over 900 mm: Vanstone.
 - .4 Fittings:
 - .1 Elbows: smooth radius, 3-piece (for 45°), or 5-piece (for 90°). Centreline radius: 1.5 x diameter.
 - .2 Branches: Conical transition with conical branch at 45° and 45° elbow.

- .3 Construction: Rectangular:
 - .1 Ducts: To SMACNA.
 - .2 Transverse joints: Proprietary duct joints welded.
 - .3 Fittings:
 - .1 Elbows: Smooth radius; centreline radius 1.5 x width of duct. No vanes.
 - .2 Branches: With conical branch at 45° and 45° elbow.
- .4 Fire Stopping:
 - .1 Retaining angles around duct, on both sides of fire separation.
 - .2 Coordinate with Section 07 84 00 - Fire Stopping.

2.2 SEAL CLASSIFICATION

- .1 Classification as follows:

MAXIMUM PRESSURE PA	SMACNA SEAL CLASS
2,500	A

- .2 Seal Classification:
 - .1 Class A: Longitudinal seams, transverse joints, duct wall penetrations, and connections made airtight with sealant and tape.

2.3 SEALANT

- .1 Sustainability Characteristics:
 - .1 Adhesives and sealants: In accordance with Section 07 92 00 - Joint Sealants.
 - .2 Adhesives and sealants: SCAQMD Rule 1168.
- .2 Oil resistant, polymer type flame resistant high velocity duct sealing compound.
 - .1 Temperature range of - 30°C to plus + 93°C.

2.4 TAPE

- .1 Tape: Polyvinyl treated, open weave fibre glass, 50 mm wide.

2.5 HANGERS AND SUPPORTS

- .1 Band Hangers: Use on round and oval ducts up to 500 mm diameter, of same material as duct, but next sheet metal thickness heavier than duct.
- .2 Trapeze Hangers: Ducts over 500 mm diameter or longest side, to ASHRAE and SMACNA.

- .3 Hangers: Galvanized steel angle with galvanized steel rods to ASHRAE and SMACNA, and following table:

DUCT SIZE (mm)	ANGLE SIZE (mm)	ROD SIZE (mm)
up to 750	25 x 25 x 3	6
751 to 1,050	40 x 40 x 3	6
1,051 to 1,500	40 x 40 x 3	10
1,501 to 2,100	50 x 50 x 3	10
2,101 to 2,400	50 x 50 x 5	10
2,401 and over	50 x 50 x 6	10

- .1 Upper hanger attachments:
- .1 For concrete: Manufactured concrete inserts.
 - .2 For steel joist: Manufactured joist clamp or steel plate washer.
 - .3 For steel beams: Manufactured beam clamps:

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 metal duct installation in accordance with manufacturer s written instructions.
- .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

- .1 Do work in accordance with SMACNA and ASHRAE.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate band hangers 100 mm beyond insulated duct.
- .3 Install breakaway joints in ductwork on sides of fire separation.

3.3 HANGERS

- .1 Band Hangers: Install in accordance with SMACNA.
- .2 Angle Hangers: Complete with locking nuts and washers.

- .3 Hanger Spacing: As follows:

DUCT SIZE (mm)	SPACING (mm)
to 1,500	3,000
1,501 and over	2,500

3.4 SEALING AND TAPING

- .1 Apply sealant in accordance to manufacturer s recommendations.
- .2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.5 LEAKAGE TESTS

- .1 Refer to Section 23 05 94 - Pressure Testing of Ducted Air Systems.
- .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
- .3 Perform leakage tests in sections.
- .4 Perform trial leakage tests to demonstrate quality of work.
- .5 Do not install additional ductwork until trial tests have been achieved.
- .6 Test section minimum of 30 m long with not less than 3 branch takeoffs and two 90° elbows.
- .7 Complete tests before performing insulation or concealment Work.

3.6 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 recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .2 Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

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 air duct accessories and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.
- .3 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

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

- .4 Packaging Waste Management: Remove for recycling as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 ACCESS DOORS IN DUCTS

- .1 Non-Insulated Ducts: Sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: Sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: Neoprene.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: Two sash locks complete with safety chain.
 - .2 301 to 450 mm: Four sash locks complete with safety chain.
 - .3 451 to 1,000 mm: Piano hinge and minimum two sash locks.

2.3 TURNING VANES

- .1 Factory or shop fabricated single or double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.4 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.5 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

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 air duct accessories installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Access Doors:
 - .1 Size:
 - .1 300 mm x 300 mm.
 - .2 As indicated.
 - .2 Locations:
 - .1 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by Code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .2 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Main and sub-main ducts.
 - .2 And as indicated.
 - .2 For temperature readings:
 - .1 In mixed air applications in locations as approved by Departmental Representative.
 - .2 And as indicated.

- .3 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

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

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .2 Sheet Metal and Air Conditioning National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible- 2013.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

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

- .4 Packaging Waste Management: remove for recycling, as specified in Waste Reduction Workplan Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Manufacture to SMACNA Standards.

2.2 SPLITTER DAMPERS

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double or single thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: Piano hinge.
- .6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 250 mm.
- .3 Locking quadrant with shaft extension to accommodate insulation thickness.
- .4 Inside and outside end bearings.
- .5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed Blade: Configuration, metal thickness, and construction to recommendations of SMACNA.
- .3 Maximum Blade Height: 100 mm.
- .4 Bearings: Pin in bronze bushings.
- .5 Linkage: Shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.

Part 3 Execution**3.1 EXAMINATION**

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

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return, and exhaust systems.
- .4 Runouts to registers and diffusers: Install single blade damper located as close as possible to main ducts.
- .5 Dampers: Vibration free.
- .6 Ensure damper operators are observable and accessible.

3.3 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 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 recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .3 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-12, Standard for the Installation of Air-Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .4 Sheet Metal and Air-Conditioning Contractors National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2005.
 - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 2005.
- .5 Underwriters Laboratories (UL).
 - .1 UL 181-2005, Standard for Factory-Made Air Ducts and Air Connectors.
- .6 Underwriters Laboratories of Canada (ULC).
 - .1 CAN/ULC-S110-2007, Standard Methods of Tests for Air Ducts.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for flexible ducts and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Test and Evaluation Reports:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to Codes and Standards.

- .4 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect flexible ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: Remove for recycling, as specified in Waste Reduction Workplan Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC - INSULATED

- .1 Used in supply air networks, downstream VAV boxes.
- .2 Spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and aluminum jacket, as indicated.
- .3 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC - ACOUSTIC INSULATED – MEDIUM AND HIGH PRESSURE

- .1 Used in supply air networks, upstream VAV boxes.

- .2 Spiral wound, flexible perforated aluminum with factory applied 37 mm thick flexible mineral fibre thermal insulation and encased in spiral wound flexible aluminum jacket, as indicated.
- .3 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
 - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

Frequency (Hz)	125	250	500	1,000	2,000
Diametre Duct	Acoustical Performance				
100	0.6	3	12	27	0
150	1.2	3	12	22	27
200	2.0	5	12	19	20
300	2.4	5	12	16	15

Part 3 Execution

3.1 EXAMINATION

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

3.2 DUCT INSTALLATION

- .1 Install in accordance with: CAN/ULC-S110, NFPA 90A, SMACNA, and UL 181.

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

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 ASTM International (ASTM).
 - .1 ASTM C423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .2 ASTM C916-85 (2007), Standard Specification for Adhesives for Duct Thermal Insulation.
 - .3 ASTM C1071-12, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - .4 ASTM C1338-08, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
 - .5 ASTM G21-09, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .3 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
 - .2 NFPA 90B-12, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .4 North American Insulation Manufacturers Association (NAIMA).
 - .1 NAIMA AH116-2002, Fibrous Glass Duct Construction Standards.
- .5 Sheet Metal and Air Conditioning Contractor s National Association (SMACNA).
 - .1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible-2005.
 - .2 SMACNA IAQ Guideline for Occupied Buildings Under Construction-2007.
- .6 Underwriter's Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

- .3 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location, indoors, and in accordance with manufacturer's recommendations in clean, dry, and well-ventilated area.
 - .2 Store and protect duct liners from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: Remove for recycling, as specified in Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 DUCT LINER

- .1 General:
 - .1 Mineral Fibre duct liner: Air surface coated mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
 - .3 Recycled Content: EcoLogo certified with minimum 35% by weight recycled content.
 - .4 Fungi resistance: To ASTM C1338 and ASTM G21.
- .2 Rigid:
 - .1 Use on flat surfaces where indicated.
 - .2 25 mm thick, to ASTM C1071 Type 2, fibrous glass rigid board duct liner.

- .3 Density: 48 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 (m².°C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24°C mean temperature.
 - .5 Maximum velocity on faced air side: 20.3 m/s.
 - .6 Minimum NRC of 0.70 at 25 mm thickness based on Type A mounting to ASTM C423.
 - .7 Recycled Content: EcoLogo certified containing minimum 45% by weight recycled content.
- .3 Flexible:
- .1 Use surfaces indicated and on round or oval surfaces.
 - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
 - .3 Density: 24 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.74 (m².degrees C)/W for 25 mm thickness when tested in accordance with ASTM C177, at 24°C mean temperature.
 - .5 Maximum velocity on coated air side: 30.5 m/s.
 - .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

2.2 ADHESIVE

- .1 Adhesive: To NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range - 29°C to + 93°C.
- .3 Water-based fire-retardant type.

2.3 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Polymer Nylon Metal retaining clips, 32 mm square.

2.4 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.5 SEALER

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range - 68°C to + 93°C.

Part 3 Execution**3.1 EXAMINATION**

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

3.2 GENERAL

- .1 Do work in accordance with SMACNA HVAC Duct Construction Standard, except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.3 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive to ASTM C916.
 - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres to compress duct liner sufficiently to hold it firmly in place.
 - .1 Spacing of mechanical fasteners in accordance with SMAC HVAC Duct Construction Standard.
- .2 In systems, where air velocities exceed 20.3 m/s, install galvanized sheet metal noising to leading edges of duct liner.

3.4 JOINTS

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply 2 coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Departmental Representative.

- .3 Protect leading and trailing edges of duct sections with sheet metal nosing having 15 mm overlap and fastened to duct.

3.5 CLEANING

- .1 Progress Cleaning: Clean in accordance with Section 01 74 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 recycling reuse in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA).
 - .1 ANSI/ASHRAE 51-07 (ANSI/AMCA 210-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
- .2 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.
- .3 International Organization of Standardization (ISO).
 - .1 ISO 3741-2010, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.
- .4 National Fire Protection Association (NFPA).
 - .1 NFPA 90A-12, Standard for the Installation of Air Conditioning and Ventilating Systems.
- .5 Underwriter s Laboratories (UL).
 - .1 UL 181-2005 (R2008), Factory-Made Air Ducts and Air Connectors.

1.2 ACCEPTABLE MATERIALS OR PRODUCTS

- .1 Where a particular brand name is stipulated, see Instructions to Bidders for procedure for requesting approval of substitute materials and products.

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 air terminal units and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Shop Drawings:
 - .1 Shop drawings must indicate the following:
 - .1 Capacity.
 - .2 Pressure drop.
 - .3 Noise rating.
 - .4 Leakage.
- .4 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

- .5 Test and Evaluation Reports:
 - .1 Test data: to ANSI/AMCA Standard 210.
 - .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
 - .2 Sound power level with minimum inlet pressure of 0.25 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
 - .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.
- .6 Sustainable Design Submittals:
 - .1 LEED Canada submittals: In accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management:
 - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

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

Part 2 Products**2.1 SYSTEM DESCRIPTION**

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

2.2 MANUFACTURED UNITS

- .1 Terminal units of the same type to be product of one manufacturer.

2.3 VARIABLE VOLUME BOXES

- .1 Pressure independent device.
- .2 Performance to AHRI-880.
- .3 Differential pressure not to exceed 25 Pa at inlet air velocity of 10 m/s).
- .4 Minimum operating pressure for mechanical system box: 125 Pa for low pressure systems and 375 Pa for high pressure systems.
- .5 Sound ratings of assembly not to exceed 30 NC from 1.5 m at an inlet pressure of 250 Pa.
- .6 Complete with:
 - .1 Operator and controller: See 2.5, Control, below.
 - .2 Velocity sensor: As per manufacturer's specifications.
 - .3 Multiple orifice adapter: As per manufacturer's specifications.
- .7 Casing: constructed of 0.8 mm (22 gauge) thick galvanized steel, internally lined with fibreglass insulation covered with a woven fabric facing and a perforated metal liner, to UL 181 and ANSI/NFPA-90A, complete with bands to connect air ducts.
 - .1 Mount control components inside protective metal casing.
 - .2 Leaks through casing wall shall not surpass 1% of calculated velocity, while pressure upstream and downstream of controller shall be 750 Pa and 0 Pa, respectively. The controller maintains velocity at $\pm 5\%$ operating velocity.
- .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 ASHRAE 130 Test Procedure.
- .9 Performance Data: As indicated in the Air Terminal Units Schedule shown in the drawings.

2.4 CONSTANT VOLUME BYPASS BOXES

- .1 Maintains space condition by bypassing supply air to return air.
- .2 Sizes, capacities, pressure loss, and discharge sound pressure level: as indicated.

- .3 Discharge sound pressure level: less than NC30 at a distance of 1.5 m (5 ft), with inlet pressure of 250 Pa (1 inch of water)
- .4 Complete with:
 - .1 Bypass collar for connection to return air duct.
 - .2 Minimum air volume stop.
 - .3 Controller and operator as specified under the article 2.5, Control, below.
 - .4 Manual balancing damper.
 - .5 Multiport outlets.
- .5 Casing: constructed of 0.8 mm (22 gauge) thick galvanized steel, internally lined with fibreglass insulation covered with a woven fabric facing and a perforated metal liner, to UL 181 and ANSI/NFPA-90A, complete with bands to connect air ducts.
 - .1 Mount control components inside protective metal casing.
 - .2 Leaks through casing wall shall not surpass 1% of calculated velocity, while pressure upstream and downstream of controller shall be 750 Pa and 0 Pa, respectively. The controller maintains velocity at $\pm 5\%$ operating velocity.
- .6 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 ASHRAE 130 Test Procedure.
- .7 Sequence of, operation as specified under Division 25 (Integrated Automation).

2.5 CONTROL

- .1 Equipment supplied by Integrated Automation Section:
 - .1 Digital controller.
 - .2 Current Transformer.
 - .3 Speed pressure transmitter.
 - .4 Operator.
- .2 Equipment provided by this Section:
 - .1 Pitot tubes.
 - .2 PVC pipes between Pitot tube and speed pressure transmitter.

2.6 DUCT HEATERS

- .1 Duct Heaters (Insertion Type):
 - .1 Built in accordance with CSA Standards certification mark.
 - .2 Approved for zero clearance with any combustible material.
- .2 Elements made of helical coils of nickel chrome alloy (NiCr 60) resistance wire (C grade).

.3 Heater Element Watt/Density:

- .1 The density of the heating elements shall consider the minimum air velocity and its maximum temperature to ensure the durability and safe operation of the heaters. However, this density shall not exceed the maximum values indicated below.
- .2 When the air velocity through the coil is greater than 2.28 m/s (450 ppm), provide elements with a maximum density of 6 W/cm² (40 W/in²). When the air velocity through the coil is less than 2.28 m/s (450 ppm), supply low density elements according to the table below:

Minimum air velocity m/s (in/min)	0.5 (100)	1 (200)	1.5 (300)	2.28 (450)
Maximum density of elements W/cm ² (W/in ²)	1.1 (7)	2.8 (18)	4.5 (30)	6 (40)

.4 Built with galvanized steel frame of appropriate size, with mounting flanges allowing installation without opening the control box.

.5 Controls:

- .1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring to thermostat and sail switch.
- .2 Proportional or modulating control devices mounted in a CSA approved box include the following:
 - .1 Magnetic contactors;
 - .2 TRIAC or SCR modulating controller;
 - .3 Electronic controller with temperature sensors;
 - .4 Differential pressure switch ensuring that the elements are not activated if there is no air flow;
 - .5 Toggle switch for controls;
 - .6 Main fuse;
 - .7 Main switch without fuse;
 - .8 Primary thermal protection sensor with automatic reclosing;
 - .9 Secondary thermal protection sensor with manual reclosing.

.6 Accessories:

- .1 Protective grating on each side.

.7 Characteristics: As indicated in Electric Coils Schedule shown in the drawings.

.8 Acceptable Products: Thermolec, SC model; or pre-approved equivalent substitution.

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 air terminal unit's installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of ductwork.
- .3 Install minimum of four duct diameters of straight inlet duct, same size as inlet.
- .4 Locate controls, dampers, and access panels for easy access.
- .5 Install electric heaters in accordance with manufacturer's instructions and for easy removal from ventilation ducts.
- .6 Coordinate connection to power supply with Division 26 and to control devices with "Building Automation" section.

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

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 Canada Green Building Council (CaGBC).
 - .1 LEED v4 for Interior Design and Construction Reference Guide 2017.

1.2 ACCEPTABLE MATERIALS AND PRODUCTS

- .1 Where a particular brand name is stipulated, see Instructions to Bidders for procedure for requesting approval of substitute materials and products.

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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.
 - .6 Dimensions.
- .3 Samples:
 - .1 Samples are required for following:
 - .1 Only on request.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Include (when applicable):
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

1.5 DELIVERY, STORAGE, AND HANDLING

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

- .2 Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with manufacturer s name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors, off ground, and in accordance with manufacturer s recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: Remove for recycling, as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

Part 2 Products

2.1 SYSTEM DESCRIPTION

- .1 Performance Requirements:
 - .1 Catalogued or published ratings for manufactured items: Obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to Codes and Standards.

2.2 GENERAL

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, and neck velocity, as indicated.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Plaster frames and as specified.
 - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour and Finishes: Standard as directed by Departmental Representative.

2.3 MANUFACTURED UNITS

- .1 Grilles, registers, and diffusers of same generic type, products of one manufacturer.

2.4 SUPPLY GRILLES AND REGISTERS

- .1 As per specifications on table.

Part 3 Execution**3.1 EXAMINATION**

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

3.2 INSTALLATION

- .1 Install in accordance with manufacturers instructions.
- .2 Install with cadmium plated screws in countersunk holes where fastenings are visible.

3.3 EXISTING LINEAR DIFFUSERS

- .1 Clean (when needed) and reinstall existing linear diffusers and adjust according to manufacturer's instructions before balancing to avoid air stratification, inadequate response of thermostat and occupant discomfort.

3.4 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 recycling in accordance with Section 01 74 19 - Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 25 90 01 - EMCS: Site Requirement, Applications and Systems Sequences of Operation.

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Departmental Representatives (IEEE).
 - .1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Departmental Representatives (ASHRAE).
 - .1 ASHRAE STD 135, BACnet - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
 - .1 CAN/CSA-Z234.1-FM89(C1995), Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
 - .1 CEA-709.1, Control Network Protocol Specification.
- .6 Departmental of Canada's Justice (Jus).
 - .1 Canadian Environmental Assessment Act (CEAA), 1997, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Health Canada - Workplace Hazardous Materials Information System (WHMIS).
 - .1 Data Sheet (DS).
- .8 Transport Canada (TC).
 - .1 Transportation of Dangerous Good Act, c. 34

1.3 SYSTEM DESCRIPTION

- .1 Refer to control schematics for system architecture.
- .2 The existing control system is Delta. The new control system must be integrated to the existing one et must use the same programming language.
- .3 The above-mentioned sections aim at the modification of the existing system. Any new part of equipment will have to be similar to those existing and compatible with the system in place. Include what follows:
 - .1 Building Controllers;
 - .2 Data communications equipment necessary to effect EMCS data transmission system;
 - .3 Field control devices;
 - .4 Software/Hardware complete with full documentation;
 - .5 Complete operating and maintenance manuals;
 - .6 Training of personnel;
 - .7 Acceptance tests, technical support during commissioning, full documentation;
 - .8 Wiring interface co-ordination of equipment supplied by others;
 - .9 Miscellaneous work as specified in these sections and as indicated.
- .4 Design Requirements:
 - .1 Design and provide conduit and wiring linking elements of system.
 - .2 Supply enough programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
 - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
 - .4 Provide utility power to EMCS and emergency power to EMCS as indicated.
- .5 Language Operating Requirements:
 - .1 Provide passwords to use the system in English or in French as required.

1.4 COMMISSIONING

- .1 Confirm with the Departmental Representative that Design Criteria and Design Intents are still applicable.
- .2 Do commissioning under the Departmental Representative's supervision.
 - .1 Inform the Departmental Representative in writing, at least 5 days before the start of commissioning or before each test, to get the approval.
- .3 Test each system independently and then in unison with other related systems.
- .4 Correct deficiencies, re-test in until satisfactory performance is obtained.

- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intent.
- .7 Demonstrate to the Departmental Representative the operation of the systems, including control sequences in normal and emergency mode, and in normal and emergency modes, the start/stop, interlocks and safeties resulting in system stops.
- .8 Provide a written commissioning report stating that each system operates as per design criteria.

1.5 SUBMITTALS

- .1 Submit for review:
 - .1 The technical datasheets of all equipment used.
 - .2 Controls schematics, materials lists, sequences of operation, and points lists.
- .2 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified Standards with shop drawings and product data or listing of specified organization is acceptable evidence.
 - .4 In lieu of such evidence, submit certificate from testing organization, approved by the Departmental Representative, certifying that item was tested in accordance with their test methods and that item complies with their Standard/Code.
 - .5 For materials whose compliance with organizational Standards/Codes/Specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced Standard or Specification.
 - .6 Permits and fees: In accordance with general conditions of Contract.
 - .7 Submit an acceptance certificate provided by the competent authority to the Departmental Representative.
 - .8 Existing devices intended for re-use: Submit test report.

1.6 TRAINING

- .1 Provide the required training for a complete comprehension of the system. Required training for this contract is 4 hours, divided in two sessions, one week apart minimum.
- .2 Provide the required material for the training in French and English.

- .3 Coordinate the training with the Departmental Representative for required dates and personal to train.
- .4 Submit training content for approval to the Departmental Representative.

1.7 QUALITY ASSURANCE

- .1 Have trained personnel capable of providing instruction, routine maintenance, and emergency service on systems.
- .2 Provide record of successful previous installations showing experience with similar installations.
- .3 Have access to local supplies of essential parts.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.8 IDENTIFICATIONS

- .1 Nameplates for panels:
 - .1 Identify by plastic laminate, 3 mm thick, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
 - .2 Sizes: 25 x 67 mm minimum.
 - .3 Lettering: Minimum 5 mm high, black.
 - .4 Inscriptions: Machine engraved to identify function.
- .2 Nameplates for field devices:
 - .1 Identify by plastic encased cards attached by chain or plastic tie.
 - .2 Sizes: 50 x 100 mm minimum.
 - .3 Lettering: Minimum 5 mm high produced from laser printer in black.
 - .4 Companion cabinet: Identify interior components using plastic enclosed cards with point name and point address.
 - .5 Data to include: Point name and point address.
- .3 Wiring Identification:
 - .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
 - .2 Colour coding: To CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
 - .3 Cables without conduit must be orange or bear a marking of this colour.
 - .1 Power wiring: Identify circuit breaker panel/circuit breaker number inside each EMCS panel.

- .4 Conduits Identification:
 - .1 All conduits, junction boxes, and connections of the EMCS must be identified with an orange color paint or tag.
- .5 Existing Panels:
 - .1 Correct existing identifications to show the changes made to the systems.

1.9 WARRANTY

- .1 All the software, equipment, and systems provided must be warranted against defects for one year from date of acceptance of the project.
- .2 Provide services, material, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .3 Emergency Service Calls:
 - .1 Initiate service calls when EMCS is not functioning correctly.
 - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
 - .3 Perform work continuously until EMCS restored to reliable operating condition.
- .4 Work Requests: Record each service call request, when received separately on approved form and include:
 - .1 Location, date, and time call received.
 - .2 Nature of trouble.
 - .3 Names of personnel assigned.
 - .4 Quantity and type of material used.
 - .5 Time and date work start and completion.

1.10 O & M MANUALS

- .1 Custom design O&M Manuals (both hard and soft copies) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics, or in-depth control theory.
- .3 The manuals must include:
 - .1 Controls schematics, including the existing equipment related to modified systems.

- .2 Lists of material and points lists.
- .3 Control sequences.
- .4 O&M Manuals.
- .5 Specific procedures: Restarting, alarms reception, printing, etc.
- .6 Informations related to licences: Version, certificates, update procedures.

1.11 INTEGRATION OF DOCUMENTS TO THE WORKSTATION

- .1 All the information related in the system must be provided in electronic format and integrated by the supplier to the central station and the workstations. This information must include the following:
 - .1 Complete software used to create data;
 - .2 Updated backup copy of the database;
 - .3 Systems operation manuals;
 - .4 Spec sheets of the material;
 - .5 Controls schematics in a format that can be viewed by the operator;
 - .6 Engineer's drawings in PDF format.

1.12 WORK IN EXISTING INSTALLATIONS

- .1 If the work is to be done in existing building, integrate the controls modifications to the Departmental Representative's documents, electronic and paper documents, to keep an up-to-date version.
- .2 Incorporate to the documents all modifications to the control systems, while keeping the informations relative to the existing equipment.

1.13 EXISTING CONTROLS EQUIPMENT

- .1 Collect the existing control elements that will not be reused. Store them in an approved storage area, to dispose of them.

Part 2 Products

2.1 EQUIPMENT

- .1 The control protocol and the communication protocol must comply with the ASHRAE STD 135.
- .2 Complete list of equipment and materials to be used on project and forming part of tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

Part 3 Execution**3.1 MANUFACTURER'S RECOMMENDATIONS**

- .1 Installation: To manufacturer's recommendations.

3.2 PAINTING

- .1 Perform painting in accordance with the following requirements:
 - .1 Clean and retouch the surfaces that were scratched so that they have the same original finish;
 - .2 Where retouches are not enough, a complete reconditioning (primer coat and finishing coat) of the damaged surfaces is required;
 - .3 Clean and use a primer coating on visible elements like supports, equipment frames and any other fixing devices;
 - .4 Paint all unfinished material that has been installed indoors.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARD**

- .1 American National Standards Institute (ANSI).
 - .1 ANSI C2, National Electrical Safety Code.
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME).
 - .1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .3 American National Standards Institute (ANSI)/National Fire Protection Association (NFPA).
 - .1 ANSI/NFPA 70, National Electrical Code.
- .4 Canadian Standards Association (CSA)/CSA International.
 - .1 CSA C22.1, Canadian Electrical Code, Part 1.
 - .2 CSA C22.2, Canadian Electrical Code, Part 2.
 - .3 CAN/CSA C22.3 No. 1, Networks.
 - .4 CAN/CSA C22.3 No. 7, Underground Networks.
 - .5 CSA 22.2 No. 45, Rigid Steel Conduits.

1.2 SYSTEM DESCRIPTION

- .1 Electrical:
 - .1 Installation of power supply cables from distribution and emergency panels, existing or provided by the Electrical Contractor, to local EMCS boards. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches. Each table must have a legend identifying the different circuit breakers.
 - .2 Hard wiring between field control devices and EMCS field panels.
 - .3 Communication wiring between EMCS field panels and OWS including main control centre.
 - .4 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .5 Refer to wiring diagrams included as part of flow diagrams. Trace existing control wiring installation and provide updated wiring schematics, including additions and/or deletions to control circuits for approval by Departmental Representative before commencing work.

- .2 Mechanical:
 - .1 Pipe taps required for EMCS equipment will be supplied and installed according to the applicable sections (instructions from the EMCS Contractor).
 - .2 Installation of air flow stations, dampers, and other devices requiring sheet metal trades to be installed according to the applicable sections.
- .3 VAV Terminal Units:
 - .1 Air flow probe for VAV boxes to be supplied and installed. Air flow dp sensor, actuator and associated VAV controls to be supplied and installed by EMCS contractor. Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators to be the responsibility of EMCS contractor. Coordinate air flow adjustments with balancing trade.
- .4 Construction (Structural):
 - .1 Special steelwork as required for installation of Work.

1.3 PERSONNEL QUALIFICATIONS

- .1 Qualified supervisory personnel to:
 - .1 Continuously direct and monitor all work.
 - .2 Attend site meetings.

1.4 EXISTING CONDITIONS

- .1 Opening and Resurfacing: Refer to the prescription hereafter.
- .2 Repair all surfaces damaged during execution of Work.
- .3 Turn over to Departmental Representative existing materials removed from work not identified for re-use.

Part 2 Products

2.1 SPECIAL SUPPORTS

- .1 Structural grade steel, primed, and painted after construction, but before installation.

2.2 WIRING

- .1 As per requirements of Division 26 - Electrical.
- .2 For 70 V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600 V. Colour code to CSA 22.1.
- .3 For wiring under 70 V, use FT4 rated wiring.

- .4 Sizes:
 - .1 120V Power supply: to match or exceed breaker, size #12 minimum.
 - .2 Wiring for safeties/interlocks for starters, motor control centres, to be stranded, #14 minimum.
 - .3 Field wiring to digital device: at least 20AWG stranded twisted pair.
 - .4 Analog input and output: shielded #20 minimum stranded twisted pair. Wiring must be continuous without joints.
- .5 Terminations:
 - .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

2.3 CONDUITS

- .1 As per requirements of Division 26 - Electrical.
- .2 Conduits must have a minimum of 20 mm (0.79 in) diameter.
- .3 Electrical metallic tubing to CSA C22.3. Flexible and liquid tight flexible metal conduit to CSA C22.2. Rigid steel threaded conduit to CSA C22.2 No. 45.
- .4 Junction and Pull Boxes: Welded steel.
 - .1 Surface mounting cast FS: Screw-on flat covers.
 - .2 Flush mounting: Covers with 25 mm minimum extension all round.
- .5 Outlet Boxes: 100 mm minimum, square.
- .6 Conduit Boxes, Fittings:
 - .1 Bushings and connectors: With nylon insulated throats.
 - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for Rigid Conduit:
 - .1 Couplings and fittings: Threaded type steel.
 - .2 Double locknuts and insulated bushings: Use on sheet metal boxes.
 - .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
- .8 Fittings for Thin Wall Conduit:
 - .1 Connectors and couplings: steel, set screw type.

2.4 WIRING DEVICES, COVER PLATES

- .1 Conform to CSA.

- .2 Receptacles:
 - .1 Duplex: CSA type 5-15R.
 - .2 Single: CSA type 5-15R.
 - .3 Cover plates and blank plates: Finish to match other plates in area.

2.5 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT

- .1 Solid Masonry, Tile, and Plastic Surfaces: Lead anchors or nylon shields.
 - .1 Hollow masonry walls, suspended drywall ceilings: Toggle bolts.
- .2 Exposed Conduits or Cables:
 - .1 50 mm diameter and smaller: One-hole steel straps.
 - .2 Larger than 50 mm diameter: Two-hole steel straps.
- .3 Suspended Support Systems:
 - .1 Individual cable or conduit runs: Support with 6 mm diameter threaded rods and support clips.
 - .2 Two or more suspended cables or conduits: Support channels supported by 6 mm diameter threaded rod hangers.

Part 3 Execution

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Conduits for wiring.
 - .1 All wiring must be installed in EMT conduits:
 - .1 In exposed areas, mechanical and electrical rooms.
 - .2 In gyps ceilings and other non accessible ceilings.
 - .3 Masonry walls.
 - .2 In suspended ceilings, protected wires can be installed without conduit if they are properly affixed to the structure.
 - .3 Use rigid conduits and weatherproof joints for conduits installed outside the building.

3.2 SUPPORTS

- .1 Install special supports as required and as indicated.

3.3 ELECTRICAL NETWORK - GENERAL

- .1 Do complete installation in accordance with requirements of:
 - .1 Division 26 - Electrical and this specification.
 - .2 CSA 22.1 Canadian Electrical Code.
 - .3 ANSI/NFPA 70.
 - .4 ANSI C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA C22.3 No. 7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling, and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1,000 and 2,000 mm above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: Flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

3.4 CONDUIT SYSTEM

- .1 Install telecommunication cables in conduits.
- .2 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .3 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

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- .4 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.
 - .5 Bend conduit so that diameter is reduced by less than $\frac{1}{10}$ th original diameter.
 - .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
 - .7 Limit conduit length between pull boxes to less than 30 m.
 - .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
 - .9 Use flexible conduits to make the transition between control elements and the EMT conduits. Flexible conduits must not exceed 500 mm in length (20 inches).
 - .10 Fastenings and supports for conduits, cables, and equipment:
 - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
 - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
 - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
 - .11 Install polypropylene fish cord in empty conduits for future use.
 - .12 Where conduits become blocked, remove and replace blocked sections.
 - .13 Pass conduits through structural members only after receipt of Departmental Representative written approval.
 - .14 Conduits may be run in flanged portion of structural steel.
 - .15 Group conduits wherever possible on suspended or surface channels.
 - .16 Pull Boxes:
 - .1 Install in inconspicuous, but accessible locations.
 - .2 Support boxes independently of connecting conduits.
 - .3 Fill boxes with paper or foam to prevent entry of construction material.
 - .4 Provide correct size of openings. Reducing washers not permitted.
 - .5 Mark location of pull boxes on record drawings.
 - .6 Identify AC power junction boxes, by panel and circuit breaker.
 - .17 Install terminal blocks or strips indicated in cabinets to Section 26 - Electrical.

- .18 Install bonding conductor for 120 V and above in conduit.

3.5 WIRING

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:
 - .1 Circuits are continuous, free from shorts, unspecified grounds.
 - .2 Resistance to ground of all circuits is greater than 50 Megohms.
- .5 Provide Departmental Representative with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

3.6 WIRING DEVICES, COVER PLATES

- .1 Receptacles:
 - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
- .2 Cover Plates:
 - .1 Install suitable common cover plate where wiring devices are grouped.
 - .2 Use flush type cover plates only on flush type outlet boxes.

3.7 GROUNDING

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
- .2 Install separate grounding conductors in conduit within building.

- .3 Install ground wire in all PVC ducts and in tunnel conduit systems.
- .4 Tests: Perform ground continuity and resistance tests, using approved method appropriate to site conditions.

3.8 TESTS

- .1 Perform following tests:
 - .1 Preliminary tests:
 - .1 Conduct as directed to verify compliance with specified requirements.
 - .2 Make needed changes, adjustments, replacements.
 - .3 Insulation resistance tests:
 - .1 Measure all circuits, feeders, equipment for 120 - 600 V with 1,000 V instrument. Resistance to ground to be more than required by Code before energizing.
 - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.
 - .2 Give 14 days written notice of intention to test.
 - .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
 - .4 Conceal work only after tests satisfactorily completed.
 - .5 Report results of tests to Departmental Representative in writing.

END OF SECTION

Part 1 General**1.1 RELATED SECTIONS**

- .1 Section 25 05 01 - EMCS: General Requirements.
- .2 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCES

- .1 Air Movement and Control Association, Inc. (AMCA).
 - .1 AMCA Standard 500-D, Laboratory Method of Testing Dampers for Rating.
- .2 American National Standards Institute (ANSI).
 - .1 ANSI C12.7-1993 (R1999), Requirements for Watthour Meter Sockets.
 - .2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
- .3 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.
- .4 Canadian Standards Association (CSA).
 - .1 CSA-C22.1SB-F02, Canadian Electrical Code, Part 1 (19th Edition) Safety Standard for Electrical Installations.

1.3 SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions.
- .2 Pre-Installation Tests:
 - .1 Submit random samples of delivered equipment as required by the Departmental Representative, which must be tested prior to installation. Replace devices or components whose performance and accuracy do not meet the prescribed requirements.
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.4 EXISTING CONDITIONS

- .1 Cutting and Adjusting: In accordance with the requirements of the specific conditions and those indicated below.
 - .1 If needed, repair surfaces that were damaged during Work execution.
 - .2 Hand over to the Departmental Representative all removed material that cannot be reused.

Part 2 Products**2.1 GENERAL**

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, heat resistant, vibration-proof assembly.
- .3 Operating Conditions: 0 - 32°C with 10 - 90% relative humidity (RH) (non-condensing) unless otherwise specified.
- .4 Terminations: Use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie-talkies.
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Installed measuring instruments ranges must be such that normal reading should be between the first third and second third of the total measuring range of the instrument.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

2.2 TEMPERATURE SENSORS

- .1 The type of temperature detectors must be resistive.
 - .1 Technology:
 - .1 Thermistor-type resistive element, with negative temperature coefficient, 10,000-ohm nominal value at 24°C, accuracy of 0.2°C, usable when the device reception allows linearization of the signal. Response time less than 3 seconds for a temperature change of 10°C.
 - .2 Mounting depending on the application:
 - .1 Air duct temperature sensors: With a conduit fitting box.

- .2 Unless otherwise indicated, coin probes are of the following type:
 - .1 Offices: Adjustable smart probes, limited set points;
 - .2 Corridors and public places: Blind probes;
 - .3 Technical room: Blind probes.
- .3 Range adapted to the application, with possibility to limit the range for room probes.
- .4 5 VDC power supply from a PLC.
- .3 Acceptable products: Greystone TE-200; Mamac TE-700; Delta RTS-400.

2.3 SMART TEMPERATURE SENSORS

- .1 Wall probes with digital display.
 - .1 Room temperature sensors are addressable. The sensing element is thermistor with negative temperature coefficient, impedance compatible with other room probes. The probes must be connected to the digital controller via a dedicated communication network. They are equipped with programmable push buttons and an alphanumeric display that indicates the room temperature, the set point and all other points desired by the Departmental Representative.
 - .2 Included plug allowing to connect to a portable computer the Contractor provided zone terminal, or the Contractor supplied pocket device for access to the area data bus.

2.4 STATIC PRESSURE PROBES

- .1 Pressure tap for duct mounting.
 - .1 Multiple and nipple measurement points to average.
 - .2 Accuracy of $\pm 1\%$ of the actual static pressure in the duct. Maximum pressure drop of approximately 160 Pa for an air movement velocity of 10 m/s in the manifold.

2.5 PRESSURE PROBES DUE TO AIR SPEED

- .1 Differential pressure port for duct mounting.
 - .1 Multiple measurement points for static pressure and total pressure, medium pressure gauge, built-in pressure equalizer.
 - .2 Accuracy of $\pm 1\%$ of the actual air velocity in the duct.

2.6 ELECTROMECHANICAL RELAYS

- .1 Inverter relays, bipolar, pluggable, with connection base.
 - .1 Activation by electromagnetic coil.
 - .2 Inverter contacts plated or not subject to corrosion.
 - .3 Mounting the DIN rail base.

- .4 5 A output contacts at 120 VCC.
- .5 Coils supplied at 120 VDC or 24 VDC.
- .6 LED status indicator light.

2.7 ACTUATORS FOR TERMINAL ELEMENTS

- .1 Direct coupled, "all or nothing" and modulating actuators.
 - .1 Gear mechanism, two-direction electric motor with feedback position control.
 - .2 Direct coupling on the shutter shaft. Mechanical and electronic end stops.
 - .3 24 V power supply CC; typical consumption of 2 VA.
 - .4 Control signal 0-10 VDC or floating type with position feedback. Direction selector knob.
 - .5 Stroke time of 120 seconds for 0-100% of position.

2.8 CO₂ SENSORS

- .1 Materials:
 - .1 The installation must include a complete system for monitoring and detecting CO₂ (carbon dioxide) at the location indicated on drawings.
 - .2 Gas detection system comprising an interpretation module of the detector cell:
 - .1 Detector cell based on I.R.N.D. without possible influence of humidity, dust or other ambient gases.
 - .2 A module designed from a microprocessor allowing the general operation of the system.
 - .3 Scale of detection 0-2,000 ppm. 2% accuracy on the 200-1,500 ppm scale.
 - .4 Two outputs: 0-10 VDC and 4-20 mA (linear).
 - .5 Two-pole unipolar relay for the detection level circuit.
 - .6 An adjustable level of engagement over the entire reading scale, but adjusted by the manufacturer to 850 ppm.
 - .3 System Operation:
 - .1 The infrared source is filtered to transmit only the frequency scale absorbed by the CO₂. The absorption rate varies according to the CO₂ concentrations present in the ambient air. The amplification of this exclusive process allows the establishment of the reading of the concentration of gas continuously.
 - .2 The CPU controls the activity of the system. It verifies the transmission quality of the gas concentrations and engages the devices relating to the state of the system. When the concentration reaches the set point, a two-way unipolar relay trips to command a correction of the situation.
 - .4 Calibration certificate:
 - .1 Provide a calibration certificate by the manufacturer.

Part 3 Execution**3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Provide space for fire protection. Ensure and maintain rated fire ratings.
- .6 Electrical System:
 - .1 Complete installation in accordance with Section 26 05 00.
 - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .3 Refer to electrical control schematics included as part of control design schematics on drawings mentioned in section 25 90 01 EMCS: Site Requirements, Applications and Systems Sequences of Operation. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative before beginning Work.
 - .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .5 Install communication wiring in conduit.
 - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
 - .2 Conduct sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
 - .3 Conduct filling should not exceed 40% of their capacity.
 - .4 Design drawings do not show conduit layout.
 - .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative review before beginning Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.
- .7 Supply and install the following mechanical equipment:
 - .1 Plugs necessary to stitch on targeted pipelines;

- .2 Air flow control station, registers, and similar items.
- .8 VAV Terminal Units: Supply, install and, adjust as required.
 - .1 Air probe, actuator and associated VAV controls.
 - .2 Tubing from air probe to dp sensor as well as installation and adjustment of air flow sensors and actuators.
 - .3 Co-ordinate air flow adjustments with balancing trade.

3.2 TEMPERATURE SENSORS

- .1 Install to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Duct installations:
 - .1 Do not mount in dead air space.
 - .2 Locate within sensor vibration and velocity limits.
 - .3 Securely mount extended surface sensor.
 - .4 Install room sensors at a height of 1,400 mm. Align sensors above lighting switches where applicable, except when in presence of graduators.
 - .5 Thermally isolate elements from brackets and supports to respond to air temperature only.
 - .6 Support sensor element separately from coils, filter racks.

3.3 IDENTIFICATION

- .1 Identify field devices in accordance with Section 25 05 01 - EMCS: General Requirements.

3.4 TESTING AND COMMISSIONING

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 05 01 - EMCS: General Requirements.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 25 90 01 - SGE - Site Requirements and Operating Sequences.

1.2 APPROVAL

- .1 Submit the graphics menu as well as all graphics to illustrate the proposed final work.

1.3 COMMISSIONING REPORT

- .1 Submit a final report including:
 - .1 Programming;
 - .2 Graphics;
 - .3 A certificate of compliance to this section.

Part 2 Requirements for Programming Mode

2.1 GENERAL SEQUENCES

- .1 Program each sequence in the controllers in a logical order, which refers to the sequence described in the specifications.
- .2 Document the sections indicating the programming mode, summer and winter sequences as well as special programming (e.g. Free Cooling).
- .3 Describe in the programming the use of variables (e.g. PC-CH-MAX-CO1: Maximum Heating Setpoint Controller #1).

2.2 PASSWORD ACCESS

- .1 Create at least two passwords:
 - .1 A **Viewing** password allowing to change setpoints only.
 - .2 A **Change** password allowing total access to the system.

2.3 VARIABLES

- .1 All setpoints that could be changed by the operator must be programmed as variables. This includes the setpoints, indoor-outdoor limit values, and operation modes (summer-winter).
- .2 Use acronyms that describe the use for which they are intended.
- .3 Except where otherwise specified, these values must be shown on graphics screens.

2.4 SCHEDULES

- .1 Program a master time schedule for the building or a time schedule for each building section, as required.
- .2 Time schedules must be available on each system they control.
- .3 Program the holiday schedule.
- .4 Program the system so that seasonal time changes are automatic.

2.5 CONTROL LOOPS

- .1 Program separate control loops, each having their own proportional band, integral and derivative parameter values for all loops with change of mode (e.g. Heating-Cooling and Humidification-Dehumidification).
- .2 Slow down output updating, when required for loop stabilisation, instead of using proportional bands out of standards.
- .3 Program a dead-band between two modes.
- .4 Provide required interlocks to avoid simultaneous output on both modes.
- .5 Adjust PID parameters to obtain a stable operation, without cycling, with setpoint reached in less than 10 minutes.
- .6 In anticipation of the acceptance of the work, program trends containing values at 15-second intervals for the control of outdoor air dampers, heating loops, control of water and air pressure, as well as any loop considered potentially unstable. These historical may be deleted after acceptance of the work if they are no longer considered useful.

2.6 ROOMS CONTROLS

- .1 Set limits to room setpoints between 20 and 24°C in heating, and between 23°C and 27°C in cooling.
- .2 Program a minimum deadband of 1°C between the heating and cooling.
- .3 Provide required interlocks to avoid simultaneous output on both modes.

2.7 ALARMS

- .1 Program alarms for all input points. Select alarm limits away from the alarm point when no alarm is desired for the moment.
- .2 Program alarms for following cases:
 - .1 Inconsistency between a command and the corresponding status of operation;

- .2 Room temperature off by more than 2°C (3.6°F) of the actual setpoint;
- .3 Ventilation temperature by more 2°C (3.6°F) of the actual setpoint for 30 minutes;
- .4 Water system temperature by more than 1°C (1.8°F) of the effective setpoint for 30 minutes;
- .5 Other values: 5% difference compared to the setpoint.
- .3 Program in the master controller alarms for faulty controllers:
 - .1 Controller stopped or communication malfunction.
- .4 Alarm Destinations:
 - .1 Unless otherwise specified, alarms must be directed to the following peripherals, when applicable on drawings:

POINTS	ALARMS	HOURS OF OPERATION	TRENDS	ALARMS DESTINATION	NOTES
ANALOG INPUT	X		X	F,I,E	
ANALOG OUTPUTS	X		X	F,I,E	
DIGITAL INPUTS	X	X		F,I,E	Related to corresponding output
DIGITAL OUTPUTS		X		F,I,E	
SETPOINTS	X		X	F,I,E	
VARIABLES	X			F,I,E	
SYSTEM MANAGEMENT	X			F,I,M	

F: File

I: Printer

M: Modem or network

E: Screen

- .5 Determine with the Departmental Representative the list of critical alarms and how they must be directed by e-mail, by pager, or by telephone.
- .6 Alarm messages must indicate the following:
 - .1 The name of the building;
 - .2 The system name;
 - .3 The point name;
 - .4 The alarm status.

2.8 TOTALIZATIONS

- .1 When there is an information entry as proof of operation, a totalization of the hours of operation of the mechanical equipment must be automatically performed with reset by an operator command.

2.9 TREND LOGS

- .1 Create trend logs for all systems modulating inputs and outputs. These historical values will store 200 values at 15-minute intervals.
- .2 Create trend logs for specified rooms inputs and modulating outputs. At a minimum, create trend logs for 10% of installed points. These historical values will store 200 values at 15-minute intervals.
- .3 Where a long-term trend log is requested, accumulate data on a permanent digital format that can be viewed later. These historical values will store values at 15-minute intervals for a minimum of 10 years.
- .4 Long-term trend logs are required in following cases:
 - .1 Existing central is already equipped with the long-term trends software;
 - .2 When mechanical installation consists of geothermal system.

Part 3 Requirements Relative to Graphics

3.1 GENERAL PRESENTATION OF GRAPHICS

- .1 All graphics should constitute a coherent package, easy to read, representing the entire project.
- .2 Graphics added to an existing system must be consistent with existing standards and respect installed standards.
- .3 Choose colors and sizes of text that allow easy viewing without overloading the diagram.
- .4 Avoid graphics that overload diagrams without adding relevant information.
- .5 Use animated graphics to represent the states of pumps and fans, not the commands.
- .6 A set of graphics to include:
 - .1 A start page containing general informations, general plan of the building, accesses to all systems or groups of systems, access to the alarms management page, and access to the controller's architecture network.
 - .2 A page showing the controller's architecture network.
 - .3 A page representing each floor or area of the building, with representation and access to the zone controllers, and a link to access the ventilation and heating

supplying the area. Indicate the position of digital controllers on the floors with the name of the systems they control. Program a link from controller to the monitored systems.

- .4 A page for each room control indicating all relevant values, inputs, setpoints, and outputs.
- .5 A page for each special room control, including the relevant values, inputs, setpoints, outputs, alarms, and trend logs.
- .6 A page representing each main system.
- .7 A summary screen values, including power or consumption rate as well as the cumulative consumption values for all counters.

3.2 PRESENTATION OF EACH GRAPHIC

- .1 Include in the graph of a system all the following:
 - .1 General information, such as:
 - .1 System's name;
 - .2 Outdoor temperature and humidity;
 - .3 Time and date;
 - .4 System mode (occupied, unoccupied, etc.).
 - .2 All the points specific to the system, including inputs, outputs, time, alarms, and trend logs.
 - .3 A link towards zoning controls related to this system.
 - .4 A link towards associated systems.
 - .5 A link towards control sequence and drawing in .pdf format.
 - .6 An area for writing memos.
- .2 Use symbols and colors different to represent different mechanical elements such as filters, flow stations, coils, boxes, etc., to visually identify easily all the parts.
- .3 If a graph contains too many elements, create the diagram on two or more graphics including a quick link between the different sections.
- .4 Include in the room zones graphics, setpoints, temperature, and humidity of the zones.
- .5 Use different background colors to represent areas supplied by different systems or major ducts.
- .6 Points in manual mode should be clearly indicated in graphs.

END OF SECTION

Part 1 General**1.1 REFERENCE STANDARDS**

- .1 CSA Group.
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24nd Edition), Safety Standard for Electrical Installations.
- .2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC).
 - .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

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 SP1122.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit data sheets.
- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Quebec, Canada.
 - .2 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.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .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 material or equipment is not available, submit such material or equipment to inspection authorities for approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.

- .5 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL. The following reports must be submitted:
 - .1 Examination report of seismic protection system.
 - .2 Verification report of fire alarm system.
- .6 Sustainable Design Submittals:
 - .1 LEED Canada submittals: in accordance with Section 01 35 21 - LEED Requirements.
 - .2 Construction Waste Management submittals: in accordance with Section 01 74 19.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for:
 - .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:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 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 with manufacturer's written instructions and 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

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 or labels for control items in French and English.
- .4 Use one nameplate or label for each language.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Equipment and material to be CSA certified. Where CSA certified equipment or material is 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 WIRING TERMINATIONS

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

2.4 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: 3 mm thick lamicoid plastic engraving sheet, black face, white core, mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES	DIMENSIONS	NUMBER OF LINES	LINE HEIGHT
Size 1	25 x 75 mm	1 line	12 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates or labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate or label.
- .5 Labels for junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

- .7 Pull boxes: indicate system and voltage.

2.5 WIRING IDENTIFICATION

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

2.6 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Type	Prime	Auxiliary
up to 250 V	Yellow	---
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	---
Other Communication Systems	Green	Blue
Fire Alarm	Red	---
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.7 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 switchgear and distribution enclosures light gray: to ASA 61.

2.8 SEISMIC PROTECTION

- .1 Suspended equipment:
- .1 When vibration isolators are not provided, fastening and stabilization hardware must be designed and installed to resist minimum accelerating force.
- .2 When vibration isolators are provided, install a cable aseismic system.
- .2 Electrical conduits:
- .1 For electrical conduits, install fastening and stabilization hardware following requirements of the guide « Seismic Restraint Manual: Guidelines for Mechanical Systems », last edition, as published by SMACNA. It is also accepted to use a cable aseismic system.

- .2 Stabilize the following electrical conduits.
 - .1 Electrical conduits of 32 mm diameter or more in the following rooms:
 - .1 Mechanical room;
 - .2 Electrical room, data room and access controls room.
 - .2 Electrical conduits of 64 mm diameter.
 - .3 Electrical and data cable trays.
- .3 Do not stabilize:
 - .1 Electrical conduits where the vertical distance between the fastening point to the structure and the top of the suspended conduit is below 300 mm.
 - .2 Electrical conduits not specified in previous points.
- .4 For electrical conduits, install fastening and stabilization hardware at the following rate:
 - .1 For transversal stabilization, every 12 m maximum.
 - .2 For longitudinal stabilization, every 24 m maximum.
- .5 Install flexible joints for conduits rigidly supported and connected to an equipment installed on anti-vibration springs.
- .3 A seismic movement limiter:
 - .1 Generality: designed to withstand a minimum acceleration force of 1.0 G with elastomer cushions to prevent strong impact. As per selected type, supply proper quantity and install to stabilize components in all axis.
 - .2 Type LS-1: one axis in horizontal plan only.
 - .3 Type LS-2: all axis in horizontal plan only.
 - .4 Type LS-3: vertically as well as all axis in horizontal plan.
 - .5 Type LS-4: vertically as well as one axis in horizontal plan.
 - .6 Accepted products:
 - .1 Vibron, model HS-1 (type LS-1), SH-2 (type LS-2), HS-3 (type LS-3), and HS-4 (type LS-4);
 - .2 Aeroflex (VMC), serie SR/SRD;
 - .3 Mason;
- .4 Cable aseismic stabilization system:
 - .1 System designed for installations using aircraft cables.
 - .2 Accepted products: Vibron; serie SCR by VMC (Racan); Mason.
- .5 Shop drawings:
 - .1 Submit drawings for all components of the seismic protection system.
 - .2 Submit drawings indicating the position of components for the stabilization of equipment and electrical conduits.
 - .3 Indicate for each stabilization component of each equipment, including cable trays and electrical conduits:

- .1 Weight of the stabilized component;
- .2 Accelerating force;
- .3 Corresponding horizontal and vertical forces;
- .4 Type of stabilization element and working axis;
- .5 Quantity and position of stabilization element;
- .6 Fastening type.
- .4 Submit the calculations proving the effectiveness of the different types of fastenings and stabilization elements if not a pre-designed type.
- .5 The design of the seismic protection system must be done by an engineer recognized by Province of Quebec, mandated by the Contractor. Issue a copy with each operation manual. Documents to be sealed by the specialized Engineer.

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:
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Electrical equipment must be laterally restricted to comply to seismic loading requirements stated in National Building Code of Canada.

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 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3,000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1,200 mm.
 - .2 Wall receptacles:
 - .1 General: 400 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .3 Telephone and interphone outlets: 300 mm.
 - .4 Wall mounted telephone and interphone outlets: 1,200 mm.
 - .5 Fire alarm stations: 1,200 mm.
 - .6 Thermostat: 1,200 mm.

3.6 SEISMIC PROTECTION

- .1 Follow manufacturer's recommendations for fastening of pre-designed components.
- .2 Allow the installation of fastening points on equipment not equipped of such points.
- .3 Avoid oblong holes for adjustment bolts.
- .4 Follow manufacturer's recommendations for the spacing between movement limiters and the equipment to be stabilized. Maximum space to be 6 mm. Install movement limiters on equipment's final position to follow required spacing.
- .5 Seal and validate all required documents mentioned above by a qualified engineer. Following installation, this engineer must examine all works and issue an examination report.
- .6 Inform the Departmental Representative 48 hours in advance of each visit done by the engineer conducting the examination.
- .7 Submit all reports issued following the examination visit.

3.7 FIELD QUALITY CONTROL

- .1 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Circuits originating from branch distribution panels.
 - .2 Lighting and its control.
 - .3 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .4 Systems: fire alarm and communications.
 - .5 Insulation resistance testing:

- .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1,000 V instrument.
 - .3 Check resistance to ground before energizing.
- .2 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .3 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

3.8 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel, care and maintenance of systems, system equipment and components.
- .2 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.
- .3 Waste Management: separate waste materials for recycling and/or reuse 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.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 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 the Building Manager 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.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Coordination: Coordinate work of this Section to avoid interference with work by other Sections.

1.4 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 Building Manager's property.

Part 2 Products**2.1 MATERIALS**

- .1 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.
- .2 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 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.

3.2 EXECUTION

- .1 Demolition and Removal: Coordinate requirements of this Section with information contained Architectural documents and as follows:
 - .1 Disconnect electrical circuits; maintain electrical service and main distribution panel 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 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 Disconnect circuits back to main distribution panel and re label respective circuit breaker as "SPARE".
 - .8 Place weatherproof blank cover plates on exterior outlet boxes remaining after demolition and removal activities.
 - .9 Remove existing conduits, boxes, cabling and wiring associated with removed luminaires, electrical devices and equipment.
 - .10 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.

- .11 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.

3.3 CONTINUITY OF ELECTRICAL SERVICES

- .1 Provide full continuity of the electrical services to the building's occupants during and after the works.
- .2 When electrical works on existing distribution is affecting adjacent areas, supply and install conduits, wiring and equipment required for the temporary redistribution of electrical services if necessary.

3.4 ELECTRICAL SERVICES INTERRUPTION

- .1 Electrical service interruptions must not be done without the written approval of the Departmental Representative.
- .2 Electrical services interruption must be minimized and conducted with close coordination with the Departmental Representative. A notice must be issued 15 days prior to work and be reminded 48 hours before work.
- .3 Electrical services interruptions must be planned and documented. The Contractor must submit, for approval, a detailed description of required works and steps. Duration of each steps must be set to allow the Departmental Representative to make a decision.
- .4 If an interruption is refused by the Departmental Representative, the Contractor must plan a possible way to return electrical services back on in less than 20 minutes.

3.5 TEMPORARY FIRE ALARM SYSTEM

- .1 During the demolition and installation of the sprinklers system in the work areas, install temporary fire alarm heat detector, following ULC-S524 requirements.
- .2 Connect the temporary detectors to the existing fire alarm system.
- .3 All modifications on existing fire alarm system must be verified following ULC-S537.

3.6 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).

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 PRODUCT DATA

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

Part 2 Products**2.1 BUILDING WIRES**

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

2.2 ARMOURED CABLES

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

2.3 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath: thermoplastic jacket and armour of closely wound aluminum wire.
- .2 Type: low energy 300 V control cable: stranded annealed copper conductors sized as indicated:
 - .1 Insulation: TW 40°C polyethylene.
 - .2 Overall covering: polyethylene FT4 jackets or flat galvanized steel.

Part 3 Execution**3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

- .1 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .3 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .4 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .5 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 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.

3.4 INSTALLATION OF ARMoured CABLES

- .1 In general, all electrical wiring to be done in conduits. However, the following options are acceptable in the following special cases:
 - .1 Where false ceilings are accessible (removable tiles), the main lighting circuit shall be in conduit with junction boxes anchored to the building structure and homogeneously distributed over the entire surface of the installation. From these junction boxes, it is allowed to connect each fixture individually with armoured cable. However, there must be no more than four fixtures individually connected to each junction box and the maximum allowable length of armoured cable is 5 m.
 - .2 The armoured cable can also be used in the same way and under the same conditions for lighting for receptacle outlets and unit heaters in drywall partitions. The maximum allowable length of armoured cables is 5 m.
- .2 Group cables wherever possible on channels.
- .3 Unless specified otherwise, all wiring is to be concealed within architectural elements.

3.5 INSTALLATION OF CONTROL CABLES

- .1 Install control cables in conduit.
- .2 Ground control cable shield.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

Part 2 Products**2.1 EQUIPMENT**

- .1 Insulated grounding conductors: green, copper conductors, size as indicated.
- .2 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Pressure wire connectors.

Part 3 Execution**3.1 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including, conductors, connectors and 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 Soldered joints not permitted.

3.2 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.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

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 hangers and supports, and include product characteristics, performance criteria, physical size, finish, and limitations.

Part 2 Products**2.1 SUPPORT CHANNELS**

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted and suspended.
- .2 Support channels must be made of hot-dipped galvanized steel.

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 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 Representative.

3.2 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted "T" bar ceilings. Ensure that "T" bars are adequately supported to carry weight of equipment specified before installation.

- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels every 1.5 meters.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA).
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1, 24th Edition.

1.3 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.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

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 turned edge covers.

Part 3 Execution**3.1 JUNCTION, PULL BOXES, AND INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 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 feeding panel or as indicated.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA).
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1, 24th Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

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.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

2.3 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 6 mm 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 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA).
 - .1 CAN/CSA C22.2 No. 18-98 (R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M1981 (R2003), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985 (R2003), Electrical Metallic Tubing.

1.3 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.

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 Rigid metal conduit: to CSA C22.2 No. 45, galvanized steel threaded.
- .2 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible steel.

2.3 CONDUIT FASTENINGS

- .1 One-hole steel straps to secure surface conduits 50 mm and smaller.
 - .1 Two-hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for several ducts, to be disposed at 1.5 m of interaxial distance.

- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.
- .2 Coating: same as conduit.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.5 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 or in unfinished areas.
- .3 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .4 Use electrical metallic tubing (EMT) when not subject to mechanical injury.
- .5 Use rigid galvanized steel threaded conduit for cast concrete or when subject to mechanical injury.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 19 mm.
- .8 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19 mm diameter.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .11 Install fish cord in empty conduits.
- .12 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.

- .13 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCE STANDARDS

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

Part 2 Products**2.1 CABLETROUGH**

- .1 Cabletroughs and fittings: to CAN/CSA C22.1 No. 126.1 and NEMA VE 1.
- .2 Wire mesh type, Class C1 to CAN/CSA C22.2 No.126.1.
- .3 Trays: steel, 305 mm wide with depth of 100 mm.
- .4 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reducers where required, manufactured accessories for cabletrough supplied.
 - .1 Radius on fittings: 305 mm minimum.
- .5 Ground cable trays with #2 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.

2.2 SUPPORTS

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

Part 3 Execution**3.1 INSTALLATION**

- .1 Install complete cabletrough system in accordance with NEMA VE 2.
- .2 Support cabletrough on both or on one side.
- .3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

3.2 CABLES IN CABLETROUGH

- .1 Install cables individually.
- .2 Lay cables into cabletrough. Use rollers when necessary to pull cables.
- .3 Secure cables in cabletrough at 6 m centres, with nylon ties.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

Part 2 Products**2.1 NOT APPLICABLE**

- .1 Not applicable.

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 cable installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Inform of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 CABLE INSTALLATION IN DUCTS

- .1 Install cables as indicated in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using qualified personnel.
 - .1 Include necessary instruments and equipment.

- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds.
 - .1 Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Repair damage to adjacent materials caused by cables installation.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Closeout Submittals:
 - .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Test reports:
 - .1 Submit certified test reports indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions.
 - .4 Manufacturer's Field Reports: manufacturer's field reports specified.

Part 2 Products**2.1 MATERIALS**

- .1 Control system: by one manufacturer and assembled from compatible components.

2.2 MANUAL WALL CONTROLS

- .1 Low voltage wall dimmer with digital communication, communicating with the room light controller.
- .2 Accepted products: LMDM-101 by Legrand, NPODM by AcuityControls or Dialog by Douglas.

2.3 OCCUPANCY DETECTOR

- .1 Occupancy detector for surface installation on ceiling, with digital communication, communicating with the room light controller.
- .2 Dual technology detection, with PIR and ultrasonic detection.
- .3 Allowing a manual-on and auto-off control.
- .4 Accepted products: LMDC-100 by Legrand, nCM PDT by AcuityControls or Dialog by Douglas.

2.4 ROOM CONTROLLER

- .1 Including one, two or three relays.
- .2 0-10 V signal for each relay for dimming.
- .3 Relay capacity: 15 A at 347 V.
- .4 Accepted products: LMRC-110 by Legrand, nPP16 by AcuityControls or WRC-3260 by Douglas.

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 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.
- .2 Programming of controllers must be done by manufacturer.
- .3 Program must be done for a manual-on auto-off occupancy control.
- .4 Include two hours of formation given by the manufacturer and presented to building manager representative.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests:
 - .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Actuate control units in presence of Departmental Representative to demonstrate lighting circuits are controlled as designated.

- .3 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA).
 - .1 CSA C22.2 No. 42, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CAN/CSA C22.2 No. 42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

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 wiring devices and include product characteristics, performance criteria, physical size, finish, and limitations.

Part 2 Products**2.1 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 Ivory 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.
- .2 Other receptacles with ampacity and voltage as indicated.
- .3 Receptacles of one manufacturer throughout project.

2.2 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.
- .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Stainless steel, vertically brushed, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.

2.3 SOURCE QUALITY CONTROL

- .1 Cover plates from one manufacturer throughout project.

Part 3 Execution**3.1 EXAMINATION**

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

3.2 INSTALLATION

- .1 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height as indicated in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Cover plates:
 - .1 Install suitable common cover plates where wiring devices are grouped.
 - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.3 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

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.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for approval by Departmental Representative.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.
 - .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, and cleaning procedures.

Part 2 Products**2.1 FINISHES**

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

2.2 LUMINAIRES

- .1 As indicated in luminaire schedule.

Part 3 Execution**3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

3.2 WIRING

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

3.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires independently of ceiling.

3.4 LUMINAIRE ALIGNMENT

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

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 27 05 28 – Pathways for communications systems;

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute(ANSI) / Telecommunications Industries Association (TIA);
 - .1 ANSI/TIA-607-C (2015) – Generic telecommunications bonding and grounding (earthing) for customer premises;
 - .2 ANSI/TIA-606-C – Administration Standard for Telecommunications Infrastructure;
- .2 Electrical code of Canada 2018.
- .3 National Building Code of Canada 2015;

1.3 ABBREVIATIONS

- .1 GND – Grounding;
- .2 BND – Bounding;
- .3 Contractor; designates the telecommunications contractor.

1.4 SYSTEM DESCRIPTION

- .1 Telecommunications grounding and bonding system consist of grounding busbars, bonding backbones, and other bonding conductors;
- .2 Provides ground reference for telecommunications systems within building and bonding to it of telecommunications rooms;
- .3 Metallic pathways, cable shields, conductors, and hardware within telecommunications spaces are bonded to telecommunications grounding and bonding system.

1.5 DOCUMENTS TO SUBMIT FOR APPROVAL

- .1 After the award of the contract, the bidding Contractor must provide a copy of shop drawings in electronic format (PDF) for approval. These drawings must identify the items chose by the bidding Contractor;
- .2 The submitted shop drawings must include, in a clean and legible way, the following information:
 - .1 The item number (as identified in the list of products) – see part 3;
 - .2 If the document contains more than one item, identification of the proposed products must be done in a clean, easy to read and not misleading way;
 - .3 The drawing must include a schematic, a picture and/or a technical drawing of the item, a product description and technical specifications;

- .4 The shop drawing will enable the Applicant to order a spare and/or an equivalent product in the future.
- .3 The Applicant's representative has the right to reject a product that is not in accordance with the present specification. Only approved products can be installed.

Part 2 Constraints

- .1 All grounding hardware must be made of copper. Before any connection, contact areas must be cleaned thoroughly with an abrasive pad and a conductive grease must be applied on all surfaces;
- .2 Each end of a GND cable of caliber 6 AWG or bigger must be terminated with a two-hole long barrelled compression lug if connected to a GND busbar, an equipment, a molding or any other metallic surface. A GND cable of caliber 10 AWG or smaller must be terminated by a one-hole compression lug. The barrel length is not important. Crimping must be done with a tool with a minimal compression strength of 10 000 pounds;
- .3 Any GND cable connected to another GND cable of same caliber or bigger requires a good preparation and an appropriate connector for telecommunications applications. There are different types of approved connectors. For outside work, aluminothermic connections (Cadwell) or wedging connectors with insulating housing (Ampact) are the only approved types;
- .4 For interior work, wedging connectors (Ampact – same as for outside work) and “H-Tap” or “C-Tap” tapping connectors are accepted. After the connection is completed, it must be covered with an appropriate insulating housing;
- .5 The connectors illustrated below are approved by the Electrical Code **but are not suited to be used in telecommunications**. With time, they become a high frequency noise source on the GND and the integrity of the connection is compromised.



Part 3 Products

3.1 GROUDING BUSBAR FOR 19" (483mm) RACK ASSEMBLY

- .1 Hard-drawn copper bar, semi-hard, electrical grade, tapped holes.

Part 4 Execution**4.1 Grounding busbar**

- .1 A new GND wall mounted busbar on the IT room (no. 4.104) mounted with isolators must be provided and installed by the electrical contractor. If no bar has been installed at the time of telecom work, the site supervisor must be informed;
- .2 The telecom contractor must connect the rack's GND busbar to the floor's main GND busbar. The connection must be completed with a green insulated 10 AWG cable and must be supply and install by the telecom contractor.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 27 05 26 – Grounding and bonding for communications systems;

1.2 REFERENCE STANDARDS

- .1 American National Standards Institute(ANSI) / Telecommunications Industry Association (TIA)
 - .1 ANSI/TIA-607-C (2015) – Generic telecommunications bonding and grounding (earthing) for customer premises.
 - .2 ANSI/TIA-569-D (2015) – Telecommunications pathways and spaces
 - .3 ANSI/TIA-606-C – Administration Standard for Telecommunications Infrastructure.
- .2 Building Industry Consultant Service International (BICSI)
 - .1 BICSI TDMM-13 – Telecommunications distribution methods manual.
- .3 National Building Code – Canada, 2015
- .4 Electrical code of Canada 2018.

1.3 ABBREVIATIONS

- .1 GND – Grounding;
- .2 BND – Bounding;
- .3 Contractor; designates the telecommunications contractor.

1.4 DOCUMENTS TO SUBMIT FOR APPROVAL

- .1 After the award of the contract, the bidding Contractor must provide a copy of shop drawings in electronic format (PDF) for approval. These drawings must identify the items chose by the bidding Contractor;
- .2 The submitted shop drawings must include, in a clean and legible way, the following information:
 - .1 The item number (as identified in the list of products) – see part 3;
 - .2 If the document contains more than one item, identification of the proposed products must be done in a clean, easy to read and not misleading way;
 - .3 The drawing must include a schematic, a picture and/or a technical drawing of the item, a product description and technical specifications;
 - .4 The shop drawing will enable the Applicant to order a spare and/or an equivalent product in the future.
- .3 The Applicant’s representative has the right to reject a product that is not in accordance with the present specification. Only approved products can be installed.

Part 2 Constraints**2.1 DUCTS, CABLE TRAYS, PATHWAYS, CONDUITS, ETC.**

- .1 Cable Trays
 - .1 A telecom cable tray is exclusively dedicated to voice, network, multimedia and physical security cables. No electrical or grounding cables may occupy the same tray.
 - .2 In a mechanical or equipment room, for any cable tray providing a cabinet, rack or wall panel, the Contractor must provide and install a drop section with corner guides. Cables' bending radius must be protected while exiting a cable tray.
 - .3 The cable tray system must be type basket tray(mesh) and must be 305 mm width by 100 mm depth install with tie rod.
 - .4 Supply and install by division 26.
- .2 Ducts and conduits
 - .1 All used conduits are provided and installed by the electrical contractor. Installation of conduits is necessary in specific cases:
 - .1 Passage of cables in a public zone, a closed or inaccessible ceiling and in an aggressive environment like a warehouse;
 - .2 Passage of cables in a floor slab or a wall;
 - .3 Passage of outdoor cable in a building towards a mechanical room with a flammability standard of FT1 or less;
 - .4 Vertical transit toward another floor or through a hard to access space;
 - .5 When mechanical protection is required.
- .3 Before using any conduit, the Contractor must verify the following:
 - .1 That a pull box be installed if there are two or more 90° elbows or if the length of a conduit exceeds 100 feet (30 m). When a pull box is required, it must be easily accessible and used in a straight part of the conduit. A pull box may not be used to replace an elbow;
 - .2 An elbow made from a conduit must be bent with appropriated equipment and respect a bend radius of at least six times it's diameter;
 - .3 The use of a "condulet" (lb) type prefabricated connection is prohibited since its internal bend radius does not respect telecommunication standards;
 - .4 No conduit may have a diameter lower than 19 mm;
 - .5 Conduit, whether they are used or not, must have a functional pull rope in nylon. The pull rope must be attached to each end of the conduit;
 - .6 A conduit must be protected at each end with a protective fitting to protect the cables from its sharp edges;
 - .7 Conduits, pull boxes, junction boxes and outlet boxes must be grounded following the current standards;
 - .8 Coupling connectors must be made of steel with retaining bolts.

- .4 If at least one of the above points has not been observed, inform an Applicant's representative as soon as possible;
- .5 All ducts and conduits used in a project must be installed by the electrical contractor. Installation of conduits is required in specific cases:
 - .1 For passage through a continuous slab to slab wall with minimal fire resistance;
 - .2 For passage through a floor slab to access another floor.
- .6 Exclusive use of J-hook, trays, conduits and ducts
 - .1 J-hooks, cable trays, conduits or ducts used for telecom are to be used for telecom only and cannot be shared with other services such as electric cables, fire alarms cables, etc.
 - .2 Each conduit is dedicated to one service only and cannot be shared with another. It is not permitted to install telecommunication cables with video, security or even optical fiber cables.
- .7 Filling constraints for J-hooks, conduits and ducts
 - .1 In telecommunications, unless otherwise stated, the filling level of conduits must be equal or less than 35% of their capacity. To optimise conduit use, the table below presents the maximum number of cables inside a conduit of a given diameter:

Nominal diameter of conduit mm	Maximum quantity of PTNB 24 AWG caliber, CAT 6A unshielded cables
21	5
27	8
35	14
41	20
53	33
78	72

Note: the use of conduits bigger than 78 mm in diameter is not authorised.

Part 3 Products**3.1 J-HOOKS FOR CATEGORY 6 CABLES**

- .1 Must be specifically designed for telecommunications to support telecom distribution cables.

3.2 INDOOR SERVICE POLES FOR J-HOOKS

- .1 Mounted on the ceiling and can have multiple J-hooks attached to it.

Part 4 Execution**4.1 CONDUITS**

- .1 A series of conduits will be provided and installed by division 26. These conduits will lead away from the IT room towards the rented space. No cable can cross the public zone outside of a conduit;
- .2 The telecommunication horizontal pathways must be compliant with ANSI/TIA 569 standard and be installed at a far enough distance from electrical circuits so as to minimize the effect of electromagnetic interferences (EMI).

4.2 J-HOOKS

- .1 Use the layout plan for distribution of location's cabling network;
- .2 The Contractor has the responsibility to choose the cable run with the shortest distance without exceeding the 90 meters maximum length;
- .3 Regroup, if possible, a maximum of the the cables to form arteries. Cables may exit the artery in the last meters of its run in the ceiling.
- .4 Provide and install J-hooks with a maximum of 1 500 mm between each;
- .5 Every path must be dedicated to one IT service. Network cables may not share the same hooks as A/V cables.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 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-S524-06, Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525-07, Audible Signal Devices for Fire Alarm Systems, Including Accessories.
 - .3 CAN/ULC-S530-91 (R1999), Heat Actuated Fire Detectors.
 - .4 CAN/ULC-S537-04, Verification of Fire Alarm Systems.

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 multiplex fire alarm system and voice communication systems, and include product characteristics, performance criteria, physical size, finish, and limitations.

1.4 CLOSEOUT SUBMITTALS

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

1.5 QUALITY ASSURANCE

- .1 Inspection tests to conform to: CAN/ULC-S537.
- .2 Submit inspection report, to Departmental Representative.

Part 2 Products**2.1 WIRING**

- .1 Copper conductors.
- .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.

- .3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- .4 To speaker circuits: twisted, pairs, and in accordance with manufacturer's requirements.

2.2 AUTOMATIC ALARM INITIATING DEVICES

- .1 Heat detectors, fixed temperature.
- .2 Conventional type.
- .3 Compatible with existing system.
- .4 For temporary detection of work areas during demolition and construction of sprinkler fire protection system.

2.3 AUDIBLE SIGNAL DEVICES

- .1 Speakers:
 - .1 Cone type: round, recessed, 100 mm mounted.
 - .1 Fire-retardant, moistureproof.
 - .2 Multiple taps adjustable from 0.25 to 2 W.
 - .3 Frequency response: 200 to 8000 Hz.
 - .4 Same model as existing.

2.4 END-OF-LINE DEVICES

- .1 End-of-line devices to control supervisory current in signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely.

Part 3 Execution

3.1 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.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 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. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

- .3 Connect alarm circuits.
- .4 Install end-of-line devices at end of signalling circuits.
- .5 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .6 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- .7 Install speakers and connect to speaker circuits.

3.3 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 detectors transmit alarm to control panel first stage 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.
- .3 Provide final PROM program re-burn for system Departmental Representative incorporating program changes made during construction.

END OF SECTION