

Project Manual

Issued for Tender
2025-10-31

**Durham District School Board
Henry Street High School –
Culinary Classroom Renovation**

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QCG Project No. ED-25-052

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PROCUREMENT AND CONTRACTING REQUIREMENTS GROUP

Division 00 Procurement and Contracting Requirements

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1 Summary

- .1 In connection with the "The Project", for which Quasar Consulting Group has been retained to provide services, The undersigned has requested that Quasar Consulting Group provide recipient with certain instruments of services prepared by Quasar Consulting Group and its Subconsultants in electronic machine readable format. These documents in such format shall hereinafter be referred to as the "Electronic Documents". In consideration Quasar Consulting Groups' agreement to release electronic documents, the recipient agrees as follows:

2 Agreement for Delivery of Documents in Electronic Format

- .1 It is understood and agreed that all drawings, specifications, data, or other documents of any kind prepared by Quasar Consulting Group or its Subconsultants, whether in hard copy or any electronic or machine readable format, including electronic documents (collectively "Electronic Documents") are, and shall remain, instruments of their services. These Electronic Documents were prepared solely for use in connection with this project. This agreement is not intended in any way to alter the respective interests of the parties in the instruments of services as set forth in any agreement for services between recipient and Quasar Consulting Group, notwithstanding Quasar Consulting Group' agreement to release the Electronic Documents to recipient.
- .2 The Electronic Documents are provided as a convenience to the recipient for informational purposes only in connection with the recipient's performance of its responsibilities and obligations relating to the project. The Electronic Documents do not replace or supplement the paper copies of the drawings and specifications which are, and remain, the contract documents for the project or the paper copies of any other document prepared by Quasar Consulting Group or its Subconsultants.
- .3 The parties agree that the Electronic Documents are not, nor shall they be construed to be a product. It is expressly agreed by the recipient that there are no warranties of any kind in such Electronic Documents or in the media in which they are contained, either expressed or implied.
- .4 Quasar Consulting Group or its subconsultants make no representations, nor claims to the accuracy of the geometric and dimensional components and hold no liability for any measurements or modelling recreations pertaining to the use and viewing of Electronic Documents.
- .5 It is further understood and agreed that no Electronic Documents shall be signed or sealed.
- .6 If any differences exist between printed instruments of services and the Electronic Documents, the information contained in the printed documents shall be presumed to be correct and take precedence over the Electronic Documents.
- .7 Recipient assumes all liability that results from any interpretation of, or modification or alteration in any way, to the Electronic Documents.
- .8 The Electronic Documents may be supplied in any commercially available or privately developed software which may include but shall not be limited to the following: STAAD, Adobe Acrobat, Bentley products such as MicroStation, Autodesk products such as AutoCAD, ReCap, Revit, Leica products such as CloudWorx, TruView, Cyclone, Microsoft products such as Word, Excel, PowerPoint, or MS Project. Transfer of Electronic Documents in no way conveys right or license to use the underlying software nor extinguish the rights of Quasar Consulting Group to reuse the information in the general course of professional practice.
- .9 It is understood by recipient that the media in which any Electronic Documents are transmitted can deteriorate over time and under various conditions. Quasar Consulting Group is not responsible for such deterioration. In addition, any conversion of the format is solely the responsibility of the recipient. Recipient understands that the conversion of paper copies of instruments of services into electronic or machine readable format, or the conversion of Electronic Documents from the machine readable format

used by Quasar Consulting Group, to some other format may introduce errors or other inaccuracies and agrees to release Quasar Consulting Group and its Subconsultants from any liability or claims for recovery of damages or expenses arising as the result of such errors or inaccuracies.

- .10 Where the recipient has received specific permission to use the Electronic Documents in connection with recipient's obligation to prepare certain documents for the project, recipient shall, in addition to the other obligations set forth herein, be obligated to remove Quasar Consulting Group' or the Subconsultant's title block from the copy of the Electronic Documents used by recipient.
- .11 Recipient further agrees that Quasar Consulting Groups' documents were prepared for use in connection with this project only, and that the Electronic Documents are supplied to recipient for the limited purpose stated above only. Recipient agrees not to use, or allow others to use, the Electronic Documents, in whole or in part, for any purpose or project other than as stated above without the expressed prior written permission of Quasar Consulting Group.
- .12 Recipient agrees to waive any and all claims and liability against Quasar Consulting Group and its Subconsultants resulting in any way from any failure by recipient to comply with the requirements of this agreement for the delivery of documents in electronic format.
- .13 Recipient further agrees to indemnify and hold harmless Quasar Consulting Group and its Subconsultants and each of their partners, officers, shareholders, directors, and employees from any and all claims, judgments, suits, liabilities, damages, costs, or expenses (including reasonable defense and attorney's fees) arising as the result of either: (1) recipient's failure to comply with any of the requirements of this agreement for the delivery of documents in electronic format; or (2) a defect, error, or omission in the Electronic Documents or the information contained therein, which defect, error, or omission was not contained in the contract documents as defined in Paragraph 2 or where the use of such contract documents would have prevented the claim, judgment, suit, liability, damage, cost, or expense.

Signature of Representative of Recipient

Name of Authorized Signing Officer, please print

End of Document

1 General

1.01 Section Includes

- .1 This Section specifies products, criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions. It is intended as a supplement to each Section and is to be read accordingly.

1.02 References

- .1 Division 00 and Division 01 apply to and are a part of each Mechanical Division:
 - .1 Division 20 – Common Mechanical Requirements;
 - .2 Division 21 – Fire Suppression;
 - .3 Division 22 – Plumbing;
 - .4 Division 23 – Heating, Ventilating, and Air Conditioning;
 - .5 Division 25 – Integrated Automation.
- .2 The provisions of this Section also apply to the following sections:
 - .1 Section 08 31 00 – Access Doors and Panels.
 - .2 Section 10 44 16 – Fire Extinguishers.

1.03 Submittals

- .1 Submit shop drawings/product data sheets for:
 - .1 pressure gauges and thermometers;
 - .2 electric motors (submit with equipment they are associated with).
- .2 Submit weight loads for selected equipment (upon request).
- .3 Submit copy of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations.
- .4 Submit a list of equipment identification nameplates indicating proposed wording and sizes.
- .5 Submit a list of pipe and duct identification colour coding and wording.
- .6 Submit a proposed valve tag chart and a list of proposed valve tag numbering and identification wording.
- .7 Submit drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
- .8 Submit any other submittals specified in this Section or other Sections of Mechanical Divisions.

1.04 Maintenance Material Submittals

- .1 As specified in Part 2 of this Section, submit a spare belt set, tagged, and identified, for each belt driven piece of equipment.

2 Products

2.01 Firestopping and Smoke Seal Materials

- .1 Firestopping and smoke seal system materials for mechanical penetrations through fire rated construction are specified in Section 20 05 17 – Sleeves and Sleeve Seals for Mechanical Piping, and work is to be done as part of mechanical work unless otherwise specified in Division 07.

2.02 Access Doors

- .1 Access doors to be provided under work of Division 08 by General Trades Contractor.
- .2 Coordinate with Mechanical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services, where possible, be accessible from common access door. Coordinate work to ensure same common location access doors are not supplied by more than one Division.
- .3 Size access doors to suit the concealed work for which they are supplied, and wherever possible they are to be of standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .4 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain fire separation integrity.
- .5 Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to the Consultant for review.

2.03 Flexible Piping Connectors

- .1 Double wall stainless steel flexible connectors for piping connections to vibration isolated equipment, each selected by manufacturer to suit the application. Shop drawings or product data sheets must indicate construction and performance requirements that suit the application.
- .2 Manufacturers:
 - .1 Hyspan Precision Products Inc.;
 - .2 Senior Flexonics Ltd.;
 - .3 The Metraflex Co.

3 Execution

3.01 General Piping and Ductwork Installation Requirements

- .1 Unless otherwise specified, locate, and arrange horizontal pipes and ducts above or at ceiling on floors, arranged so that under consideration of all other work in area, maximum ceiling height and/or usable space is maintained. If required to maintain ceiling heights, reroute and/or resize ductwork, with Consultant's approval.
- .2 Unless otherwise specified, install work concealed in finished spaces, and concealed to degree possible in partially finished and unfinished spaces. Refer to and examine Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Walls which are painted are considered finished.
- .3 Install pipes and ducts parallel to building lines and to each other.

- .4 Neatly group and arrange exposed work.
- .5 Locate work to permit easy access for service or maintenance as required and/or applicable. Locate valves, dampers and any other equipment which will or may need maintenance or repairs and which are to be installed in accessible construction so as to be easily accessible from access doors. Where valves, dampers and similar piping or ductwork accessories occur in vertical services in shafts, pipe spaces or partitions, locate accessories at floor level.
- .6 Make connections between pipes of different materials using adapters suitable for application. Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe.
- .7 Comply with equipment and material manufacturer's installation instructions unless otherwise specified herein or on drawings, and unless such instructions contradict governing codes and regulations.
- .8 Carefully clean ducts, pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.
- .9 Install piping and ductwork which are to be insulated so that they have sufficient clearance to permit insulation and finish to be applied continuously and unbroken around pipe or duct, except for ductwork at fire barriers, in which case insulation will be terminated at each side of the duct fire damper.
- .10 Inspect surfaces and structure prepared by other trades before performing work. Verify surfaces or structure to receive work has no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of work will constitute acceptance of such surfaces as being satisfactory.
- .11 Any ferrous piping that exhibits in excess of 5% surface rust, either inside or outside or both, is to be wire brush cleaned to bare metal and coated with suitable primer. Steel pipe, fittings and accessories are to be free of corrosion and dirt when work is complete or prior to being concealed from view. Where dirt is evident, clean piping prior to being concealed.
- .12 For factory applied finishes, repaint or refinish surfaces damaged during shipment and installation. Quality of repair work is to match original finish. This requirement also applies to galvanized finishes.
- .13 Where mechanical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on products to protect against corrosion or provide products which will not corrode in the environment, i.e. aluminium ductwork, copper or stainless steel pipe, etc.
- .14 Provide screwed unions or flanges in piping connections to equipment and in regular intervals in long (in excess of 12 m (40')) piping runs to permit removal of sections of piping.
- .15 Unless otherwise specified and except where space limitations do not permit, piping elbows are to be long radius. Eccentric reducers are to be installed with straight side at top of piping.

3.02 Pipe Joint Requirements

- .1 Do not make pipe joints in walls or slabs.
- .2 Ream piping ends prior to making joints.
- .3 Properly cut threads in screwed steel piping and coat male threads only with Teflon tape or paste, or an equivalent thread lubricant. After pipe has been screwed into fitting, valve, union, or piping accessory, not more than 2 pipe threads are to remain exposed.
- .4 Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove scale and oxide from bevels and leave smooth and clean. Use factory made welding tees or welding outlet fittings for piping branches off mains. Do not use shop or site fabricated fittings unless written approval has been obtained.

- .5 Welded joints are to be made by CWB certified licensed journeyman welders qualified in accordance with CSA B51, Boiler Pressure Vessel and Pressure Piping Code, and who are in possession of a proper certificate of qualification for each procedure to be performed. Each weld is to be identified with the welder's identification symbol, and welds are not to be concealed until they have been inspected and approved. Electrodes are to be in accordance with CSA W48 Series, Electrodes, and requirements of CAN/CSA W117.2, Safety in Welding, Cutting and Allied Processes are to be followed.
- .6 Unless otherwise specified, make flanged joints with Garlock 5500 or equivalent gasket materials to suit the application, and bolts and nuts. Bolts are not to be longer than length necessary to screw nut up flush to the end of bolt. Bolts used for flanged connections in piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A-193 Grade B-7, with heavy hexagon nuts to ASTM A-194 CL-2H. Provide suitable washers between each bolt head and flange and between each nut and flange.
- .7 A random check of bolted flanged connections will be made to verify flanged connections are properly mated with no shear force acting on bolts. Supply labour to disconnect and reconnect selected flanged joints. If improperly mated joints are found, remove and reinstall affected piping so flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.
- .8 Unless otherwise specified make soldered joints in copper piping using flux suitable for and compatible with type of solder being used. Clean the outside of pipe end and inside of fitting, valve, or similar accessory prior to soldering.
- .9 Install mechanical joint fittings and couplings in accordance with manufacturer's instructions.
- .10 Grooves are to be rolled. Make arrangements with coupling and fitting manufacturer for shop and/or site instructions and demonstrations as required, and adhere to manufacturer's instructions with respect to pipe grooving, support, type of gasket required, anchoring and guiding the grooved piping system.
- .11 If pressure crimped couplings and fittings are used, ensure gaskets are fully compatible with piping fluid, and valves and piping accessories are suitable. Use only fitting manufacturer supplied crimping equipment. Comply with manufacturer's latest published specification, instructions, and recommendations with respect to pipe, coupling, and fitting preparation and installation, and support, anchoring and guiding of the piping system.
- .12 Solvent weld PVC piping in 2 parts, primer stage and cementing stage, in accordance with manufacturer's recommendations, ASTM D2855, and CSA requirements.
- .13 Install PVC piping with gasketed joints in accordance with manufacturer's current published specifications, instructions and recommendations, and CSA requirements.

3.03 Duct Openings

- .1 Duct openings, air inlet and outlet openings, fire damper and similar openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by trade responsible for particular construction in which opening is required.
- .2 Size openings for fire dampers to suit damper arrangement with folding blade out of air stream.
- .3 For duct openings except where fire dampers are required, pack and seal space between duct or duct insulation and duct opening as specified above for pipe openings in non-fire rated construction.

3.04 Sleeve and Formed Opening Location Drawings

- .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.

- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

3.05 Installation of Pipe Escutcheon Plates

- .1 Provide escutcheon plates suitably secured over exposed piping passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install plates so they are tight against building surface concerned, completely covering pipe sleeves and/or openings, except where waterproof sleeves extend above floors, in which case fit plate tightly around sleeve.

3.06 Supply of Access Doors

- .1 Supply access doors to give access to mechanical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on drawings.
- .2 Before commencing installation of mechanical work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange mechanical work to suit.
- .3 Access doors will be installed by trade responsible for particular type of construction in which doors are required. Supply access doors to trade installing same at proper time.
- .4 Wherever possible, access doors to be of a standard size for each application. Confirm exact dimensions and minimum size restrictions with the Consultant prior to ordering.
- .5 Group piping and ductwork to ensure minimum number of access doors is required.
- .6 Coordinate with Electrical Contractor and General Trades Contractor to ensure access doors on project are provided by a single manufacturer, installed as part of work of General Trades Contractor and work involving both mechanical and electrical services should, where possible, be accessible from common access door. Coordinate work to ensure common location access doors are not supplied by both Mechanical Divisions and Electrical Divisions.

3.07 Installation of Valves

- .1 Generally, valve locations are indicated or specified on drawings or specified in Sections of the Specification where valves are specified, however, regardless of locations shown or specified, following requirements apply:
 - .1 provide shut-off valves to isolate systems, at base of vertical risers, in branch take-offs at mains and risers on floors, to isolate equipment, to permit work phasing as required, and wherever else required for proper system operation and maintenance;
 - .2 install shut-off valves with handles upright or horizontal, not inverted, and located for easy access;
 - .3 unless otherwise specified, provide a check valve in discharge piping of each pump;
 - .4 valve sizes are to be same as connecting pipe size;

- .5 valves are to be permanently identified with size, manufacturer's name, valve model or figure number and pressure rating, and wherever possible, valves are to be product of same manufacturer;
- .6 for valves in insulated piping, design of valve stem, handle and operating mechanism is to be such that insulation does not have to be cut or altered in any manner to permit valve operation.

3.08 Finish Painting of Mechanical Work

- .1 Finish paint exposed mechanical work as specified and/or scheduled in accordance with requirements of Division 09.
- .2 Touch-up paint damaged factory applied finishes on mechanical work products.

3.09 Pipe Leakage Testing

- .1 Before piping has been insulated or concealed, and before equipment, fixtures and fittings have been connected, test piping for leakage.
- .2 Tests are to be witnessed by the Consultant and/or Owner's representative, and, where required, representatives of governing authorities. Give ample notice of tests in writing and verify attendance. Have completed test report sheets dated and signed by those present to confirm proper test results.
- .3 When circumstances prevent scheduled tests from taking place, give immediate and adequate notice of cancellation to all who were scheduled to attend.
- .4 Gravity Drainage and Vent Piping
 - .1 Test piping in accordance with local governing building code.
 - .2 After fixtures and fittings are set and pipes are connected to building drain or drains, turn on water into pipe, fixtures, fittings and traps in order to detect any imperfect material or workmanship. Perform a smoke test if required by local governing authorities.
- .5 Pumped Drainage Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
- .6 Domestic Water Piping
 - .1 Test piping with cold water at a pressure of 1-½ times normal working pressure and maintain pressure for a minimum of 2 hours.
- .7 Sprinkler System Piping
 - .1 Test system piping in accordance with requirements of NFPA No. 13, "Installation of Sprinkler Systems", and in accordance with any additional requirements of governing authorities.
- .8 Standpipe System Piping
 - .1 Test system piping in accordance with requirements of NFPA No. 14, "Standpipe and Hose Systems", and in accordance with any additional requirements of governing authorities.
- .9 CO2 Fire Extinguishing System Piping
 - .1 Test system piping in accordance with requirements of NFPA No. 12, "Standard on Carbon Dioxide Extinguishing Systems", and in accordance with any additional requirements of governing authorities.

- .10 Clean Agent Fire Extinguishing System Piping
 - .1 Test system piping in accordance with requirements of NFPA No. 2001, "Standard on Clean Agent Extinguishing Systems", and in accordance with any additional requirements of governing authorities.
- .11 Heat Transfer (HVAC) System Piping
 - .1 Test piping with cold water at a pressure of 1035 kPa (150 psi) for a minimum of 2 hours.
- .12 Steam and Condensate Piping
 - .1 Test piping with cold water for a minimum of 2 hours at following pressures:
 - .1 0 kPa to 105 kPa (0 psi to 15 psi) low pressure piping – 690 kPa (100 psi);
 - .2 110 kPa to 690 kPa (16 psi to 100 psi) medium pressure piping – 1035 kPa (150 psi);
 - .3 greater than 690 kPa (100 psi) high pressure piping – 1380 kPa (200 psi).
- .13 Natural Gas Piping
 - .1 Test piping in accordance with requirements of CAN/CSA B149.1 and any additional requirements of local governing authorities.
 - .2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.
 - .3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
- .14 Propane Gas Piping
 - .1 Test piping in accordance with requirements of CAN/CSA B149.2 and any additional requirements of local governing authorities.
 - .2 After completion of the verification test, locate required tag stating results of the verification test at the point of entry of gas main into building, affixed to the pipe in a secure manner.
 - .3 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
- .15 Compressed Air Piping
 - .1 Test piping with dry compressed air or nitrogen at 690 kPa (100 psi) for a minimum of 2 hours.
 - .2 Test piping joints with a water-soap solution while piping is under pressure to detect leaks.
- .16 Fuel Oil Piping
 - .1 Test piping (not tanks) with dry compressed air or nitrogen for a minimum period of 2 hours at 1035 kPa (150 psi).
 - .2 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
- .17 Gasoline Piping

- .1 Test piping (not tanks) with dry compressed air or nitrogen for a minimum period of 2 hours at 1035 kPa (150 psi) in accordance with TSSA requirements.
 - .2 Check piping joints and connections for leaks with a water/soap solution while piping is under pressure.
- .18 Refrigerant Piping
- .1 Test refrigerant piping for leakage and dehydrate in accordance with requirements of Chapter 29 of ASHRAE Handbook – Fundamentals (2021).
- .19 Control Air Piping and Tubing
- .1 Test control air piping and tubing with dry compressed air or nitrogen before concealing and again before connection of instruments.
 - .2 Rough-in test pressure is to be 345 kPa (50 psi) maintained over 24 hours with a pressure drop not to exceed 35 kPa (5 psi).
 - .3 Test joints for leaks with a soap solution.
 - .4 Finish test is to be 205 kPa (30 psi) with a permissible loss of 7 kPa (1 psi) over a 4 hour period. Prior to connecting instruments, blow systems clean and dry, and test component connections for leaks with a water/soap solution.
- .20 Pure Water Piping
- .1 When piping has been properly flushed and cleaned, test at 690 kPa (100 psi) for 2 hours with only distilled water or filtered dry compressed air. If distilled water is used, drain system when testing is complete.
- .21 Following requirements apply to all testing:
- .1 ensure piping has been properly flushed, cleaned and is clear of foreign matter prior to pressure testing;
 - .2 temporarily remove or valve off piping system specialties or equipment which may be damaged by test pressures prior to pressure testing systems, and flush piping to remove foreign matter;
 - .3 when testing is carried out below highest level of the particular system, increase test pressure by the hydrostatic head of 7 kPa (1 psi) for every 600 mm (24") below the high point;
 - .4 include for temporary piping connections required to properly complete tests;
 - .5 piping under test pressure is to have zero pressure drop for length of test period;
 - .6 tighten leaks found during tests while piping is under pressure. If this is impossible, remove and refit piping and reapply test until satisfactory results are obtained;
 - .7 where leaks occur in threaded joints in steel piping, no caulking of these joints will be allowed under any conditions;
 - .8 tests are to be done in reasonably sized sections so as to minimize number of tests required;
 - .9 in addition to leakage tests specified above, demonstrate proper flow throughout systems including mains, connections and equipment, as well as proper venting and drainage, and include for any necessary system adjustments to achieve proper conditions.

3.10 Interruption to and Shut-Down of Mechanical Services and Systems

- .1 Coordinate shut-down and interruption to existing mechanical systems with Owner. Generally, shut-downs may be performed only between the hours of 12:00 midnight Friday until 6:00 a.m. Monday morning, unless otherwise specified in Division 01. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein this Article. Services for operation of existing non-renovated areas of building are to be maintained.
- .2 Upon award of a Contract, submit a list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and the Consultant in writing 5 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any system or service without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete the work for which shut-down is required are available at site.
- .5 Pipe freezing shall be used to connect new piping to existing piping. Alternative methods may be proposed, if site conditions are evaluated and permit, and are approved by the Consultant.
- .6 Where existing isolation valves do not hold, pipe freezing shall be used to connect new piping to existing piping.

3.11 Mechanical Service Requirements for Floating Floor Slabs

- .1 Where mechanical services are required to be installed in or through a vibration isolated floating slab, install such services so as not to transmit any vibration to base slab on which floating floor slab is placed.
- .2 Wherever possible, arrange mechanical work to avoid penetrating a floating floor slab.

3.12 Excavation and Backfill Work

- .1 Unless otherwise specified in Division 31, provide all excavation and backfill associated with the mechanical scope of work.
- .2 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage local utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.
- .3 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.
- .4 Where Work falls under jurisdiction of local governing utility, confirm requirements and comply with utility requirements.
- .5 Unless otherwise specified in Division 31, provide excavation, backfill and related work required for mechanical work. Obtain a copy of soil test report if available from the Consultant. Depth of excavations must accommodate local governing requirements and local standard practices to compensate for local frost levels of Place of the Work.
- .6 Inverts and locations of existing site services may have been site surveyed and approximate location may be shown on drawings. Confirm inverts and locations are correct, prior to commencing excavation and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await a direction. Grade bottom of trench excavations as required.

- .7 In firm, undisturbed soil, lay pipes directly on soil, unless otherwise directed.
- .8 Before backfilling, arrange for inspection of work by the Consultant. Do not backfill work unless reviewed with the Consultant. Failure to do so prior to backfilling will require re-excavating work and re-backfill at no additional cost to Owner.
- .9 Unless otherwise specified, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm (6") thickness compacted to a density of 100% Standard Proctor. Hand compact first layers up to a compacted level of minimum 300 mm (12") above top of pipe. Hand or machine compact the balance up to grade.
- .10 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the pipe, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.
- .11 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.
- .12 Provide minimum 1.37 m (4.5') of cover for underground piping subject to freezing and located outside building.
- .13 Provide minimum 450 mm (18") of cover for underground piping subject to freezing and located inside building.
- .14 After first lift of backfill has been compacted, mark entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D-UGMT.
- .15 Unless otherwise directed in Division 02 and/or Division 31, store and dispose of excavated materials as follows:
 - .1 during progress of contract, place material as directed in such a manner to minimize damage or disfigurement of ground and which in no way impedes progress of work;
 - .2 separately place surplus topsoil and subsoil as directed; leave site clean and unencumbered.
- .16 Perform pumping as required to keep excavations free of water.
- .17 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit a copy of testing agency's report to the Consultant for review.
- .18 Fill depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.
- .19 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, etc.) with General Contractor.

3.13 Cutting, Patching and Core Drilling

- .1 Unless otherwise provided by General Trades, perform cutting, patching, and core drilling of existing building required for installation of mechanical work. Perform cutting in a neat and true fashion, with proper tools and equipment to Consultant's approval. Patching is to exactly match existing finishes and be performed by tradesmen skilled in particular trade or application. Work is subject to review and acceptance by the Consultant.

- .2 Criteria for cutting holes for additional services:
 - .1 cut holes through slabs only; no holes to be cut through beams;
 - .2 cut holes 150 mm (6") diameter or smaller only; obtain approval from Structural Consultant for larger holes;
 - .3 keep at least 100 mm (4") clear from beam faces;
 - .4 space at least 3 hole diameters on centre;
 - .5 for holes that are required closer than 25% of slab span from supporting beam face, use cover meter above slab to clear slab top bars;
 - .6 for holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars;
 - .7 submit sleeving drawings indicating holes and their locations for Structural Consultant's review.
- .3 Do not cut or drill any existing work without approval from Owner and Consultant. Be responsible for damage done to building and services caused by cutting or drilling.
- .4 Where pipes pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around pipes or pipe insulation.
- .5 Prior to drilling or cutting an opening, determine, in consultation with Consultant and Owner, and by use of non-destructive radar scan (magnetic scan) of slab or wall, presence of any existing services and reinforcement bars concealed behind building surface to be cut and locate openings to suit. Coring is not permitted through concrete beams or girders.
- .6 Where drilling is required in waterproof slabs, size opening to permit snug and tight installation of a pipe sleeve sized to leave 12 mm (½") clearance around pipe or pipe insulation. Provide a pipe sleeve, constructed of Schedule 40 galvanized steel pipe with a flange at one end and of a length to extend 100 mm (4") above slab, in opening. Secure flange to the underside of slab and caulk void between sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.
- .7 Firestop and seal openings in fire rated construction. Do not leave openings open overnight unless approved by Owner and Consultant.

3.14 Packing and Sealing Core Drilled Pipe Openings

- .1 Pack and seal void between pipe opening and pipe or pipe insulation for length of opening as follows:
 - .1 non-fire rated interior construction – pack with mineral wool and seal both ends of opening with non-hardening silicone base caulking compound to produce a water-tight seal;
 - .2 exterior walls above grade – pack with mineral wool and seal both ends of sleeves water-tight with non-hardening silicone base caulking compound unless mechanical type seals have been specified;
 - .3 exterior walls below grade (and any other wall where water leakage may be a problem) – seal with link type mechanical seals as specified.

3.15 Flashing for Mechanical Work Penetrating Roof

- .1 Unless otherwise specified in Division 07, perform required flashing work, including counter-flashing, for mechanical work penetrating and/or set in roof.

- .2 Perform flashing work in accordance with requirements of drawing details and/or requirements specified in Division 07.

3.16 Cleaning Mechanical Work

- .1 Refer to cleaning requirements specified in Division 01.
- .2 Clean mechanical work prior to application for Substantial Performance of the Work.
- .3 Include for vacuum cleaning interior of air handling units and ductwork systems.

3.17 Connections to Other Equipment

- .1 Carefully examine Contract Documents during bidding period and include for mechanical work piping and/or ductwork connections to equipment requiring such connections.

3.18 Seismic Restraint Anchor Points for Equipment

- .1 Where mechanical equipment requires seismic restraint, it is to be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by equipment manufacturers, so equipment may be bolted down or restrained in the field.
- .2 Equipment to be restrained must be designed such that the strength and anchorage of its internal components exceed force level; used to restrain and anchor the equipment to the supporting structure.

3.19 Installation of Flexible Connectors

- .1 Provide flexible connectors in piping connections to seismically restrained equipment, where applicable, and wherever else shown.
- .2 Provide flexible connectors in piping connections to vibration isolated equipment.

3.20 Fan Noise Levels

- .1 Submit sound power levels with fan shop drawings/product data, with levels measured to AMCA 300 and calculated to AMCA 301.

3.21 Equipment and System Manufacturer's Certification

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for equipment/system manufacturer's authorized representative to visit site to examine installation, and after any required corrective measures have been made, to certify in writing to the Consultant that equipment/system installation is complete and in accordance with equipment/system manufacturer's instructions.

3.22 System Startup

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in mechanical work Sections in accordance with following requirements:
 - .1 Submit a copy of each equipment/system manufacturer's start-up report sheet to the Consultant for review, and incorporate any comments made by the Consultant.
 - .2 Under direct on-site supervision and involvement of equipment/system manufacturer's representative, start-up equipment/systems, make any required adjustments, document procedures, leave equipment/systems in proper operating condition, and submit to the Consultant complete set of start-up documentation sheets signed by manufacturer/supplier and Contractor.

- .2 Provide labour and material to conduct the integrated systems testing of interconnected life safety systems in accordance with CAN/ULC-S1001-11, and provide written report for Consultant's review. Ensure all required trade contractors are present on site as directed by the Integrated Testing Coordinator during the CAN/ULC-S1001-11 functional testing. Refer to Section 01 91 26.13.

End of Section

1 General

1.01 Pre-Tendered Mechanical Equipment

- .1 Refer to Appendix for complete information regarding scope of work for pre-tendered equipment. Equipment has been pre-tendered, ordered, and paid for by the Owner. Associated work to be included as part of Work of Mechanical Division of this Project, that is to include for, but not be limited to, provision of following:
 - .1 coordination with respective equipment manufacturers with regards to delivery, unloading and acceptance on site;
 - .2 inspection upon delivery and acceptance;
 - .3 unloading, transporting and moving/hoisting into installation position;
 - .4 installation, connection, testing, and certification.
- .2 Take over order and coordinate with various manufacturers/suppliers of pre-ordered equipment and associated Work. During inspection of pre-ordered equipment and associated components at site, report deficiencies to respective supplier and to the Owner and be responsible for resolving such deficiencies directly with respective supplier(s).
- .3 Be available for and attend factory testing at supplier's offices of pre-ordered equipment and associated Work, as requested by the Consultant.
- .4 Coordinate final installation requirements with manufacturers/suppliers of pre-ordered equipment and associated Work.
- .5 For reference purposes, copy of shop drawing may be obtained from the Consultant after order has been made.
- .6 Review installation schematics and diagrams, control system schematics, and wiring diagrams supplied by manufacturers/suppliers of pre-ordered equipment and associated Work. Coordinate interconnections with related various building systems.
- .7 Refer also to Appendix for further details and requirements of pre-tendered equipment. Be responsible for review of issued documents and request further information from the Consultant, if required. Include and incorporate required provisions and associated costs required for a complete installation.
- .8 Review and coordinate with each respective vendor of pre-tendered equipment the exact equipment and accessories that are being supplied and/or installed, and services being performed by pre-tendered equipment vendor. With each respective pre-tender equipment vendor, determine installation products and services which are not included as part of pre-tender packages, but which need to be supplied by respective pre-tender equipment vendor in order to complete onsite installation, and include for all costs associated with the above.
- .9 Obtain following from suppliers of pre-tendered equipment and submit to Owner:
 - .1 operating and maintenance materials, testing and commissioning reports, and inspection certificates/ULC approvals/local governing inspection authority approvals, warranties and other supplied documents; organize and combine documents into manuals as specified in Division 01 and/or Division 20;
 - .2 spare parts, maintenance tools and kits, and loose accessories.

2 Products – Not Used

3 Execution

3.01 Pre-Tendered Mechanical Equipment

- .1 Refer to respective equipment Section - Part 3 for additional installation requirements.
- .2 Install equipment in accordance with drawing notes, specifications, and manufacturer's instructions and to comply with Owner's on-site standards and regulations.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies requirements, criteria, methods, and execution for mechanical demolition work that are common to one or more mechanical work Sections, and it is intended as a supplement to each Section and is to be read accordingly.

2 Products – Not Used

3 Execution

3.01 Disconnection and Removal of Existing Mechanical Work

- .1 Where indicated on drawings, disconnect, and remove existing mechanical work, including hangers, supports, insulation, etc. Disconnect at point of supply, remove obsolete connecting services and make system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.
- .2 Scope and extent of demolition or revision work is only generally indicated on drawings. Estimate scope, extent and cost of work at site during bidding period site visit(s). Claims for extra costs for demolition work not shown or specified but clearly visible or ascertainable at site during bidding period site visits will not be allowed.
- .3 If any re-design is required due to discrepancies between mechanical drawings and site conditions, notify the Consultant who will issue a Site Instruction. If, in the opinion of the Consultant, discrepancies between mechanical drawings and actual site conditions are of a minor nature, required modifications are to be done at no additional cost.
- .4 Where existing mechanical services extend through, or are in an area to serve items which are to remain, maintain services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during renovation work, so as to be concealed behind new or existing finishes.
- .5 Unless otherwise specified, remove from site and dispose of existing materials which have been removed and are not to be relocated or reused.

3.02 Roofing Work

- .1 Where roof revisions and/or replacements are part of project, include for disconnecting, lifting, or temporarily removing mechanical equipment on roof as required to permit completion of roofing work, and for re-installing equipment when roofing work is complete.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. Where requirements of this Section contradict requirements of Division 00 or Division 01, conditions of Division 00 or Division 01 to take precedence.
- .2 Be responsible for advising product vendors of requirements of this Section.

1.02 Related Requirements

- .1 Division 00 and Division 01 apply to and are a part of this Section.

1.03 Specifications Language and Style

- .1 These specifications are written in the imperative mood and in streamlined form. The imperative language is directed to Contractor, unless stated otherwise.
- .2 Complete sentences by reading "shall", "Contractor shall", "shall be", and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.
- .3 Fulfill and perform all indicated requirements whether stated imperatively or otherwise.
- .4 When used in the context of a Product, read the word "provide" to mean "supply and install to result in a complete installation ready for its intended use."

1.04 Definitions

- .1 "concealed" – means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
- .2 "exposed" – means work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .3 "finished" - means when in description of any area or part of an area or a product which receives a finish such as paint, or in case of a product may be factory finished.
- .4 "provision" or "provide" (and tenses of "provide") – means supply and install complete.
- .5 "install" (and tenses of "install") – means secure in position, connect complete, test, adjust, verify, and certify.
- .6 "supply" – means to procure, arrange for delivery to site, inspect, accept delivery, and administer supply of products; distribute to areas; and include manufacturer's supply of any special materials, standard on site testing, initial start-up, programming, basic commissioning, warranties, and manufacturers' assistance to Contractor.
- .7 "delete" or "remove" (and tenses of "delete" or "remove") – means to disconnect, make safe, and remove obsolete materials; patch and repair/finish surfaces to match adjoining similar construction; include for associated re-programming of systems and/or change of documentation identifications to suit deletions, and properly dispose of deleted products off site unless otherwise instructed by Owner and reviewed with the Consultant.
- .8 "BAS" – means building automation system; "BMS" – means building management system; "FMS" – means facility management system; and "DDC" means direct digital controls; references to "BAS", "BMS", "FMS" and "DDC" generally mean same.

- .9 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern work and to which work must adhere.
- .10 "OSHA" and "OHS" – stands for Occupational Safety and Health Administration and Occupational Health and Safety Act, and wherever either one is used, they are to be read to mean local governing occupational health and safety regulations that apply to and govern work and to which work must adhere, regardless if Project falls within either authority's jurisdiction.
- .11 "Mechanical Divisions" – refers to Division 20, Division 21, Division 22, Division 23, Division 25, and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .12 "Electrical Divisions" – refers to Division 26, Division 27, Division 28, and other Divisions as specifically noted, and which work as defined in Specifications and/or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .13 "Consultant" – means person, firm or corporation identified as such in Agreement or Documents, and is licensed to practice in Place of the Work, and has been appointed by Owner to act for Owner in a professional capacity in relation to the Work.
- .14 Wherever words "indicated", "shown", "noted", "listed", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", or "noted" on Contract Documents.
- .15 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to the satisfaction of", "submitted to", etc., Consultant.

1.05 Documents

- .1 Documents for bidding include but are not limited to issued Drawings, Specifications and Addenda.
- .2 Specification is arranged in accordance with CSI/CSC 49 Divisions of MasterFormat.
- .3 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of work and form a basis for determining pricing. They are intended to be cooperative. Perform work that is shown, specified, or reasonably implied on the drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .4 Review Drawings and Specifications in conjunction with documents of other Divisions and, where applicable, Code Consultant's report.
- .5 Unless otherwise specifically noted in Specifications and/or on Drawings, Sections of Mechanical Divisions are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and Sections are to be read as a whole.
- .6 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of building is to be taken on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
- .7 Drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, offsets, fittings, transformations and similar products required as a result of obstructions and other architectural and/or structural details but not shown on Drawings.

- .8 Locations of equipment and materials shown may be altered, when reviewed by the Consultant, to meet requirements of equipment and/or materials, other equipment or systems being installed, and of building, all at no additional cost to Contract.
- .9 Specification does not generally indicate specific number of items or amounts of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
- .10 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical, and apply to work of Mechanical Divisions and Electrical Divisions. Be responsible for reviewing starter, MCC, VFD, and motor specification requirements prior to Bid submission. Confirm and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
- .11 Drawings and Specifications have been prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by the Consultant to any other party.
- .12 In the case of discrepancies between the drawings and specifications, documents will govern in order specified in "General Conditions", however, when scale and date of drawings are same, or where discrepancy exists within specification, most costly arrangement will take precedence.

1.06 Metric and Imperial Measurements

- .1 Generally, both metric and imperial units of measurement are given in Sections of Specification governed by this section. Measurement conversions may be generally "soft" and rounded off. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable local code requirements, and/or as applicable, make accurate measurements onsite. Where significant discrepancies are found, immediately notify Consultant for direction.

1.07 Examination of Documents and Site

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work, and include for such conditions in Bid Price.
- .2 Report to Consultant, prior to Bid Submittal, any existing site condition that will or may affect performance of work as per Documents. Failure to do so will not be grounds for additional costs.
- .3 Upon finding discrepancies in, or omissions from Documents, or having doubt as to their meaning or intent, immediately notify Consultant, in writing.

1.08 Work Standards

- .1 Where any code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, unless otherwise specifically noted, latest published edition at time of submission of Bids adopted by and enforced by local governing authorities having jurisdiction. Include for compliance with revisions, bulletins, supplementary standards or amendments issued by local governing authorities.
- .2 Where regulatory codes, standards and regulations are at variance with Drawings and Specification, more stringent requirement will apply unless otherwise directed by Owner and reviewed with the Consultant.
- .3 Supplementary mandatory specification and requirements to be used in conjunction with project include but are not limited to following:

- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI);
- .2 Air Movement and Control Association (AMCA);
- .3 American Iron and Steel Institute (AISI);
- .4 American National Standards Institute (ANSI);
- .5 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
- .6 American Society of Mechanical Engineers (ASME);
- .7 American Society of Testing and Materials (ASTM);
- .8 American Water Works Association (AWWA);
- .9 Associated Air Balance Council (AABC);
- .10 Building Industry Consulting Services, International (BICSI);
- .11 Canadian Gas Association (CGA);
- .12 Canadian General Standards Board (CGSB);
- .13 Canadian Standards Association (CSA);
- .14 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
- .15 Electrical Safety Authority (ESA);
- .16 Electronic Industries Association (EIA);
- .17 Factory Mutual Systems (FM);
- .18 Illuminating Engineering Society (IES);
- .19 Institute of Electrical and Electronic Engineers (IEEE);
- .20 International Standards Organization (ISO);
- .21 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS);
- .22 National Building Code of Canada (NBC);
- .23 National Electrical Manufacturers Association (NEMA);
- .24 National Environmental Balancing Bureau (NEBB);
- .25 National Fire Protection Association (NFPA);
- .26 National Standards of Canada;
- .27 NSF International;
- .28 Occupational Health and Safety Act (OHSA);
- .29 Ontario Building Code (OBC);
- .30 Ontario Electrical Safety Code (OESC);

- .31 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA);
 - .32 Technical Standards and Safety Authority (TSSA);
 - .33 Thermal Insulation Association of Canada (TIAC);
 - .34 Underwriters' Laboratories of Canada (ULC);
 - .35 Workplace Hazardous Materials Information System (WHMIS);
 - .36 Material Safety Data Sheets by product manufacturers;
 - .37 Local utility inspection permits;
 - .38 Codes, standards, and regulations of local governing authorities having jurisdiction;
 - .39 Additional codes and standards listed in Trade Sections;
 - .40 Owner's standards.
- .4 Provide applicable requirements for barrier free access in accordance with latest edition of local governing building code.
- .5 Where any governing Code, Regulation, or Standard requires preparation and submission of special details or drawings for review they are to be prepared and submitted to appropriate authorities. Be responsible for costs associated with these submittals.
- .6 Unless otherwise specified, install equipment in accordance with equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
- .7 Work is to be performed by journeyperson tradesmen who perform only work that their certificates permit, or by apprentice tradesmen under direct on site supervision of experienced journeyperson tradesman. Journeyperson to apprentice ratio is not to exceed ratio determined by the Board as stated in Ontario College of Trades and Apprenticeship Act or local equivalent governing body in Place of the Work.
- .8 Journeyperson tradesmen are to have a copy of valid trade certificates available at site for review with the Consultant at any time.
- .9 Experienced and qualified superintendent is to be on-site at times when work is being performed.
- .10 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to the Consultant and submission of reports and certificates to the Consultant.
- .11 Properly protect equipment and materials on site from damage due to elements and work of trades, to satisfaction of Owner and reviewed with the Consultant. Equipment and materials are to be in new condition upon Substantial Performance of the Work.
- .12 Mechanical piping system work, including equipment, must comply in all respects with requirements of local technical standards authorities and CSA B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, mechanical work products must bear a CRN number.
- .13 Electrical items associated with mechanical equipment are to be certified and bear stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.

1.09 Permits, Certificates, Approvals, and Fees

- .1 Contact and confirm with local authorities having jurisdiction including utility providers, requirements for approvals from such authorities. Obtain and pay for permits, certificates, and approvals required to complete Work.
- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of Work. If any defect, deficiency or non-compliant is found in work by inspection, be responsible for costs of such inspection, including any related expenses, making good and return to site, until work is passed by governing authorities.
- .3 Obtain and submit to Consultant, approval/inspection certificates issued by governing authorities to confirm that Work as installed is in accordance with rules and regulations of local governing authorities and are acceptable.
- .4 Include in each copy of operating and maintenance instruction manuals, copies of approvals and inspection certificates issued by regulatory authorities.

1.10 Requirements for Contractor Retained Engineers

- .1 Professional engineers retained to perform consulting services with regard to Project work, i.e. seismic engineer, fire protection engineer or structural engineer, are to be members in good standing with local Association of Professional Engineers, and are to carry and pay for errors and omissions professional liability insurance in compliance with requirements of governing authorities in Place of the Work.
- .2 Retained engineer's professional liability insurance is to protect Contractor's consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regards to the Work of this Contract.
- .3 Unless otherwise specified in Division 00 or Division 01, liability insurance requirements are as follows:
 - .1 coverage is to be a minimum of \$1,000,000.00 CDN inclusive of any one occurrence;
 - .2 insurance policy is not to be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice;
 - .3 liability insurance is to be obtained from an insurer registered and licensed to underwrite such insurance in the Place of the Work;
 - .4 retained consultants are to ascertain that sub-consultants employed by them carry insurance in the form and limits specified above;
 - .5 evidence of the required liability insurance in such form as may be required is to be issued to Owner, Owner's Consultant, and Municipal Authorities as required prior to commencement of aforementioned consultant's services.

1.11 Workplace Safety

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for products where required, and maintain one copy at site in a visible and accessible location available to personnel.
- .2 Comply with requirements of Occupational Health and Safety Act and other regulations pertaining to health and safety, including worker's compensation/insurance board and fall protection regulations. When

working in confined spaces, comply with requirements of Occupational Health and Safety Act - Ontario Regulation 632, "Confined Spaces" and any other applicable Ministry of Labour requirements.

- .3 If at any time during course of work, hazardous materials other than those identified in Documents and pertaining to Project Scope of Work, are encountered, or suspected that were not identified as being present and which specific instructions in handling of such materials were not given, cease work in area in question and immediately notify Consultant. Comply with local governing regulations with regards to working in areas suspected of containing hazardous materials. Do not resume work in affected area without approval from Owner and reviewed with the Consultant.

1.12 Planning and Layout of Work

- .1 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .2 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions. Generally, order of right of way for services to be as follows:
 - .1 piping requiring uniform pitch;
 - .2 piping 100 mm (4") dia. and larger;
 - .3 large ducts (main runs);
 - .4 cable tray and bus duct;
 - .5 conduit 100 mm (4") dia. and larger;
 - .6 piping less than 100 mm (4") dia.;
 - .7 smaller branch ductwork;
 - .8 conduit less than 100 mm (4") dia.
- .3 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify Consultant where headroom or ceiling space appears to be inadequate prior to installation of work.
- .4 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Where any invert, grade, or size is at variance with Contract Drawings, notify Consultant prior to proceeding with work.
- .5 Prepare plan and interference drawings (at a minimum drawing scale of 1:50 or ¼"=1' 0") of work for coordination with each trade Contractor. Arrange for preparation of detailed section drawings of ceiling spaces of corridors and any other congested areas. Sections are to be cross referenced with plan drawings so that trades may make use of section drawings. Section drawings to indicate lateral and elevation dimensions of major services within ceiling space. Lateral dimensions are to be from grid lines and elevations from top of floor slab. Obtain from Consultant, engineering drawings for this use. Contractors' interference drawings are to be distributed among other Trade Contractors. Submit drawings to the Consultant for review. Failure of General Contractor to prepare and coordinate overall interface drawings of trades does not relieve respective Division Contractor of responsibility to ensure that work is properly planned and coordinated.

- .6 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .7 Shut-off valves, balancing devices, air vents, equipment, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .8 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were missed due to lack of coordination.

1.13 Scheduling

- .1 Include for any and all scheduling, coordination, and construction phasing to suit project, specified in Division 01 and/or as indicated on the drawings. Review exact phasing requirements with Consultant prior to start of Work.
- .2 Phasing and scheduling of Work is required in order to maintain existing building operations. Include costs (including costs for "off hours" work) for scheduling, co-ordination, and construction phasing to suit this project as specified in Division 01 and on drawings. Review phasing requirements with the Consultant prior to start of Work.
- .3 Protect existing areas above, below, and adjacent areas of Work from any debris, noise, or interruptions to existing services to satisfaction of Owner and reviewed with the Consultant. Maintain in operation existing services to these areas to allow Owner to continue use of these areas. If services that are required to be maintained run through areas of renovations, provide necessary protection to services or reroute, in coordination with Owner and Consultant. Include for required premium time work to meet these requirements.
- .4 Work being performed within occupied spaces and work affecting surfaces adjacent to occupied spaces may need to be performed after regular business hours. For areas where spaces are used by Owner on a 24 hours basis or over various hours, coordinate hours of work with Owner on a regular basis to suit Owner's schedule. Execute work at times confirmed with and agreed to by Owner and reviewed with the Consultant, so as not to inconvenience Owner's occupation or in any way hinder Owner's use of building. Include for required premium timework to meet these requirements.
- .5 Project partial occupancy permits may be required throughout project. Provide for each partial permit, required local governing authority certificate and any other testing/verification certificates for systems.

1.14 Coordination

- .1 Review Contract Documents and coordinate work with work of each trade. Coordination requirements are to include but not be limited to following:
 - .1 requirements for openings, sleeves, inserts and other hardware necessary for installation of work;
 - .2 concrete work such as housekeeping pads, sumps, bases, etc., required for work, and including required dimensions, operating weight of equipment, location, etc.;
 - .3 depth and routing of excavation required for work, and requirements for bedding and backfill;
 - .4 wiring work required for equipment and systems but not specified to be done as part of mechanical work, including termination points, wiring type and size, and any other requirements.
- .2 Ensure materials and equipment are delivered to site at proper time and in such assemblies and sizes so as to enter into building and be moved into spaces where they are to be located without difficulty.

- .3 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so equipment is delivered to site when it is required, or so it can be stored within building, subject to available space as confirmed with Owner and reviewed with Owner, and protected from elements.
- .4 Ensure proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Comply with code requirements with regards to access space provision around equipment. Remove and replace any equipment which does not meet this requirement.
- .5 Where work is to be integrated, or is to be installed in close proximity with work of other trades, coordinate work prior to and during installation.

1.15 Products

- .1 Be responsible for ordering of products (equipment and materials) in a timely manner in order to meet project-scheduling timelines. Failure to order products to allow manufacturers sufficient production/delivery time to meet project-scheduling timelines is an unacceptable reason to request for other suppliers or substitutions.
- .2 Provide Canadian manufactured products wherever possible or required and when quality and performance is obtainable at a competitive price. Products are to be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, products are to be new and are to comply with applicable respective Canadian standards. References to UL listings of products to include requirements that products are to be also Underwriters Laboratories of Canada (ULC) listed for use in Canada. Products are to meet or exceed latest ANSI/ASHRAE/IES 90.1 standards, as applicable. Do not supply any products containing asbestos materials or PCB materials.
- .3 Systems and equipment of this Project are to be "State of the Art" and be most recent and up to date series/version of product that is available at time of shop drawing review process. Products that have been stored or "on shelf" for an extended period of time will not be accepted. Software is to be of latest version available and be provided with updates available at time of shop drawing review process. Systems are to be designed such that its software is backwards compatible. Future upgrades are not to require any hardware replacements or additions to utilize latest software.
- .4 Products scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any product specified by manufacturer's name and model number. Where manufacturers are listed, first name listed is base specified company. Bid Price may be based on products supplied by any of manufacturers' base specified or named as acceptable for particular product. If manufacturers are not stated for a particular product, base Bid Price on product supplied by base specified manufacturer.
- .5 Documents have been prepared based on product available at time of Bidding. If, after award of Contract, and if successful manufacturer can no longer supply a product that meets base specifications, notify Consultant immediately. Be responsible for obtaining other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by the Consultant and are considered as substitutions subject to a credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems, etc., include required changes. Such changes are to be submitted in detail to the Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions. Above conditions supplement and are not to supersede any specification conditions with regards to substitutions or failure to supply product as per issued documents.
- .6 Listing of a product as "acceptable" does not imply automatic acceptance by the Consultant and/or Owner. It is responsibility of Contractor to ensure that any price quotations received and submittals made are for products that meet or exceed specifications included herein.

- .7 If products supplied by a manufacturer named as acceptable are used in lieu of base specified manufacturer, be responsible for ensuring that they are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces, etc.), and changes to associated or adjacent work resulting from provision of product supplied by a manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and dimensions of such equipment differs from base specified equipment, prepare, and submit for review accurately dimensioned layouts of rooms affected, identifying architectural and structural elements, systems and equipment to prove that equipment in room will fit properly meeting design intent. There will be no increase in Contract Price for revisions.
- .8 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to the Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to the Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of proposed substitution. Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by the Consultant.
- .9 Where products are listed as "or approved equal", certify in writing that product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of base specified product and is equivalent or better than base specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products is at sole discretion of the Consultant. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of approved equal product. There must be no increase in Contract price due to Consultant's rejection of proposed equivalent product.
- .10 Whenever use of product other than base specified product is being supplied, ensure corresponding certifications and product information (detailed catalogue and engineering data, fabrication information and performance characteristics) are submitted to the Consultant for review. Failure of submission of these documents to the Consultant in a timely manner to allow for review will result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract.
- .11 Products supplied by a manufacturer/supplier other than a manufacturer listed as acceptable may be considered for acceptance by the Consultant if requested in writing with full product documentation submitted, a minimum of 10 working days prior to Bid closing date.
- .12 Any proposed changes initiated by Contractor after award of Contract may be considered by the Consultant at the Consultant's discretion, with any additional costs for such changes if accepted by Owner and reviewed with the Consultant, and costs for review, to be borne by Contractor.
- .13 Whenever use of product other than based specified products or named as acceptable is being supplied, time for process of submission of other products and Consultant's review of products will not alter contract time or delay work schedule.

1.16 Shop Drawings

- .1 At start-up meeting, review with the Consultant products to be included in shop drawing submission. Prepare and submit list of products to the Consultant for review.
- .2 Submit electronic copies of shop drawings unless otherwise directed by the Consultant. Coordinate exact requirements with the Consultant.

- .3 Submit for review, drawings showing detail design, construction, and performance of equipment and materials as requested in Specification. Submit shop drawings to the Consultant for review prior to ordering and delivery of product to site. Include minimally for preparation and submission of following, as applicable:
 - .1 product literature cuts;
 - .2 equipment data sheets;
 - .3 equipment dimension drawings;
 - .4 system block diagrams;
 - .5 sequence of operation;
 - .6 connection wiring schematic diagrams;
 - .7 functionality with integrated systems.
- .4 Each shop drawing or product data sheet is to be properly identified with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
- .5 Where any item of equipment is required by Code or Standard or By-Law to meet a specific energy efficiency level, or any other specific requirement, ensure this requirement is clearly indicated on submission.
- .6 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned to be resubmitted.
- .7 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) – If Consultant's review of shop drawing is final, Consultant to stamp shop drawing;
 - .2 "REVISE AND RESUBMIT" – If Consultant's review of shop drawing is not final, Consultant to stamp shop drawing as stated above, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant's notations and resubmit.
- .8 Following is to be read in conjunction with wording on Consultant's shop drawing review stamp applied to each and every shop drawing or product data sheet submitted:
 - .1 "THIS REVIEW BY CONSULTANT IS FOR SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT CONSULTANT APPROVES DETAILED DESIGN INHERENT IN SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH CONTRACTOR. CONSULTANT'S REVIEW DOES NOT RELIEVE CONTRACTOR OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN SHOP DRAWINGS OR OF CONTRACTOR'S RESPONSIBILITY FOR MEETING REQUIREMENTS OF CONTRACT DOCUMENTS. BE RESPONSIBLE FOR DIMENSIONS TO BE CONFIRMED AND CORRELATED AT JOB SITE, FOR INFORMATION THAT PERTAINS SOLELY TO FABRICATION PROCESSES OR TO TECHNIQUES OF CONSTRUCTION AND INSTALLATION, AND FOR COORDINATION OF WORK OF SUB-TRADES."

- .9 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system are to be submitted together.
- .10 Obtain shop drawings for submission from product manufacturer's authorized representatives and supplemented with additional items specified herein.
- .11 Do not order product until respective shop drawing review process has been properly reviewed with the Consultant.
- .12 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
- .13 Applicable mechanical equipment has been selected to meet energy efficiency requirements of ANSI/ASHRAE/IES 90.1, Energy Standards for Buildings, and shop drawings/product data submittals for such equipment must indicate compliance with this Standard or they will be returned for correction and re-submittal.

1.17 Equipment Loads

- .1 Supply equipment loads (self-weight, operating weight, housekeeping pad, inertia pads, etc.) to the Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location, and method of support of equipment may differ from those assumed by the Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, it is imperative that equipment loads, location, and method of support be confirmed prior to fabrication of structural steel. Review locations of equipment with the Consultant prior to construction.

1.18 Openings

- .1 Supply opening sizes and locations to the Consultant to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .2 No openings are permitted through completed structure without written approval from Owner and reviewed with the Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to the Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, and/or voids created under scope of work of project, and ensure that any openings created under scope of work have been closed off, fire-stopped and smoke-sealed. Unless directed by Owner and reviewed with the Consultant, do not leave any openings unprotected and unfinished overnight.

1.19 Scaffolding, Hoisting and Rigging

- .1 Unless otherwise specified or directed, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and reviewed with the Consultant.
- .2 Immediately remove from site scaffolding, rigging and hoisting equipment when no longer required.
- .3 Do not place major scaffolding/hoisting equipment loads on any portion of structure without approval from Owner and reviewed with the Consultant.

1.20 Changes in the Work

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare and submit to the Consultant for review, a quotation being proposed cost for executing change or revision.
- .2 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 Unless otherwise specified in Division 00 or Division 01, allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .4 Unless otherwise specified in Division 00 or Division 01, following additional requirements apply to all quotations submitted:
 - .1 when change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work;
 - .2 material costs are not to exceed those published in the latest edition of Allpriser price guide, less 20%;
 - .3 mechanical material labour unit costs are to be in accordance with Mechanical Contractors Association of America Labor Estimating Manual, less 25%;
 - .4 electrical material labour unit costs are to be in accordance with National Electrical Contractors Association Manual of Labor Units at difficult level, less 25%;
 - .5 costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work;
 - .6 cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary;
 - .7 costs for rental tools and/or equipment are not to exceed local rental costs;
 - .8 overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals;
 - .9 quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .7 Do not execute any change or revision until written authorization for the change or revision has been obtained from the Consultant.

1.21 Progress Payment Breakdown

- .1 Prior to submittal of first progress payment draw, submit a detailed breakdown of work cost to assist Consultant in reviewing and approving progress payment claims.

- .2 Payment breakdown is subject to Owner's approval and Consultant's review. Progress payments will not be processed until an approved breakdown is in place. Breakdown is to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including testing, adjusting and balancing, system testing and verification, and project closeout submittals.
- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as indicated on progress draw.

1.22 Notice for Required Field Reviews

- .1 Whenever there is a requirement for the Consultant to perform a field review prior to concealment of any work, to inspect/re-inspect work for deficiencies prior to Substantial Performance of the Work, for commissioning demonstrations, and any other such field review, give minimum 5 working days' notice in writing to the Consultant.
- .2 If Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until the Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform a field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

1.23 Preliminary Testing

- .1 When directed by the Consultant, promptly arrange, pay for, and perform site tests on any piece of equipment or any system for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and governing Codes and Regulations, prior to Substantial Performance of the Work.
- .2 When, in Consultant's opinion, tests are required to be performed by a certified testing laboratory, arrange and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts and/or workmanship of any kind.
- .4 When, in Consultant's opinion, tests indicate that equipment, products, etc., are defective or deficient, immediately remove such equipment and/or products from site and replace them with acceptable equipment and/or products, at no additional cost.

1.24 Provisions for Systems/Equipment Used During Construction

- .1 Permanent building mechanical systems are not to be used for temporary heating or cooling purposes during construction.

1.25 Temporary Services

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to temporary heating, cooling, and water. Unless otherwise noted, provide required services in compliance with requirements of local governing building code and local governing inspection authorities.
- .2 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of local governing code and local governing authorities.

1.26 Maintaining Equipment Prior to Acceptance

- .1 Maintain equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.
- .2 Employ a qualified millwright to check and align shafts, drives, and couplings on all base mounted split coupled motor driven equipment.
- .3 Where equipment lubrication fittings are not easily accessible, extend the fittings to accessible locations using copper or aluminium tubing.
- .4 All filters are to be new upon Substantial Performance of the Work. This is in addition to any spare filters specified.

1.27 Record Documentation

- .1 Drawings for this project have been prepared on a CAD system using Revit software of release version reviewed with the Consultant. For purpose of producing record "as built" drawings, copies of Contract Drawings can be obtained from the Consultant.
- .2 As work progresses at site, clearly mark in red in a neat and legible manner on a set of bound white prints of Contract Drawings, changes, and deviations from routing of services and locations of equipment shown on Contract Drawings, on a daily basis. Changes and deviations include those made by addenda, change orders, and site instructions. Use notes marked in red as required. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date at all times, and ensure set is always available for periodic review. As-built set is also to include the following:
 - .1 dimensioned location of inaccessible concealed work;
 - .2 locations of control devices with identification for each;
 - .3 for underground piping and ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories if applicable, and locate dimensions from benchmarks to be preserved after construction is complete;
 - .4 for fire protection systems, record actual locations of equipment, sprinkler heads, and valves, drains, and test locations, and deviations of pipe routing and sizing from that shown on the drawings;
 - .5 location of piping system air vents;
 - .6 location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
- .3 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of Contract Drawing set in accordance with marked up set of "as-built" white prints including deviations from original Contract Drawings, thus forming an "as-built" drawing set. Submit "as-built" site drawing prints to the Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of the Consultant.
- .4 Use final reviewed "as-built" drawing set to provide CAD files of drawings thus forming true "as-built" set of Contract Drawings. Identify set as "Project Record Copy". Load digital copies of final reviewed by the Consultant as-built drawings onto USB type flash drive. Provide 2 complete sets of "as-built" drawings on separate USBs. Submit "as-built" sets of white prints and USBs to Consultant.
- .5 Submitted drawings are to be of same quality as original Contract Drawings. CAD drawing files are to be compatible with Revit software release version confirmed with the Consultant.

- .6 Unless otherwise noted in Division 00 or Division 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to satisfaction of Owner and reviewed with the Consultant.
- .7 For projects with phased turnover of project (refer to Division 01), review with the Consultant completeness of as-built drawings prior to turn over of an area. Interim as-built drawings to be made available to Owner's maintenance personnel.
- .8 Where part of the Mechanical Scope of Work, retain and pay for services of a land surveyor registered in Place of the Work to measure, verify, and record size, location, invert elevation and pitch of buried piping services, and, when complete, transfer survey work to as-built drawings.

1.28 Operation and Maintenance Data

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply indexed copies of equipment manufacturers' operating and maintenance (O&M) instruction data manuals. Consolidate each copy of data as a PDF file on a USB drive. Consolidated O&M manual PDF to include:
 - .1 front cover: project name; wording – "Mechanical Systems Operating and Maintenance Manual"; and date;
 - .2 introduction sheet listing Consultant, Contractor, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses;
 - .3 equipment manufacturer's authorized contact person name, telephone number and company website;
 - .4 Table of Contents sheet, and corresponding index tab sheets;
 - .5 copy of each "REVIEWED" or clean, updated "REVIEWED AS NOTED" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, company website address, and email address for local source of parts and service; when shop drawings are returned marked "Reviewed As Noted" with revisions marked on shop drawing copies, they are to be revised by equipment supplier to incorporate comments marked on "Reviewed" shop drawings and a clean updated copy is to be included in operating and maintenance manuals;
 - .6 Operating data is to include:
 - .1 pressure test reports, and certificates issued by governing authorities;
 - .2 description of each system and its controls;
 - .3 control schematics for equipment/systems including building environmental controls;
 - .4 wiring and connection diagrams;
 - .5 if applicable, BAS architecture and all required operating data;
 - .6 description of operation of each system at various loads together with reset schedules and seasonal variances;
 - .7 operation instruction for each system and each component;
 - .8 description of actions to be taken in event of emergencies and/or equipment failure;
 - .9 valve tag schedule, and flow diagrams to indicate valve locations.
 - .7 Maintenance data is to include:

- .1 operation and trouble-shooting instructions for each item of equipment and each system;
- .2 schedules of tasks, frequency, tools required, and estimated task time;
- .3 recommended maintenance practices and precautions;
- .4 complete parts lists with numbers.
- .8 Performance data is to include:
 - .1 equipment and system start-up data sheets;
 - .2 equipment performance verification test results, and final commissioning report;
 - .3 final testing, adjusting and balancing reports.
- .9 copies of warranties;
- .10 items requested specifically in Section Articles.
- .2 Operating and maintenance instructions are to relate to job specific equipment supplied under this project and related to Owner's building. Language used in manuals is to contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system.
- .3 Before applying for a Certificate of Substantial Performance of the Work, assemble one copy of O&M Manual and submit to the Consultant for review prior to assembling remaining copies. Incorporate Consultant's comments into final submission.

1.29 Commissioning

- .1 After successful start-up and prior to Substantial Performance of the Work, commission the mechanical work. Commissioning work is the process of Contractor demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, as further described below.
 - .1 Retain services of a testing, adjusting, and balancing agency to perform testing and balancing of mechanical system air/fluid flows and capacities, prior to operational performance testing. Refer to Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems.
 - .2 Test, adjust and operate equipment and systems after start-up but before functional performance testing, to confirm operations are in accordance with requirements of Contract Documents. Verify modes and sequences of control and monitoring, interlocks, and responses to emergency conditions. Complete commissioning data sheets to document successful operational performance testing.
 - .3 Repeat successful operational performance testing with completed commissioning data sheet documentation in the presence of Consultant and Owner to validate and verify equipment and systems are complete in all respects, function correctly, and are ready for acceptance.
 - .4 Submit final commissioning data sheets, TAB reports as specified in Section 20 05 93 – Testing, Adjusting, and Balancing for Mechanical Systems, project closeout documents, and other required submittals.

1.30 Warranty

- .1 Unless otherwise specified in Division 00 and Division 01, warrant mechanical work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of a Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, e.g., 5 years, first year of warranty period is to be governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are to be direct from equipment manufacturer and/or supplier to Owner. Submit signed and dated copies of extended warranties to the Consultant.
- .3 Warranty to include parts, labour, travel costs and living expenses incurred by manufacturer's authorized technician to provide factory authorized on-site service.
- .4 Repair and/or replace any defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner's staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 It is understood that warranties are to commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Be responsible for providing whatever "bridging" or additional extended warranty period is required from time that material is purchased until this time.
- .7 Visit building during warranty period with Owner representatives. Owner to organize these visits. At these meetings, Owner representatives are to review performance of systems. If performance is satisfactory, then no further action needs to be taken. If unsatisfactory, then correct deficiencies, as directed by Owner representatives, to satisfaction of Owner's representatives. These site visits to occur:
 - .1 once during 1st month of building operation;
 - .2 once during 3rd month of building operation;
 - .3 once between 4th and 10th month in a season opposite to 1st and 3rd month visits.

1.31 Closeout Submittals

- .1 Prior to application for Substantial Performance of the Work, submit required items and documentation specified, including following as applicable to the project:
 - .1 Operating and Maintenance Manuals;
 - .2 as-built record drawings and associated data;
 - .3 extended warranties for equipment as specified;
 - .4 operating test certificates, i.e. Sprinkler Test Certificate;
 - .5 final commissioning report and TAB report;
 - .6 identified keys for equipment and/or panels for which keys are required, and other items required to be submitted;
 - .7 other data or products specified.

1.32 Instructions to Owner

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train Owner's designated personnel in aspects of operation and maintenance of equipment and systems as specified. Demonstrations and training are to be performed by qualified technicians employed by equipment/system manufacturer/supplier. Supply hard copies of training materials to each attendee.
- .3 Unless where specified otherwise in trade Sections, minimum requirements are for manufacturer/suppliers of each system and major equipment, to provide minimum two separate sessions each consisting of minimum 4 hours on site or in factory training (at Owner's choice), of Owner's designated personnel (for up to 6 people each session), on operation and maintenance procedures of system.
- .4 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals during training sessions. Training modules include but are not limited to:
 - .1 Operational Requirements and Criteria – equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations;
 - .2 Troubleshooting – diagnostic instructions, test and inspection procedures;
 - .3 Documentation – equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like;
 - .4 Maintenance – inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools;
 - .5 Repairs – diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .5 Before instructing Owner's designated personnel, submit to the Consultant for review preliminary copy of training manual and proposed schedule of demonstration and training dates and times. Incorporate Consultant's comments in final copy.
- .6 Obtain in writing from the Consultant list of Owner's representatives to receive instructions. Submit to Consultant prior to application for Certificate of Substantial Performance of the Work, complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
- .7 Obtain signatures of Owner's staff to verify they properly understood system installation, operation, and maintenance requirements, and have received operating and maintenance instruction manuals and "as-built" record drawings.
- .8 Submit to the Consultant copy of electronic version of training materials and include in operating and maintenance manuals submission.

1.33 Final Inspection

- .1 Submit to Consultant, written request for final inspection of systems. Include written certification that:
 - .1 deficiencies noted during job inspections have been completed;
 - .2 field quality control procedures have been completed;
 - .3 systems have been tested and verified, balanced, and adjusted, and are ready for operation;
 - .4 maintenance and operating data have been completed and submitted to, reviewed with the Consultant and accepted by Owner;
 - .5 tags and nameplates are in place and equipment identifications have been completed;
 - .6 clean-up is complete;
 - .7 spare parts and replacement parts specified have been provided and acknowledged by the Consultant;
 - .8 as-built and record drawings have been completed and submitted to and reviewed with the Consultant and accepted by Owner;
 - .9 Owner's staff has been instructed in operation and maintenance of systems;
 - .10 commissioning procedures have been completed.

2 Products – Not Used

3 Execution

3.01 Cleaning

- .1 During construction, keep site reasonably clear of rubbish and waste material resulting from work on a daily basis to the satisfaction of Owner and Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove rubbish and debris, and be responsible for repair of any damage caused as a result of work.
- .2 Clean equipment and devices installed as part of this project.

End of Section

1 General

1.01 Section Includes

- .1 Motors and starters for all equipment specified in Mechanical Divisions.

1.02 Related Requirements

- .1 Section 26 05 83 – Wiring Connections.

1.03 Submittals

- .1 Submit shop drawings/product data sheets for:
 - .1 electric motors (submit with equipment they are associated with).
- .2 Submit a list of equipment identification nameplates indicating proposed wording and sizes.

2 Products

2.01 Equipment Belt Drives

- .1 ANSI/RMA Standard V-belt type rated at minimum 1.5 times motor nameplate rating, and in accordance with following requirements:
 - .1 belts are to be reinforced cord and rubber, and multiple belts are to be matched sets;
 - .2 sheaves are to be cast iron or steel, secured to shafts with removable keys unless otherwise specified, standard adjustable pitch ($\pm 10\%$ range) for motors under 10 hp, fixed pitch type with split tapered bushing and keyway for motors 10 hp and larger, and, if required, replaced as part of mechanical work to suit system air/water quantity testing and balancing work;
 - .3 motor slide rail adjustment plates are to allow for centre line adjustment.
- .2 Supply a spare belt set (tagged and identified) for each belt drive and hand to Owner upon Substantial Performance of the Work.

2.02 Equipment Drive Guards and Accessories

- .1 For V-belt drives – removable, 4-sided, fully enclosed, galvanized sheet steel guards to OSHA standards, cleaned, factory primed and painted with yellow equipment enamel, complete with a 2-piece full length hinged front panel to permit belt maintenance or replacement without removing guard, and 40 mm (1-1/2") diameter tachometer openings at each shaft location.
- .2 For flexible couplings – removable "U" shaped galvanized steel guards to OSHA Standards with a 2.3 mm (3/32") thick frame and expanded mesh face.
- .3 For unprotected fan inlets and outlets – unless otherwise specified, removable 20 mm (3/4") galvanized steel wire mesh with galvanized steel frames, all to OSHA Standards.

2.03 Electric Motors

- .1 Unless otherwise specified, motors are to conform to NEMA Standard MG 1, applicable IEEE Standards, and applicable CSA C22.2 standards, and are to meet NEMA standards for maximum sound level ratings under full load. Confirm motor voltages prior to ordering.
- .2 Vertically mounted and submersible motors are to be purposely designed for mounting in this attitude.

- .3 Efficiency of 1-phase motors to 1 hp is to be in accordance with CAN/CSA C747. Efficiency of 3-phase motors 1 hp and larger is to be in accordance with CAN/CSA C390 or IEEE 112B.
- .4 Unless otherwise specified, 1-phase motors smaller than ½ hp are to be 115 V, continuous duty capacitor start type with an NEMA 48 or 56 frame size, solid base, heavy-gauge steel shell with solid die-cast end shields, dynamically balanced die-cast rotor, integral automatic reset thermal overload protection, Class "B" insulation, and a 1.15 service factor at 40°C (105°F) ambient temperature.
- .5 Explosion-proof 1-phase motors are to be totally enclosed, fan cooled, 115 V continuous duty capacitor start type in accordance with CSA C22.2 No. 145, as specified for standard 1-phase motors but suitable for use in Class 1 Group D hazardous locations and complete with a rolled steel shell and a 1.0 service factor at 40°C (105°F) ambient temperature.
- .6 Unless otherwise specified, motors ½ hp and larger are to be totally enclosed, fan cooled, 3-phase, T-frame, squirrel cage continuous duty induction motors suitable for voltages indicated on Drawings, NEMA Design "B" for normal starting torque or Design "C" for high starting torque as required by the application, each complete with Class "B" insulation, a 1.15 service factor at 40°C ambient temperature, grease lubricated open ball bearings with grease fittings to permit re-lubrication without dismantling motor, a cast iron frame with cast iron feet where required, cast iron end bracket and precision machined bearing fit, and balanced carbon steel shaft assembly with die-cast aluminum rotor windings.
- .7 Explosion-proof 3-phase motors are to be totally enclosed fan cooled motors in accordance with CSA C22.2 No. 145, generally as specified above for standard 3-phase motors but suitable for use in Class 1 Group D hazardous locations and with a 1.0 service factor at 40°C (105°F) ambient temperature.
- .8 Motor(s) for 2-speed cooling tower(s) are to be as specified above but 2-speed single winding type.
- .9 Motor(s) for 2-speed fan(s) are to be as above but 2-speed double winding type.
- .10 Unless otherwise indicated, motors 30 hp and larger are to be complete with a heat sensing PTC thermistor in the end turn of stator winding for each phase and connected in series inside motor with 2 marked leads brought out to motor conduit box.
- .11 Motors for equipment with variable frequency drives are to be generally as specified above but inverter duty type to NEMA Standard MG 1 Part 31, quantified by CSA for operation from a variable frequency drive of type specified, and complete with Class "H" insulation. Motors are to be equipped with AEGIS, or approved equal, shaft grounding ring system to protect bearings from damage by diverting harmful shaft voltages and bearing currents to ground.
- .12 Motors 150 hp and larger with "wye-delta" reduced voltage starters are to be complete with six leads for connection to motor starter.
- .13 Motors for equipment which is scheduled or specified with a corrosion resistant coating or constructed from corrosion resistant materials are to be factory coated with a primer and epoxy paint finish.
- .14 Manufacturers:
 - .1 TECO-Westinghouse Motors (Canada) Inc.;
 - .2 Canadian General Electric;
 - .3 Baldor Electric Co.;
 - .4 U.S. Electrical Motors;
 - .5 Weg Electric Corp.;
 - .6 Marathon Electric;

- .7 Toshiba Corp.;
- .8 Leeson Canada.

2.04 Motor Starters and Accessories

- .1 Motor starters must be capable of starting associated motors under the imposed loads. Confirm starter voltage matches motor prior to ordering.
- .2 Unless otherwise specified, starters for 1-phase motors are to be 115 V, thermal overload protected manual starting switches with a neon pilot light, a surface or recessed enclosure to suit the application, and, where automatic operation is required, a separate H-O-A switch in an enclosure to match starter enclosure.
- .3 Unless otherwise specified, starters for 3-phase motors less than 50 hp are to be combination "quick-make" and "quick-break" fused disconnects and full voltage non-reversing across-the-line starters, each complete with and overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .4 Unless otherwise specified, starters for 3-phase motors 50 hp to 150 hp are to be reduced voltage, non-reversing, auto-transformer type starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .5 Unless otherwise specified, starters for 3-phase motors 150 hp and larger are to be reduced voltage, non-reversing, closed transition "wye-delta" starters complete with one overload relay per phase, an enclosure to suit the application, and, a H-O-A switch, pilot lights, control transformer, auxiliary contacts, and other accessories as per motor starter schedule.
- .6 Starters for 2-speed double winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .7 Starters for 2-speed single winding motors are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to permit equipment to coast down to low speed before it is operated at low speed.
- .8 Starters for reversible motors for cooling towers are to be generally as specified above but suitable for motor and equipped with a 45 second time delay to allow fan(s) to coast down to a stop before being operated in reverse rotation.
- .9 Unless otherwise specified, motor starter enclosures are to be in accordance with following NEMA ratings:
 - .1 enclosures located in sprinklered areas – Type 2;
 - .2 enclosures exposed to the elements – Type 3R, constructed of stainless steel;
 - .3 enclosures inside the building in wet areas – Type 3R, constructed of stainless steel;
 - .4 enclosures in explosion rated area – Type 7 with exact requirements to suit the area and application;
 - .5 enclosures except as noted above – Type 1;
 - .6 enclosures located in finished areas – as above but recess type with brushed stainless steel faceplate.

- .10 Motor control centres are to be multi-unit, 2.28 m (9') high, NEMA Class 1, type "B", factory assembled, dead front, floor mounted, free-standing motor control centre with tin plated copper bus and an NEMA Type 1 or Type 2 enclosure as for loose starters specified above. Each motor control centre is to be complete with starters as specified above, load and control wiring terminal boards, and required facilities for line and load side power wiring connections.
- .11 Disconnect switches for motor control centres are to be heavy-duty, CSA certified, front operated switches as per motor starter schedule, each complete with a handle suitable for padlocking in "off" position and arranged so that door cannot be opened with handle in "on" position and an NEMA enclosure as specified for loose starters. Fusible units are to be complete with fuse clips to suit fuse types specified below.
- .12 Fuses are to be, unless otherwise scheduled or specified, English Electric Ltd. HRC fuses, Form I Class "J" for constant running equipment and Form II Class "C" for equipment that cycles on and off.
- .13 Manufacturers:
 - .1 Rockwell Automation Inc. - Allen-Bradley;
 - .2 Eaton Corp. – Cutler-Hammer;
 - .3 Eaton Corp. – Moeller Electric;
 - .4 Siemens Canada;
 - .5 Schneider Electric.

2.05 Sprinkler Proofing

- .1 Provide drip shields for protection of surface mounted equipment enclosures from water spray and dripping of liquids. Features of shields include:
 - .1 factory constructed by respective equipment manufacturers;
 - .2 constructed from non-combustible materials (sheet steel);
 - .3 enamel painted to match equipment;
 - .4 surfaces and edges filled/sanded smooth prior to painting;
 - .5 supported from equipment with structural steel rods/metal framing or other method approved by Consultant;
 - .6 structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields and methods of supporting.
- .3 Equipment with top cable/conduit entries to include additional sealing of entries with gasketing and/or waterproof sealant to prevent water from entering enclosure.
- .4 Design ventilation louvers such that live components are not exposed to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler proof" standards for equipment specified as NEMA 1, 2 or 12.
- .6 Obtain CSA approval where required by local governing authorities.

3 Execution

3.01 Installation of Equipment Drive Guards and Accessories

- .1 Provide OSHA guards for exposed accessible rotating parts such as belt drives, couplings, fan wheels, and shaft ends on mechanical equipment.
- .2 Install belt guards to allow movement of motors for adjusting belt tension.
- .3 Provide a means to permit lubrication and use of test instruments with guards in place.
- .4 Secure guards to equipment or equipment base but do not bridge sound or vibration isolation.
- .5 Where equipment oil level gauges, oil reservoirs, grease cups, or grease gun fittings are integral with equipment but are not easily accessible for service, extend to an accessible location using aluminium or copper tubing.

3.02 Supply of Motor Starters and Accessories

- .1 Unless otherwise shown or specified, supply a starter for each item of motorized equipment. Refer to Motor Starter Schedule.
- .2 Where 3-phase starters are indicated in motor control centres, supply motor control centres with starters and bolt to a concrete housekeeping pad.
- .3 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor control centre, provide a disconnect switch in motor control centre in lieu of a motor starter.
- .4 Where 3-phase starters are indicated and/or scheduled to be mounted on a motor starter panel, starters will be mounted and connected, complete with panels and splitter trough, as part of electrical work. Hand starters to electrical trade at site when they are required.
- .5 Where package type equipment with integral starters, or equipment with starters integral in loose power and control panels supplied with equipment is fed from a motor starter panel, a disconnect switch will be provided on motor starter panel as part of electrical work.
- .6 Unless otherwise specified or shown on drawings, 1-phase motor starters will be mounted adjacent to equipment they serve and connected complete as part of electrical work. Hand starters to electrical trade at site at the proper time.

3.03 Electrical Wiring Work for Mechanical Work

- .1 Unless otherwise specified or indicated, following electrical wiring work for mechanical equipment will be done as part of the electrical work:
 - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from starters or disconnects to equipment.
 - .2 "line" side power wiring to individual wall mounted starters, and "load" side wiring from starters to equipment.
 - .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives (VFD), and "load" side power wiring from the panels and VFD's to equipment.
 - .4 provision of receptacles for plug-in equipment.

- .5 provision of disconnect switches for motors in excess of 10 m (30 ft) from starter location, or cannot be seen from starter location, and associated power wiring.
 - .6 motor starter interlocking in excess of 24 V.
 - .7 wiring from motor winding thermistors in motors 30 hp and larger to motor starter contacts.
 - .8 120 V power connections to electrical receptacles integral with small ceiling exhaust fans.
 - .9 120 V power connections to small exhaust fans, and ceiling fans for all line voltage control devices, including but not limited to wiring through toggle switches, line voltage thermostats, countdown timer switches, or line voltage speed controllers. Coordinate requirements with Electrical Division.
 - .10 120 V wiring connections to lighting fixture/switch combinations integral with air handling units.
 - .11 120 V wiring connections to duplex receptacles integral with air handling unit control panels.
 - .12 120 V wiring connections to BAS system controllers/panels and other control system or component requiring 120 V power including, but not limited to, VAV boxes, dampers, low voltage transformers, etc.
- .2 Mechanical wiring work not listed above or specified herein or on drawings to be done as part of electrical work is to be installed in conduit and is to be done as part of mechanical work in accordance with wiring requirements specified for electrical work.

End of Section

1 General

1.01 Section Includes

- .1 Variable Frequency Drives (VFD's) for all equipment specified in Mechanical Divisions.

1.02 Submittals

- .1 Shop Drawings/Product Data: Submit shop drawings with product data sheets for variable frequency drives (VFDs). Include:
 - .1 construction and performance details;
 - .2 wiring and control schematics;
 - .3 dimensions of units;
 - .4 calculations specific to installation showing total harmonic voltage distortion is less than 5%;
 - .5 certified production test results with serial numbers for harmonic mitigation performance and energy efficiency under actual variable frequency drive loading.

1.03 Closeout Submittals

- .1 Certification Letter: Submit a start-up and installation certification letter from supplier of VFDs as specified in Part 3 of this Section;
- .2 Parameters: Prepare list of parameters for uploading for Owner's future use as specified in Part 3 of this Section. Load on USB type flash drive and submit to the Consultant.
- .3 Extended Warranty: Where extended warranty is specified to be included, include a copy of VFD extended warranty in each Operating and Maintenance Manual. Prior to Substantial Performance of Work, submit a copy of warranty to Owner.
- .4 Additionally, coordinate with Prime Contractor and Electrical Contractor to ensure that shop drawings clearly identify that proposed VFDs and connected motors are 100% compatible and Mechanical Contractor to sign off on selected VFDs.
- .5 Additionally, coordinate with Prime Contractor and Mechanical Contractor to ensure that shop drawings clearly identify that proposed VFDs and connected motors are 100% compatible and that Mechanical Contractor has signed off on selected VFDs.

1.04 Coordination with Electrical Divisions

- .1 This Section specifies VFD requirements for motors. Ensure that VFDs packaged with various system equipment, complies with specifications of this Section.
- .2 VFDs are each to be approved by respective manufacturers of VFDs and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.
- .3 Coordinate and review with Electrical Divisions, responsibility requirements for supply of VFDs, harmonic filters and requirements for control and power conductors and connections.
- .4 Check that motors are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground.
- .5 Additionally, review and confirm responsibilities with Consultant and Prime Contractor.

1.05 Coordination with Mechanical Divisions

- .1 This Section specifies VFD requirements for Mechanical Division motors. Mechanical Divisions Contractor and trades to ensure that VFDs packaged with their equipment, complies with specifications of this Section.
- .2 VFDs are each to be approved by respective manufacturers of VFDs and connected motors, as suitable for installation on scheduled motors. VFD output current rating to match or exceed connected motor nameplate full load current rating.
- .3 Coordinate with Mechanical Divisions, responsibility requirements for supply of VFDs and harmonic filters. Do not supply VFDs that are pre-packaged with mechanical equipment and supplied as part of Work of Mechanical Divisions.
- .4 Check that motors supplied by Mechanical Divisions and which are to be connected to VFDs, are equipped with AEGIS or approved equal, shaft grounding ring system to protect bearings from damage in motors by diverting harmful shaft voltages and bearing currents to ground. Identify in writing to Consultant any motors without such requirements.
- .5 Additionally, confirm responsibilities with Consultant and Prime Contractor.

1.06 Warranty

- .1 VFDs to be warranted free from defective labour and materials for period of 36 months from date of Substantial Performance of the Work. Include for initial one year Contract warranty and an additional 2 year extended warranty direct to Owner. Extended warranty terms and conditions are to be identical to one year Contract warranty, and extended warranty period is to commence day Contract warranty expires.

2 Products

2.01 VFD Basic Requirements

- .1 VFDs supplied on project to be products of same manufacturer and be CSA approved, ULC listed and labelled. Base specified product is ABB ACH series units that include compliance with following standards:
 - .1 CSA C22.2 No.14 Industrial Control Equipment;
 - .2 UL 508 - Industrial Control Equipment;
 - .3 UL 508C – Power Conversion Equipment;
 - .4 NEMA ICS 7 - Adjustable-Speed Drives.
- .2 Basis for limiting harmonics is to be provided generally to IEEE Standard 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, except intended for user's electrical distribution system with point of common coupling (where harmonic limits are assessed) to be set at input terminals of harmonic mitigating equipment.
- .3 Refer to Schedule of VFDs on drawings for features to include with respective VFDs.
- .4 VFDs to include following basic requirements:
 - .1 regardless of horsepower (hp) rating are to be of same VFD model; I/O and control circuit boards as well as keypads are to be identical and interchangeable regardless of hp rating;

- .2 to be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without safety tripping or component damage (flying start);
- .3 6-pulse width modulated (PWM) AC to AC converter utilizing latest isolated gate bipolar transistor (IGBT) technology; PWM switching pattern to include a motor flux optimization circuit that automatically reduces applied motor voltage to the motor to optimize energy consumption and audible motor noise;
- .4 carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency without derating VFD or operating at high carrier frequency only at low speeds;
- .5 provisions that determine motor torque and flux every 25 μ s (40,000 times per second);
- .6 completely assembled and tested by manufacturer in their facility;
- .7 designed to provide at least 250,000 hours mean time before failure (MTBF) when specified preventative maintenance is performed.
- .8 bypass system completely factory wired and tested;
- .9 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted options;
- .10 control panel keyboard and display with password protection against parameter changes.

2.02 VFD Ratings

- .1 VFDs to be rated to operate from 3-phase input voltage of 208 V or 600 V \pm 10%, as scheduled, and frequency range from 48 Hz to 63 Hz. In addition, a tolerated voltage window to allow system to operate from a line of +30% to -35% nominal voltage. System to incorporate circuitry that allows drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
- .2 VFDs to employ a full wave rectifier to prevent input line notching and operate at a minimum fundamental input power factor of 0.97 at all speeds and loads.
- .3 VFDs efficiency to be 96% or better at full speed and load.
- .4 Output voltage and current ratings to match adjustable frequency operating requirements of standard 3-ph, 60 Hz, NEMA design B inverter-duty motors in compliance with NEMA-MG1, Part 31 Standard. Overload current capacity for variable torque overload capacity to be 110% of rated current for 1 minute out of 10 minutes and 130% for 2 seconds. Output frequency to be adjustable between 0 Hz and 500 Hz.
- .5 Open loop static speed regulation to be 0.1% to 0.3% (10% of motor slip). Dynamic speed accuracy to be 4%-sec. or better open loop.
- .6 When a suitable motor is used, drive provides breakaway torque equal to 200% of rated motor torque. Torque response time to be 5 ms or less.
- .7 Enclosures:
 - .1 in climate controlled areas – minimum NEMA 12 with drip shield;
 - .2 in non-climate controlled areas – NEMA 3R.

2.03 Harmonic Filters and Reactors

- .1 VFDs to include internal 5% impedance AC line reactor (or equivalent 5% impedance dual positive and negative DC bus reactors) provided as a standard to reduce input current harmonic content and provide isolation from power line transients and to reduce RFI emissions.
- .2 VFDs serving motors sized 11 kW (15 hp) or more to be provided with harmonic filters to limit harmonics distortion produced by each drive to following maximum levels as measured on input side of drive:
 - .1 Total harmonic distortion (voltage) – 5%;
 - .2 Total harmonic distortion (current) – 10%.
- .3 Harmonic filter to be based on MIRUS International Inc. “LINEATOR AUHF” series, with features as follows:
 - .1 manufactured and tested in accordance with latest applicable standards of ULC, CSA and NEMA;
 - .2 treat characteristic low frequency harmonics generated by a 3-phase, diode bridge rectifier load (5th, 7th, 11th, 13th, etc.);
 - .3 passive inductor/capacitor network;
 - .4 low capacitive reactance (KVAR) of less than 20% of kVA rating, to ensure compatibility with engine generator sets;
 - .5 full load efficiency of harmonic mitigation equipment / VFD combination to be greater than 96%;
 - .6 copper wiring;
 - .7 220°C system insulation class and temperature rise of 130°C;
 - .8 anti-vibration pads between reactor or transformer core and enclosure;
 - .9 manufacturer’s standard ventilated, NEMA-3R enclosure.

2.04 Controls and Adjustment Functions

- .1 Include for following:
 - .1 programmable critical frequency lockout ranges to prevent VFD from operating load continuously at an unstable speed;
 - .2 proportional integral derivative (PID) speed loop regulators with an auto tune function as well as manual adjustments; PID set point controllers to allow pressure or flow signals to be connected to VFD, using microprocessor in VFD for closed loop control; includes 250 mA of 24 VDC auxiliary power and capability of loop powering a transmitter supplied by others; two parameter sets for first PID that allow sets to be switched via a digital input, serial communications or from keypad for night setback, summer/winter set points, etc.; independent, second PID loop that can utilize second analogue input and modulate analogue outputs to maintain set point of an independent process (i.e. valves, dampers, etc.); set points, process variables, etc. to be accessible from serial communication network;
 - .3 programmable analogue inputs that accept current or voltage signals.
 - .4 programmable analogue outputs (0-20 mA or 4-20 mA), that may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, and other data;

- .5 programmable digital inputs;
 - .6 programmable digital Form-C relay contact outputs for programmable on and off delay times and adjustable hysteresis; rated for maximum switching current 8 A at 24 VDC and 0.4 A at 250 VAC; maximum voltage 300 VDC and 250 VAC; continuous current rating 2 A RMS;
 - .7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation; two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;
 - .8 two independently adjustable accel and decel ramps with 1-1800 seconds adjustable time ramps;
 - .9 fireman's override input - upon receipt of a contact closure from fireman's control station, VFD operates in one of two modes: operate at a programmed predetermined fixed speed or operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback; mode overrides all other inputs (analogue/digital, serial communication and keypad commands), except customer defined safety run interlock, and forces motor to run in one of the two modes; "Override Mode" to be displayed on control panel; upon removal of override signal, VFD resumes normal operation.
- .2 Operator Control Panel:
- .1 front mounted plug-in operator control panel consisting of keypad, multi-line backlit LCD display for programming and fault diagnostics;
 - .2 keys (switches) for HAND, OFF, AUTO, and manual speed control INCREASE/DECREASE;
 - .3 menu navigation and parameter selection keys for custom programming;
 - .4 date and time clock - clock to have a battery backup with 10 years minimum life span; clock to be used to date and time stamp faults and record operating parameters at time of fault; if battery fails VFD I automatically reverts to hours of operation since initial power up; clock also to be programmable to control start/stop functions, constant speeds, PID parameter sets and output relays; VFD to have a digital input that allows an override to time clock (when in off mode) for a programmable time frame; four (4) separate, independent timer functions that have both weekday and weekend settings;
 - .5 parameter names, fault messages, warnings and other information to be displayed in complete words or standard abbreviations to allow user to understand what is being displayed without use of a manual or cross reference table, as follows:
 - .1 "HAND" position to start drive and modify reference frequency by use of INCREASE/DECREASE keys;
 - .2 "OFF" position stops drive;
 - .3 "AUTO" position allows drive to be started or stopped using whichever remote start/stop command configured; drive speed controlled by external speed reference input or by PID controller.
 - .4 applicable operating values to be capable of being displayed in engineering (user) units; operating displayed include:
 - .1 Output Frequency;
 - .2 Motor Speed (RPM, %, or Engineering units);

- .3 Motor Current;
- .4 Drive Temperature;
- .5 DC Bus Voltage;
- .6 Output Voltage.

2.05 Protective Functions

- .1 For each programmed warning and fault protection function, keypad displays a message in complete words or standard abbreviations.
- .2 VFDs include metal oxide varistors (MOV's) for phase to phase and phase to ground line voltage transient protection.
- .3 Short circuit current rating of 100,000 amps to be provided per UL 508C without relying on line fuses.
- .4 Ground fault protection, motor phase loss protection and phase unbalance protection to be provided. Single phase protection to be provided on input and output.
- .5 VFDs to provide electronic motor overload protection qualified per UL 508C.
- .6 Protection to be provided for AC line or DC bus overvoltage at 130% of maximum rated or undervoltage at 65% of minimum rated.
- .7 Stall protection to be programmable to provide a warning or stop VFD after motor has operated above a programmable torque level for a programmed time limit.
- .8 Underload protection to be programmable to provide a warning or stop VFD after motor has operated below a selected underload curve for a programmed time limit.
- .9 Overtemperature protection to provide a warning if power module temperature is less than 5°C (9°F) below overtemperature trip level.
- .10 Input terminal to be provided for connecting a motor thermistor (PTC type) to drive's protective monitoring circuitry. An input to also be programmable to monitor an external relay or switch contact.
- .11 VFDs through 56 kW (75 hp) to be protected from damage from input and output power miss-wiring. VFD to sense this condition and display an alarm on control panel.
- .12 EMI / RFI filters to be provided as per standard EN 61800-3.
- .13 dv/dt long lead filter (LRC) to protect power system network.
- .14 Automatic reset feature to automatically reset selected faults and attempt to restart drive based on control parameters such as adjustable time delays, number of restart attempts and duration of restart attempts. Faults include following:
 - .1 Overcurrent;
 - .2 Overvoltage;
 - .3 Undervoltage;
 - .4 Analogue input signal reference loss;
 - .5 External fault.

- .15 Additional built-in protection circuits include:
 - .1 Overcurrent trip limit;
 - .2 Undervoltage trip limit;
 - .3 Microprocessor fault;
 - .4 Keypad control panel loss;
 - .5 Serial communication loss;
 - .6 External fault interlock inputs;
 - .7 Adjustable output frequency and motor speed limits;
 - .8 Pass code parameter change protection;
 - .9 Keypad operator control lockout.

2.06 Electronic Bypass

- .1 Electronic bypass system to be a fully operational horsepower rated manual and automatic system for full speed operation without VFD, with following components and features:
 - .1 factory wired and tested microprocessor controlled bypass system consisting of an output contactor and bypass contactor, service (isolation) switch and VFD input fuses; (bypass designs, which have no VFD only fuses, or that incorporate fuses common to both VFD and bypass will not be accepted);
 - .2 bypass enclosure door and VFD enclosure to be interlocked such that input power is turned off before either enclosure can be opened;
 - .3 door interlocked padlockable disconnect switch that disconnects all input power from drive and all internally mounted devices;
 - .4 following operators:
 - .1 bypass Hand-Off-Auto;
 - .2 drive mode selector and light;
 - .3 bypass mode selector and light;
 - .4 bypass fault reset;
 - .5 bypass LCD display, 2 lines for programming and status / fault / warning indications.
 - .5 motor protection from single phase power conditions; bypass system to detect a single phase input power condition while running in bypass, disengage motor in a controlled fashion, and give a single phase input power indication;
 - .6 bypass system does not depend on VFD for bypass operation; bypass to be completely functional in both Hand and Automatic modes even if VFD is removed from enclosure for repair / replacement;
 - .7 run permissive circuit - for damper or valve control; dry contact closure that will signal damper to open (VFD motor does not operate); when damper is fully open, a normally open dry contact (end-switch) closes; closed end-switch is wired to a VFD digital input and allows motor operation;

- two separate safety interlock inputs, when either is opened, motor to coast to stop, and damper to close;
- .8 bypass control to monitor status of VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil; this failed contactor operation to be indicated on Bypass LCD display as well as over serial communications protocol;
 - .9 bypass control to include a programmable time delay for bypass start and control panel indication that this time delay is in process; this allows VAV boxes to be driven open before motor operates at full speed in bypass mode; time delay to be field programmable from 0-120 seconds;
 - .10 bypass control to be programmable for manual or automatic transfer to bypass; user to be able to select via control panel programming which drive faults will generate an automatic transfer to bypass and which faults require a manual transfer to bypass;
 - .11 adjustable motor current sensing circuit for bypass and VFD mode to provide proof of flow indication; condition is indicated on control panel display, transmitted over building automation protocol and on a relay output contact closure;
 - .12 programmable digital inputs, and programmable Form-C relay outputs;
 - .13 relay outputs from bypass to be programmable for any of following indications:
 - .1 system started;
 - .2 system running;
 - .3 bypass override enabled;
 - .4 drive fault;
 - .5 bypass fault;
 - .6 bypass H-O-A position;
 - .7 motor proof of flow (broken belt);
 - .8 overload;
 - .9 bypass selected;
 - .10 bypass run;
 - .11 system started (damper opening);
 - .12 bypass alarm;
 - .13 over temperature.
 - .14 digital inputs for system accept 24 VAC or 24 VDC; bypass incorporates internally sourced power supply and does not require an external control power source; bypass power board to supply 250 mA of 24 VDC for use by others to power external devices;
 - .15 interlock terminal strip: provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command; external safety interlocks to remain fully functional whether system is in VFD or bypass mode; remote start/stop contact to operate in VFD and bypass modes; terminal strip allows for independent connection of up to four (4) unique safety inputs;

- .16 User is able to select text to be displayed on keypad when safety opens; example text display indications include "Firestat", "Freezestat", "Over pressure" and "Low pressure"; user is able to determine which of four (4) safety contacts is open over serial communications connection;
- .17 Class 10, 20, or 30 (selectable) electronic motor overload protection is included as required for specific applications.

2.07 Manual Bypass

- .1 Bypass system to be a fully operational horsepower rated manual system for full speed operation without VFD, with following components:
 - .1 VFD and By-pass output contactors, mechanically and electrically interlocked to allow only one mode of operation at one time;
 - .2 service switch or contactor to isolate VFD from supply;
 - .3 VFD input fuses;
 - .4 door mounted VFD/OFF/BY-PASS selector switch;
 - .5 VFD ON and BY-PASS ON indicator lights;
 - .6 door mounted HAND/OFF/AUTO switch if Hand operation is unavailable at VFD control panel;
 - .7 terminals for external customer safety interlocks.
- .2 Bypass designs, which have no VFD only fuses, or that incorporate fuses common to both VFD and bypass are not acceptable.
- .3 Door interlocked padlockable fused disconnect switch that supplies power to VFD and bypass, and disconnects input power from drive, bypass and all internally mounted devices.

2.08 Communications

- .1 VFD to be complete with communications connections of integrated RS-485 port suitable to allow for VFD to be controlled, supervised, monitored and programmed from one remote control panel or PC with VFD system Windows based application software.
- .2 Communications protocol to be industry standard compatible to BAS of building. Coordinate exact requirements with Mechanical Divisions controls contractor and BAS vendor to ensure that appropriate interface module is supplied for drive system to communicate with BAS being used in building with interface capability to include serial communication standard protocols as follows:
 - .1 BACnet;
- .3 Serial communication to be used for drive setup, diagnostic analysis, monitoring and control with capabilities to include, but not be limited to:
 - .1 run-stop control;
 - .2 speed set adjustment;
 - .3 proportional/integral/derivative PID control adjustments;
 - .4 current limit;
 - .5 accel/decel time adjustments;

- .6 ability to lock and unlock control panel keypad;
 - .7 capability of allowing BAS to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature;
 - .8 monitoring relays output status, and digital input status and analogue output values;
 - .9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;
 - .10 remote fault reset.
- .4 Serial communication and Windows based software to be used for drive setup, diagnostic analysis, monitoring and control. Software to provide real time graphical displays of drive performance. VFD software communication capabilities include, but not be limited to:
- .1 system ON/OFF;
 - .2 system status;
 - .3 Suitable input for speed control;
 - .4 run-stop control;
 - .5 ability to force unit to bypass;
 - .6 ability to lock and unlock control panel keypad;
 - .7 allowing BAS to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and logic board temperature;
 - .8 monitoring relays output status, and all digital input status;
 - .9 transmitting diagnostic warning and fault information over communications bus to BAS or other monitoring system;
 - .10 remote fault reset;
 - .11 keypad "Hand" or "Auto" selected, and status indications and settings transmitted over serial communications bus;
 - .12 monitor if motor is running under load in both VFD and bypass (proof of flow) in VFD mode over serial communications or Form-C relay output;
 - .13 minimum of 40 field parameters to be capable of being monitored in bypass mode.

2.09 Site Services, Training, and Maintenance Manuals

- .1 Provide onsite inspection, testing, start up and verification work of VFDs and filters by manufacturer's authorized technician. Allow a minimum of 1/2 day per system. Also include for a second visit to site of one (1) day duration to train operating personnel in operation and maintenance of drives. Provide verification reports and supply soft copy of system programming parameters.
- .2 Upon completion of installation, supplier of VFDs to supply minimum one hard copy of complete sets of service and maintenance manuals including wiring and connection diagrams. Include for digital copy loaded onto a USB type flash drive.

- .3 Provide system training and instructions on operating and maintenance procedures. Refer to additional requirements in General Instructions section and Division 01.
- .4 Include for manufacturer's authorized technician to be in attendance to assist Commissioning Agent during commissioning process.

2.10 Manufacturers

- .1 Manufacturer List:
 - .1 ABB;
 - .2 Schneider Electric (Square D);
 - .3 Rockwell Automation;
 - .4 Eaton Cutler Hammer;
 - .5 Siemens Electric;
 - .6 Control Techniques.

3 Execution

3.01 Installation of Variable Frequency Drives

- .1 Provide variable frequency drives for motorized equipment in accordance with drawing requirements. Coordinate requirements for conductors and connections with Electrical Divisions Contractor.
- .2 Ensure that variable speed drives supplied are products of same manufacturer.
- .3 Unless otherwise noted on drawings or in Part 2 of this Section, include minimally, a manual bypass with each VFD. Supply electronic bypass with VFDs noted and/or scheduled on the drawings.
- .4 Ensure wire length between VFD and motor is less than 15 m (50') with properly sized conductors.
- .5 Install VFDs in accordance with manufacturer's instructions. Ensure that VFDs installation include upstream protection, either fuses or circuit breakers in accordance with VFD manufacturer's recommendations and local electrical code requirements. Advise Electrical Divisions Contractor of these requirements in addition to required conductors and connections. Provide required control wiring and connections.
- .6 Review VFD and related connected motor installation. Provide local disconnect to VFD in accordance with local governing code requirements.
- .7 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by the Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.
- .8 Properly support VFDs. Coordinate exact locations on site with the Consultant.
- .9 Where VFDs are required for custom made air handling units VFDs to be supplied, factory mounted on fan cabinets, and "load" side connected to fan motors by air handling unit manufacturer. "Line" side power wiring to these VFDs to be provided as part of Electrical Divisions work.
- .10 Where VFDs are required for commercial fans, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFD's to be provided as part of Electrical Divisions work.

- .11 Where VFDs are required for pumps, mount each VFD generally where shown but with exact location to ensure that VFD is accessible in accordance with local governing electrical code requirements. "Line" and "load" side power wiring to these VFDs to be provided as part of Electrical Divisions work.
- .12 Install harmonic mitigation filter equipment as follows:
 - .1 in accordance with manufacturer's recommended installation practices and to comply with applicable local governing codes;
 - .2 provide each VFD as specified in per Part 2, with a harmonic filter sized as per manufacturer's rating table to match rating of connected VFD;
 - .3 mount harmonic filters sized up to 110 kW (150 hp) typically to wall/ceiling construction using suitable brackets, metal C-channel framework and vibration isolators assemblies, ensuring full support of units acceptable to local governing authorities;
 - .4 mount harmonic filters sized greater than 110 kW (150 hp) typically to floor mounted concrete pads with suitable vibration isolators and seismic restraints in accordance with local governing building codes;
 - .5 ensure that adequate ventilation and space for access is provided;
 - .6 review exact locations with the Consultant prior to installation;
 - .7 coordinate with Electrical Division Contractor to ensure units are connected complete to line side supply feed and to VFD in accordance with VFD manufacturer's instructions for standalone VFDs and VFD system with bypass; include required control wiring and connections.
- .13 Ground and bond equipment as per local governing electrical code requirements and manufacturer's instructions.
- .14 Provide engraved lamacoid nameplate identifying each piece of equipment. Review exact nomenclature with the Consultant.
- .15 Be responsible for ensuring that VFDs, harmonic filters and connected motors are properly installed, connected, tested in proper working order and operation verified.

3.02 Installation of Variable Frequency Drives

- .1 Provide VFDs for motorized mechanical equipment in accordance with drawing requirements and coordinated with mechanical equipment vendors and Mechanical Divisions Contractor.
- .2 Ensure that VFDs supplied for project are products of same manufacturer.
- .3 Unless otherwise noted on drawings or in Part 2 of this Section, include minimally, a manual bypass with each VFD. Supply electronic bypass with VFDs specifically noted and/or scheduled on drawings.
- .4 Supply and install wiring and connections to VFDs and harmonic filters are to recommendations of VFD Manufacturer. Ensure wire length between VFD and motor is less than 15 m (50') with properly sized conductors. Obtain required wiring diagrams from equipment vendors. Provide required control wiring and connections.
- .5 Install VFDs in accordance with manufacturer's instructions.
- .6 Review VFD and related connected motor installation. Provide local disconnect (fusible switch or breaker) to VFD in accordance with local governing electrical code requirements and VFD manufacturer instructions. Confirm requirements with VFD vendor.

- .7 Mount VFDs operating controls/display at approximately 1.5 m (5') above finished floor level, unless otherwise directed by the Consultant. Provide dual back to back C-channel support system from floor to ceiling, complete with cross bracing to form a solid backing for VFD mounting at required locations.
- .8 Properly support VFDs. Coordinate exact locations on site with Mechanical Divisions Contractor and review with the Consultant.
- .9 Coordinate installation and control of VFDs with Mechanical Division Contractor and Controls Contractor. Confirm communications protocol required for compatibility with BAS and ensure VFD system includes for proper protocol.
- .10 Install harmonic mitigation filter equipment as follows:
 - .1 to be handled, stored and installed in accordance with manufacturer's recommended installation practices and to comply with applicable local governing codes;
 - .2 provide each VFD as specified in per Part 2, with a harmonic filter sized as per manufacturer's rating table to match rating of connected VFD;
 - .3 mount harmonic filters sized up to 110 kW (150 hp) typically to wall/ceiling construction using suitable brackets, metal C-channel framework and vibration isolators assemblies, ensuring full support of units acceptable to local governing authorities;
 - .4 mount harmonic filters sized greater than 110 kW (150 hp) typically to floor mounted concrete pads with suitable vibration isolators and seismic restraints in accordance with local governing building codes;
 - .5 ensure that adequate ventilation and space for access is provided;
 - .6 review exact locations with the Consultant prior to installation;
 - .7 provide required conductors and connections in accordance with filter manufacturer's instructions; obtain required wiring diagrams from equipment vendors;
 - .8 connect complete to line side supply feed and to VFD in accordance with VFD manufacturer's instructions for standalone VFDs and VFD system with bypass.
- .11 Ground and bond equipment as per local governing code requirements and manufacturer's instructions. Refer also to requirements of grounding and bonding article.
- .12 Provide engraved lamacoid nameplate identifying each piece of equipment. Review nomenclature with the Consultant.
- .13 Be responsible for ensuring that VFDs, harmonic filters and connected motors are properly installed, connected, tested in proper working order and operation verified.

3.03 Testing, Start-Up, and Verification

- .1 When installation of VFDs are complete, arrange for VFD manufacturer/supplier to:
 - .1 supply factory authorized technician at site for minimum of 4 hours per system to examine installation and connection of each VFD, and to perform start-up and set-up procedures in conjunction with equipment start-up and testing procedures;
 - .2 supply factory authorized technician at site for minimum of one 8 hour day to train Owner's personnel on VFD operating and maintenance procedures;

- .3 prepare and submit letter to certify that VFDs have been properly installed, tested and adjusted, and are in proper operating condition;
- .4 submit list of start-up and testing parameters for uploading for future use by Owner.
- .2 Start-up data entries to include motor nameplate power, speed, voltage, frequency and current.
- .3 Inspect VFDs and accessories for verification of proper operation and installation.
- .4 Inspect interface wiring to BAS for verification of proper operation and installation.
- .5 Verification of wire terminations to VFDs and bypass and to operational circuitry.
- .6 Installation verification of VFD, bypass and motor being driven for proper operation and reliability.
- .7 Verification that connections and communications to BAS or other monitoring/remote control system are of proper operation and installation and of full communications compatibility.
- .8 Measurement for verification of proper operation on each of following items:
 - .1 Motor voltage and frequency;
 - .2 Verification of proper motor operation;
 - .3 Control input for proper building automation system interface and control calibration.
- .9 Calibration check for following set points (and adjustment as necessary):
 - .1 minimum speed;
 - .2 maximum speed;
 - .3 acceleration and deceleration rates.
- .10 Verify harmonic compliance with onsite field measurements of both voltage and current harmonic distortion at point of common coupling-input terminals of harmonic mitigating equipment with and without equipment operating. Utilize recording type Fluke 41 or equivalent harmonics analyser displaying individual and total harmonic currents and voltages.
- .11 Document testing and results in a report signed by a Professional Engineer licensed in the Place of Work and authorized by system manufacturer. Include for minimum 3 hard copies and electronic copy of report to be submitted to the Consultant for review.
- .12 Additionally, refer to applicable installation, testing, coordination, and verification requirements in Electrical Divisions Sections.
- .13 Coordinate procedures specified above to be performed by VFD manufacturer/supplier authorized technician with system commissioning work.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies firestopping and smoke seal requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 Submittals

- .1 At least 4 weeks prior to work commencing, submit a sample of each type of firestop and smoke seal system in applied form, for approval. Identify each system with manufacturer's name and type, ULC designation, and proposed use. After samples are reviewed, work is to conform to reviewed samples.
- .2 Submit a product data sheet and a WHIMIS sheet for each firestopping and smoke seal product.
- .3 Submit for review, full company name and experience of proposed firestopping and smoke seal system applicator.
- .4 Sleeve and Formed Opening Location Drawings
 - .1 Prepare and submit for review, drawings indicating size and location of required sleeves, recesses and formed openings in poured or precast concrete work.
 - .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs.
 - .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

1.03 Closeout Submittals

- .1 Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

1.04 Quality Assurance

- .1 Applicator is to have a minimum of 3 years of successful experience on projects of similar size and complexity, and applicator's qualifications are to be reviewed by the Consultant.
- .2 Comply with firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

2 Products

2.01 Pipe Sleeves

- .1 Galvanized Sheet Steel – Minimum 16 gauge galvanized steel with an integral flange at one end to secure sleeve to formwork construction.
- .2 Polyethylene – Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 Waterproof Galvanized Steel Pipe – Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at sleeve midpoint.
- .4 Galvanized Steel or Cast Iron Pipe – Schedule 40 mild galvanized steel, or Class 4000 cast iron.

2.02 Firestopping and Smoke Seal Materials

- .1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN/ULC-S115 and CAN/ULC-S101 for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than fire resistance rating of surrounding fire rated construction.
- .2 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly.
- .3 Pipe insulation forming part of a fire and smoke seal assembly is specified in Section entitled Mechanical Insulation.
- .4 Manufacturers:
 - .1 A/D Fire Protection Systems "FIREBARRIER";
 - .2 Tremco Inc. Fire Protection Systems Group "TREMSTOP";
 - .3 3M Canada;
 - .4 Hilti (Canada) Ltd. Firestop Systems;
 - .5 Specified Technologies Inc.

2.03 Waterproofing Seal Materials

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so when bolts are tightened the links expand to seal the opening watertight. Select seal assemblies to suit pipe size and sleeve size or wall opening size.
- .2 Manufacturers:
 - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
 - .2 The Metraflex Co. "MetraSeal" type ES.

2.04 Pipe Escutcheon Plates

- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to building surface, each plate sized to completely cover pipe sleeve or building surface opening, and to fit tightly around pipe or pipe insulation.

3 Execution

3.01 Installation of Pipe Sleeves

- .1 Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:
 - .1 in poured concrete slabs – unless otherwise specified, minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves;
 - .2 in concrete or masonry walls – Schedule 40 galvanized steel pipe or Class 4000 cast iron pipe.
- .2 Sleeves in waterproofed slabs or walls are to be lengths of Schedule 40 mild galvanized steel pipe with a waterstop plate in accordance with drawing detail. Provide waterproof sleeves in following locations:

- .1 in mechanical room floor slabs, except where on grade;
 - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets;
 - .3 in floors equipped with waterproof membranes;
 - .4 in roof slab;
 - .5 in waterproof walls.
- .3 Size sleeves, unless otherwise specified, to leave 12 mm (½") clearance around pipes, or where pipe is insulated, a 12 mm (½") clearance around pipe insulation.
 - .4 Pack and seal void between pipe sleeves and pipe or pipe insulation in non-fire rated construction for the length of sleeves as follows:
 - .1 pack sleeves in interior construction with mineral wool and seal both ends of sleeves with non-hardening silicone base caulking compound;
 - .2 pack sleeves in exterior walls above grade with mineral wool and seal both ends of sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified;
 - .3 seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified.
 - .5 Where sleeves are required in masonry work, accurately locate and mark sleeve location, and hand sleeves to mason for installation.
 - .6 Terminate piping for sleeves that will be exposed so sleeve is flush at both ends with building surface so sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above finished floor.
 - .7 "Gang" type sleeving will not be permitted.
 - .8 Where sleeves are provided in non-fire rated construction for future piping, or where piping has been removed from existing sleeves, cap and seal both ends of sleeved opening.

3.02 Installation of Waterproof Mechanical Seals

- .1 Provide watertight link type mechanical seals in exterior wall openings.
- .2 Assemble and install each mechanical seal in accordance with manufacturer's instructions.
- .3 After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until seal is completely watertight.

End of Section

1 General

1.01 Submittals

.1 Submit shop drawings/product data sheets for:

.1 pressure gauges and thermometers;

2 Products

2.01 Pressure Gauges and Thermometers

.1 Pressure gauges as follows:

.1 adjustable, glycerine filled, 100 mm or 115 mm (4" or 4-½") diameter and each accurate to within 1% of scale range;

.2 type 304 stainless steel case with relief valve and polished stainless steel bayonet;

.3 stainless steel rotary movement with stainless steel bushings and socket;

.4 clear acrylic window;

.5 dual scale white dial with a scale range such that working pressure of system is at approximate mid-point of scale;

.6 black pointer.

.2 Pressure gauge accessories and additional requirements as follows:

.1 a bronze ball type shut-off valve is to be provided in the piping to each pressure gauge;

.2 each pressure gauge for piping and equipment with normal everyday flow is to be equipped with a brass pressure snubber;

.3 each pressure gauge for steam piping or steam equipment is to be equipped with a steel coil syphon;

.4 pressure gauges in fire protection piping must be ULC listed and labelled;

.3 Thermometers as follows:

.1 round, 125 mm (5") diameter, adjustable (90°) angle bimetal dial type thermometers, each accurate to within 1% of full scale;

.2 hermetically sealed stainless steel case with stainless steel ring;

.3 dampened bimetal coil;

.4 calibration adjustment screw;

.5 white aluminum dual scale dial with black and blue markings and a range such that working temperature of system is approximate mid-point of the scale;

.6 black aluminum pointer;

.7 double strength glass window;

- .8 12 mm (½") NPT connection with 6.4 mm (¼") diameter stainless steel stem;
- .9 suitable thermowell.
- .4 Manufacturers:
 - .1 H.O. Trerice Co.;
 - .2 Weiss Instruments;
 - .3 Ashcroft.

3 Execution

3.01 Installation

- .1 Provide pressure gauges in following locations where applicable:
 - .1 in valved tubing across suction, suction strainer (if applicable), and discharge piping of each circulating pump;
 - .2 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, heat exchangers, main coils, etc.;
 - .3 in expansion tank(s);
 - .4 in separate domestic hot water storage tank(s);
 - .5 at top most outlet in each standpipe fire protection system riser;
 - .6 in piping at each side of a pressure reducing valve;
 - .7 in potable water service piping downstream of meter;
 - .8 wherever else shown and/or specified.
- .2 Provide thermometers in following locations where applicable:
 - .1 in supply and return piping connections to main mechanical plant equipment such as boilers, chillers, cooling towers, heat exchangers, main coils, etc., unless temperature indication is supplied with equipment;
 - .2 wherever else shown and/or specified.
- .3 Conform to following installation requirements where applicable:
 - .1 for installation of thermometers in piping wells, provide a coat of metallic base heat transfer paste or grease in piping well;
 - .2 for pressure gauges in piping at equipment locations, install pressure gauge between equipment and first pipe fitting;
 - .3 locate, mount and adjust instruments so they are easily readable;

- .4 where pressure gauges and/or thermometers are located at high level or in an area where they cannot be easily seen, provide remote reading instruments.

End of Section

1 General

1.01 Section Includes

- .1 The work covered under this section consists of the furnishing of all necessary labour, supervision, materials, equipment, and services to completely execute the pipe hanger and supports as described in this specification.
 - .1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.
 - .2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.
 - .3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
 - .4 Fasten hangers and supports to building structure.
 - .5 Provide and set sleeves required for equipment, including openings required for placing equipment.

1.02 References

- .1 Pipe supports shall meet the requirements of ANSI/ASME B31.1-1995, Power piping.
- .2 Automatic sprinkler pipe supports shall meet the requirements of NFPA 13-1996, Standard for the Installation of Sprinkler Systems.
- .3 Duct hangers shall follow the recommendations of the SMACNA Duct Manuals.

2 Products

2.01 Prohibited Materials

- .1 Use of perforated band iron, wire or chain as hangers is not permitted.

2.02 Piping Hangers and Supports

- .1 Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, Pipe hangers and Supports-Materials, Design and Manufacture, and where possible, MSS designations are indicated with each product specified below. Conform to following requirements:
 - .1 unless otherwise specified, ferrous hanger and support products are to be electro-galvanized;
 - .2 hangers and supports for insulated piping are to be sized to fit around insulation and insulation jacket.
- .2 Hangers and supports for horizontal suspended piping as follows:
 - .1 adjustable steel clevis hanger – MSS Type 1;
 - .2 adjustable swivel ring band hanger – MSS Type 10;
 - .3 adjustable roller hanger – MSS Types 41, 43, and/or 45, with MSS Type 39 steel protection saddle.

- .3 Supports for horizontal pipe on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe clip – MSS Type 26;
 - .3 single steel pipe hook – Myatt Fig. 156;
 - .4 epoxy coated steel pipe stays or metal strapping are not permitted.
- .4 Floor supports for vertical risers as follows:
 - .1 copper tubing riser clamp – MSS Type 8;
 - .2 heavy-duty steel riser clamp – MSS Type 8.
- .5 Supports for vertical piping on vertical surfaces as follows:
 - .1 steel offset pipe clamp – Anvil Fig. 103 or Myatt Fig. 170;
 - .2 heavy-duty steel pipe bracket or soil pipe bracket – MSS Type 26;
 - .3 extension split pipe clamp – MSS Type 12;
 - .4 epoxy coated steel pipe stays or metal strapping are not permitted.
- .6 Base support for vertical risers in excess of 6 m (20') high extending out from base mounted equipment is to consist of a base elbow support with flange.
- .7 For horizontal pipe on racks, Unistrut or equal galvanized steel pipe racks with pipe securing hardware as follows:
 - .1 standard galvanized steel U-bolts/clamps supplied by rack manufacturer;
 - .2 adjustable roller chair – MSS Type 44 with MSS Type 39 steel protection saddle.
- .8 Special hangers and supports for various applications as follows:
 - .1 vibration isolated riser supports – black steel riser clamps as specified above, complete with neoprene–steel–neoprene sandwich type vibration isolation pads between clamp and floor;
 - .2 for groups of pipes having same slope – MSS Type 32 welded steel brackets, Anvil Fig. 46 universal trapeze assemblies, or Unistrut or equal support assemblies, all with U-bolts, clamps, etc., to secure pipes in place;
 - .3 for sections of piping connected to vibration isolated equipment – hangers and supports as specified above but complete with MSS Type 48 spring cushions;
 - .4 for piping on existing roof – Portable Pipe Hangers (Canada) Inc. "PP" Series prefabricated portable pipe support system components to suit pipe, complete with required accessories including bases, galvanized structural steel frames, and galvanized steel pipe hangers and supports conforming to MSS SP-58;
 - .5 for piping on new roofs – Lexcor "Flash-Tite" or Thaler Roofing Specialties Products Inc. "MERS" Series insulated aluminum support risers with diameter, height, securement method and flashing to suit the application, channel type aluminum cross members, and galvanized steel pipe hangers and supports conforming to MSS SP-58, complete with all required accessories;
 - .6 for glass drain and vent piping – special padded hangers supplied by pipe supplier;

- .7 for plastic piping – generally as specified above but in accordance with pipe manufacturer's recommendations;
 - .8 for fire protection piping – generally as above but ULC listed and/or FM approved, and in accordance with Chapter requirements of NFPA Standard applicable to piping system;
 - .9 for bare horizontal copper piping – generally as above but factory vinyl coated to prevent direct copper/steel contact;
 - .10 for bare copper vertical piping – corrosion resistant ferrous clamps with flexible rubber gasket type material (not tape) to isolate pipe from clamp;
 - .11 insulation protection shields to and including 40 mm (1-½") dia. – MSS Type 40 galvanized steel shields with ribs to keep shield centred on hanger.
- .9 Hanger rods are to be electro-galvanized carbon steel (unless otherwise specified), round, threaded, to ASTM A36, complete with captive machine nuts with washers at hangers, sized to suit loading in accordance with Table 3 in MSS SP-58, but in any case, minimum 9.5 mm (3/8") diameter.
- .10 Manufacturers:
- .1 E. Myatt & Co. Inc.;
 - .2 Anvil International Inc.;
 - .3 Empire Industries Inc.;
 - .4 Hunt Manufacturing Ltd.;
 - .5 Unistrut Canada Ltd.;
 - .6 Nibco Inc. "Tolco";
 - .7 Taylor Pipe Supports.

3 Execution

3.01 Installation of Fastening and Securing Hardware

- .1 Provide fastening and securing hardware required for mechanical work to maintain installations attached to structure or to finished floors, walls, and ceilings in a secure and rigid manner capable of withstanding dead loads, live loads, superimposed dead loads, and any vibration of installed products.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where floor, wall or ceiling construction is not suitable to support loads, provide additional framing or special fasteners to ensure proper securement to structure that is to support the products. Provide reinforcing or connecting supports where required to distribute loading to structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is obtained, comply with requirements of CAN/CSA Z166.1 and CAN/CSA Z166.2.
- .5 Do not attach fasteners to steel deck without written consent from the Consultant.

3.02 Installation of Pipe Hangers and Supports

- .1 Provide required pipe hangers and supports.
- .2 Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from structure only.
- .3 For insulated pipe, size hanger or support to suit diameter of insulated pipe and install hanger or support on outside of insulation and insulation finish.
- .4 Support requirements for underground piping are as follows:
 - .1 support underground pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified;
 - .2 support underground service piping penetrating building exterior walls or foundations to prevent pipe damage if minor building settlement occurs;
 - .3 ensure bedding and supports for underground pipes are flat and true and allowances are made for pipe hubs, couplings, or other protrusions so no voids are left between pipe and bedding.
- .5 Unless otherwise shown or specified, hang and/or support horizontal pipe above ground by means of hangers and/or supports specified in Part 2 of this Section. Unless otherwise shown or specified, hangers for suspended pipe less than or equal to 25 mm (1") dia. are to be clevis type or adjustable ring type, and hangers for suspended pipe greater than or equal to 40 mm (1-½") dia. are to be adjustable clevis type.
- .6 Space hangers and supports in accordance with following:
 - .1 cast iron pipe – hang or support at every joint with maximum 2.4 m (8') spacing;
 - .2 plastic pipe – conform to pipe manufacturer's recommended support spacing;
 - .3 glass pipe – conform to pipe manufacturer's recommended support spacing and support requirements;
 - .4 copper and steel pipe – hang or support at spacing in accordance with following schedule:

Pipe dia.	Max. Spacing Steel	Max. Spacing Copper
to 25 mm (1")	2.4 m (8')	1.8 m (6')
40 mm (1-½")	2.7 m (9')	2.4 m (8')
50 mm (2")	3.0 m (10')	2.7 m (9')
65 mm (2-½")	3.6 m (12')	3.0 m (10')
75 mm (3")	3.6 m (12')	3.0 m (10')
90 mm (3-½")	3.6 m (12')	3.6 m (12')
100 mm (4")	4.2 m (14')	3.6 m (12')
250 mm (10")	6.0 m (20')	
300 mm (12")	6.7 m (22')	

- .5 flexible grooved pipe/coupling joint piping – as above but with not less than one hanger or support between joints;

- .7 Where pipes change direction, either horizontally or vertically, provide a hanger or support on horizontal pipe not more than 300 mm (12") from elbow, and where pipes drop from tee branches, support tees in both directions not more than 50 mm (2") on each side of tee.
- .8 When pipes with same slope are grouped and a common hanger or support is used, space hanger or support to suit spacing requirement of smallest pipe in group and secure pipes in place on common hanger or support.
- .9 Provide roller hangers or supports for heat transfer piping greater than or equal to 150 mm (6") diameter and conveying a material 75°C (170°F) or greater to facilitate pipe movement due to expansion and contraction, and at each hanger or support tack weld a steel protection saddle to pipe to protect piping insulation.
- .10 Unless otherwise shown or specified, support vertical piping by means of supports specified in Part 2 of this Section, spaced in accordance with following:
 - .1 support vertical pipes at maximum 3 m (10') intervals or at every floor, whichever is lesser;
 - .2 for sections of vertical piping with a length less than 3 m (10'), support pipe at least once;
 - .3 for vertical cast iron plain end pipe (mechanical joint type), secure riser or pipe clamp around pipe under a flange integral with pipe for vertical support purposes, or provide a length of hub and spigot pipe to facilitate proper support;
 - .4 for vertical steel pipe risers in excess of 3 m (10'), weld shear lugs to pipe to carry load;
 - .5 for vibration isolated piping risers, provide rubber-steel-rubber vibration isolation pads between riser clamps and floor.
- .11 Support piping on the roof as follows:
 - .1 on new roof – supply manufactured roof supports as per Part 2 of this Section to accommodate piping involved and support spacing specified above, and hand supports to roofing trade on roof for installation as part of roofing work, then secure piping in place on supports.
- .12 Each hanger, support or securement for horizontal bare copper tubing is to be plastic coated to prevent direct contact between pipe and ferrous hanger. Each wall or floor clamp for vertical bare copper piping is to be isolated from pipe by means of strips of flexible rubber inserts. Use of painted ferrous hangers and supports, including those painted with copper coloured paint, is not acceptable. Site application of tape or other types of isolation is not acceptable.
- .13 For insulated horizontal piping less than or equal to 40 mm (1-1/2") diameter, provide galvanized steel insulation protection shields between insulation and hanger or support. Install shields immediately after pipe is insulated.
- .14 Do not support piping from steel deck without written consent from Consultant.

3.03 Equipment Bases and Supports

- .1 Unless otherwise specified or required, set floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of equipment on each side and end, or a minimum of 200 mm (8") from centreline of equipment anchor bolts to edge of the base, whichever is larger. Conform to following requirements:
 - .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads;

- .2 place anchor bolts during concrete pour and be responsible for required levelling, alignment, and grouting of equipment;
- .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details.
- .2 For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to following requirements:
 - .1 provide stands and supports, except those for small equipment, designed by a structural engineer registered in jurisdiction of the work, and submit stamped and signed design drawings with calculations as shop drawings for review;
 - .2 flange bolt steel stands to concrete housekeeping pads;
 - .3 seismically restrained stands and supports in accordance with applicable requirements.
- .3 Where indicated on mechanical drawings, provide welded, cleaned and prime coat painted structural steel platforms, designed by a structural engineer registered in the jurisdiction of the work, for service access to equipment. Submit stamped and signed design drawings with calculations as shop drawings for review. Conform to following requirements:
 - .1 platforms in accordance with OHS requirements and adequately sized, braced, anchored, and, as required, seismically restrained;
 - .2 flooring equal to Fisher & Ludlow "Tru-Weld" Type 19-4, Borden type W/B (19-W-4), welded steel bar type grating;
 - .3 support legs constructed of welded Schedule 40 black steel pipe with welded steel cross-bracing, securely anchored and sway braced;
 - .4 safety guard rails, constructed from minimum 32 mm (1-¼") dia. Schedule 40 black steel pipe, for all platforms and complete with vertical stanchions at maximum 1.2 m (48") centres, top and intermediate horizontal railing, and toe plates at floor;
 - .5 vertical ladders constructed of Schedule 40 black steel pipe, 25 mm (1") dia. for equal height rungs, 40 mm (1-½") for stringers, anchored to floors and walls and sway braced as required;
 - .6 ships ladders, used wherever space conditions permit, of welded steel construction, climbing at an approximate 60° angle, and complete with channel iron stringers, open grate equal height risers approximately 165 mm (6-½") wide and factory made by grating manufacturer, handrails, and suitable anchoring and support.

3.04 Concrete Work for Mechanical Equipment Bases and Pads

1. Unless otherwise specified in Division 03, provide poured concrete work, including reinforcing and formwork, required for mechanical equipment bases/pads. Perform concrete work in accordance with requirements specified in Division 03.
2. Unless otherwise specified in Division 03, concrete is to be minimum 20,700 kPa ready-mix concrete in accordance with CAN/CSA-A23.1 and the Ontario Building Code.
3. Submit for review, dimensioned shop drawings, prepared and stamped by a professional structural engineer registered in the jurisdiction of the work, for concrete pads or bases for support of large, heavy equipment. Indicate on shop drawings total weight of pad or base as well as equipment it is provided for, and concrete reinforcing.

4. Ensure that bases and pads are keyed into the structure to meet seismic restraint requirements where applicable.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies vibration isolation product requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 Related Requirements

- .1 Section 13 48 13 – Manufactured Sound and Vibration Control Components: floating floor for mechanical and generator rooms to minimize sound and vibration transmission to spaces below.

1.03 Submittals

- .1 Submit copies of manufacturer's product data sheets for products specified in this Section. Product data sheets are to include product characteristics, limitations, dimensions, finishes, and installation recommendations.

1.04 Closeout Submittals

- .1 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

2 Products

2.01 General

- .1 Vibration isolation products are to be in accordance with the most recent edition of the ASHRAE Handbook and/or as indicated on drawings, schedules, details, and as specified below.
- .2 Springs are to be stable, colour coded, selected to operate at no greater than 2/3 solid load, designed in accordance with Society of Automotive Engineers Handbook Supplement 9 entitled Manual on Design and Application of Helical and Spiral Springs, and with spring diameters in accordance with manufacturer's recommendations to suit static deflection and maximum equipment load.
- .3 Steel components of isolation products not exposed to the weather or moisture are to be zinc plated. Steel components of isolation products exposed to the weather or in a damp, moist environment are to be factory painted with rust inhibiting primer and 2 coats of neoprene.
- .4 Where weight of isolated equipment may change significantly due to draining or filling with a liquid, vibration isolators are to be equipped with limit stops to limit spring extensions.
- .5 Flexible piping connections to vibration isolated equipment are specified in the appropriate piping sections of the Specification.

2.02 Isolation Pads

- .1 Sandwich type pads, 20 mm ($\frac{3}{4}$ " nominal thickness, selected for 3.2 mm (1/8") static deflection unless otherwise specified, consisting of 2 waffle type or ribbed 50 durometer neoprene pads permanently bonded to a minimum 10 gauge steel plate, and complete with rubber bushed bolt holes and equipment anchor bolts with neoprene isolation grommets.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type NSN;
 - .2 The VMC Group Vibration Mounting & Controls Inc. (Korfund-Dynamics) "SHEAR-FLEX PLATES";

- .3 Kinetics Noise Control Vibron Products Group Type NGS/NGD;
- .4 Mason Industries Inc. Type SW/S/SW with HG Bolt Insertion Washers;
- .5 J. P. America Inc. Type JSJ.

2.03 Rubber Floor Isolators

- .1 Captive, bridge bearing quality neoprene mount selected for a minimum 4 mm (0.15") static deflection unless otherwise specified, with an integral ductile iron housing and integral equipment anchor bolt.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type R;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type RSM;
 - .3 Kinetics Noise Control Vibron Products Group Type RQ;
 - .4 Mason Industries Inc. Type BR;
 - .5 J. P. America Inc. Type TRM.

2.04 Open Spring Mounts

- .1 Base mount free-standing assemblies, each complete with a stable colour coded steel spring welded in place, drilled mild steel mounting plate bonded to a ribbed rubber or neoprene acoustical pad, and an external 16 mm (5/8") diameter level adjustment bolt.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type FS;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type A;
 - .3 Kinetics Noise Control Vibron Products Group Type FDS;
 - .4 Mason Industries Inc. Type SLFH;
 - .5 J. P. America Inc. Type TSO.

2.05 Closed Spring Mounts

- .1 Base mount free-standing enclosed assemblies, each complete with stable colour coded spring(s), 2 piece cast housing, non-binding rubber horizontal stabilizers, a ribbed rubber or neoprene acoustical pad bonded to base of the closed housing, and an external level adjustment bolt.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type CM;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Types B and C;
 - .3 Kinetics Noise Control Vibron Products Group Type FLS;
 - .4 Mason Industries Inc. Type C;
 - .5 J. P. America Inc. Type TSC.

2.06 Totally Retained Spring Mounts

- .1 Base mount free-standing enclosed and retained assemblies to limit both vertical and lateral movement of mounted equipment, each complete with stable colour coded spring(s), drilled welded steel housing and top plate, ribbed rubber or neoprene acoustical pad bonded to bottom of housing, vertical limit adjusting hardware, and a level adjustment bolt.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type CSR;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Type MS;
 - .3 Kinetics Noise Control Vibron Products Group Type SM;
 - .4 Mason Industries Inc. Type SLRSO;
 - .5 J. P. America Inc. Type TSR.

2.07 Spring Hangers

- .1 Welded steel plate housing with top and bottom rod mounting holes and spring retainer, neoprene double deflection isolation element, stable colour coded spring, and heavy-duty rubber washers.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type SHR-SN;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) "Spring-Flex" Series HRSA;
 - .3 Kinetics Noise Control Vibron Products Group. Type SRH;
 - .4 Mason Industries Inc. Type 30N;
 - .5 J. P. America Inc. Type TSH.

2.08 Neoprene Hanger Isolators

- .1 Neoprene double deflection rod isolators with steel housing and hanger rod bushing, selected for a minimum 4 mm (0.15") static deflection unless otherwise specified.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type NH;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type HR;
 - .3 Kinetics Noise Control Vibron Products Group Type RH;
 - .4 Mason Industries Inc. Type HD or WHD;
 - .5 J. P. America Inc. Type TRH.

2.09 Concrete Inertia Type Equipment Base

- .1 Welded steel bases, each complete with a structural black steel channel frame, concrete reinforcing rods, and brackets for spring mounts welded to frame.
- .2 Manufacturers:

- .1 Vibro-Acoustics Ltd. Type CIB;
- .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;
- .3 Kinetics Noise Control Vibron Products Group. Type CIB;
- .4 Mason Industries Inc. Type KSL;
- .5 J. P. America Inc. Type BCI.

2.10 Steel Equipment Base

- .1 Fully welded structural steel equipment and motor support bases, each complete with a wide flange steel frame, full depth cross members, brackets for spring mounts, and adjustable motor slide rails.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type SB;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WFB;
 - .3 Kinetics Noise Control Vibron Products Group Type SFB;
 - .4 Mason Industries Inc. Type WFSL;
 - .5 J. P. America Inc. Type BWS (with motor slide rail).

2.11 Combination Steel/Concrete Inertia Equipment Base

- .1 Welded steel bases with a structural black steel channel frame, concrete reinforcing rods, bottom sheet steel pan, brackets for spring mounts welded to frame and adjustable motor slide rails.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type CIB (with motor slide rails);
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type WPF (with motor slide rails);
 - .3 Kinetics Noise Control Vibron Products Group Type CIB (with motor slide rails);
 - .4 Mason Industries Inc. Type BMK or K;
 - .5 J. P. America Inc. Type BSI (with motor slide rail).

2.12 Slung Steel Base

- .1 Slung steel bases of structural members with gusset plates welded to ends and complete with adjustable motor slide rails and vertical section size to suit equipment's motor power output.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Type SS;
 - .2 The VMC Group Vibration Mounting & Controls (Korfund-Dynamics) Type CPF;
 - .3 Kinetics Noise Control Vibron Products Group Type CIB-H;
 - .4 Mason Industries Inc. Type MSL.

2.13 Continuous Rail Type Isolation for Roof Mounted Equipment

- .1 Continuous rooftop isolation shipped completely assembled, consisting of:
 - .1 galvanized steel sections formed to fit roof curb and associated equipment with a flexible air and weather seal joining upper and lower rail sections;
 - .2 stable springs, cadmium plated and selected to provide minimum deflection with 50% additional travel to solid;
 - .3 neoprene cushioned and wind restraints allowing 6 mm (¼") movement before engaging and resisting wind loads in any lateral direction.
- .2 Manufacturers:
 - .1 Vibro-Acoustics Ltd. Vibro-Acoustics Type RTR;
 - .2 The VMC Group Vibration Mounting and Controls (Korfund-Dynamics) Type RTIR;
 - .3 Kinetics Noise Control Vibron Products Group Type KSR;
 - .4 Mason Industries Inc. Type RSC;
 - .5 J. P. America Inc. Type BRC.

3 Execution

3.01 Installation of Vibration Isolation Materials

- .1 Unless otherwise stated in the drawings, schedules and/or typical details, vibration isolation is to be provided for all mechanical equipment as per the recommendations contained within in the most recent edition of the ASHRAE Handbook.
- .2 Supply to vibration isolation product manufacturer or supplier a copy of a "reviewed" shop drawing or product data sheet for each piece of equipment to be isolated and dimensioned pipe layouts of associated piping to be isolated.
- .3 Unless otherwise specified, vibration isolation products are to be product of one manufacturer.
- .4 Ensure vibration isolation manufacturer coordinates material selections with equipment provided in order to ensure adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
- .5 Unless otherwise indicated, install isolation materials for base mounted equipment on concrete housekeeping pad bases which extend at least over the full base and isolated area of the isolated equipment. Additional requirements are as follows:
 - .1 block and shim bases level so ductwork and piping connections can be made to a rigid system at proper operating level, before isolated adjustment is made, and ensure there is no physical contact between isolated equipment and building structure;
 - .2 steel bases are to clear the sub-base by 25 mm (1");
 - .3 concrete bases are to clear the sub-base by 50 mm (2").
- .6 Isolate piping larger than 25 mm (1") dia. directly connected to motorized and/or vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with following:

- .1 for pipe less than or equal to 100 mm (4") dia. – first 3 points of support;
- .2 for pipe 125 mm (5") to 200 mm (8") dia. – first 4 points of support;
- .3 for pipe equal to or greater than 250 mm (10") dia. – first 6 points of support;
- .7 First point of isolated piping support is to have a static deflection of twice the deflection of the isolated equipment but maximum 50 mm (2").
- .8 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.
- .9 Where it is impossible to use at least 2 spring hangers, provide Senior Flexonics Ltd. Style 102 (or 102-U as required) or equal, twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable in all respects for intended application, and complete with required nipples and connections to provide proper vibration isolation.
- .10 Isolate designated piping risers at floor support points in accordance with drawing detail and/or where indicated on drawings.
- .11 Erect roof curb vibration isolation in accordance with instructions shipped with assembly. Match vibration isolation with associated roof top unit and orient isolation as identified by manufacturer to ensure proper loading and optimum performance. Caulk top of roof curb with 2 beads of caulking provided and centre isolation assembly onto roof curb and, unless otherwise noted, screw in place with 50 mm (2") lag screws at 900 mm (36") O.C. Position gasket on top rail or alternatively, caulk with 2 beads of caulking provided and orient and lower roof top unit onto isolation rails and, unless otherwise noted, screw unit into top rail with 25 mm (1") lag screws at 900 mm (36") O.C. After roof top unit is secured in place, but before damageable work is installed, spray each isolated equipment assembly with water and correct any water leaks.
- .12 For control wiring connections to vibration isolated equipment ensure flexible metallic conduit with 90° bend is used for conduit 25 mm (1") dia. and smaller, and for conduit larger than 25 mm (1") dia., use Crouse Hinds EC couplings. Connections are to be long enough so that conduit will remain intact if equipment moves 300 mm (12") laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation. Coordinate these requirements with mechanical trades involved. If electrical power connections are not made in a similar manner as part of the electrical work, report this fact to the Consultant.
- .13 Arrange and pay for vibration isolation product manufacturer to visit site to inspect installation of his equipment. Perform revision work required as a result of improper installation. When vibration isolation equipment manufacturer is satisfied with the installation, obtain and submit a letter stating manufacturer has inspected the installation and equipment is properly installed.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies seismic control and restraint requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 Seismic Consultant

- .1 Retain and pay for services of an experienced Seismic Consultant who is a registered professional engineer licensed in the jurisdiction of the work and a member in good standing of a Professional Engineers Association in the jurisdiction of the work.
- .2 Seismic Consultant is to:
 - .1 determine proper seismic hazard level, design, recommend, and review proposed mechanical work seismic restraint shop, placement and securing drawings, and sign and stamp drawings prior to submittal for review as specified below;
 - .2 supervise installation of mechanical work seismic restraint and, when work is complete, certify in writing that seismic restraint work has been installed in accordance with signed, stamped and reviewed drawings;
 - .3 prepare and submit to Municipality and authorities having jurisdiction, on a form approved by Municipality and authorities having jurisdiction, at the beginning of seismic restraint work and when work is complete, original signed and sealed Letters of Assurance for design, installation, and field review of seismic restraint work.

1.03 Submittals

- .1 Obtain required equipment information and submit manufacturer's shop drawings/product data sheets for restraining devices and steel bases. Include placement data, and details of attachment to both equipment and structure meeting requirements of forces involved. Product data sheets and drawings are to be signed and stamped by Seismic Consultant referred to above.
- .2 If requested, submit samples of seismic restraint materials for review.

1.04 Closeout Submittals

- .1 Submit copies of Seismic Consultant's Letters of Assurance as specified above.
- .2 Submit copies of Seismic Consultant and seismic control manufacturer's certification letters as specified in Part 3 of this Section.

1.05 Quality Assurance

- .1 Seismic restraints are to be designed by a registered professional engineer as specified above, and are to be installed by qualified tradesmen under supervision of and to the approval of the design engineer.
- .2 Unless otherwise specified, seismic control and restraints are to be designed in accordance with Code requirements, ANSI/SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, SMACNA/ASHRAE Service Restraint Applications CD-ROM, and the P.P.I.C. Manual Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems, all of which are to form a part of this Section.
- .3 Seismic control and restraints for fire protection piping and equipment are to be in accordance with NFPA requirements. When specified and/or required, design is also to include Factory Mutual requirements.

- .4 Restraint products must be tested in an independent testing laboratory, or certified by Seismic Consultant, to confirm restraint products meet requirements of this Section, i.e. dynamic ultimate limit load state as required by Code, "Fail Safe" design, etc. If particular tests are carried out to represent a restraint type, test is to be valid for the full load range of the restraint. Submit such tests or certification when requested.
- .5 Seismic control and restraint product manufacturers are to provide required assistance during installation, and, when installation is complete, submit written reports listing any deficiencies to the installation.

2 Products

2.01 General

- .1 Isolation, anchors, bolts, bases, restraints, etc., are to be designed to withstand without failure or yielding, the dynamic G load as specified in Code for the seismic zone in which building is located. Design loads are ultimate limit state loads (1.5 times working load) acting through the centre of gravity of the anchored or restrained equipment. "Fail Safe" designs are acceptable.
- .2 For both isolated and non-isolated floor mounted equipment, i.e. tanks, heat exchangers, boilers, etc., design and provide anchors and bolts to withstand, without failure or yielding, a dynamic ultimate limit state load as defined in Code, of the greater of 0.3 g (2.94 m/s²) or as required by Code, applied horizontally through the centre of gravity.
- .3 Where impact forces may be significant, use ductile materials.
- .4 Seismic restraining devices factory supplied with equipment are to meet requirements of this Section.

2.02 Manufacturers

- .1 Mason Industries Inc.;
- .2 Kinetics Noise Control;
- .3 Vibro-Acoustics Ltd;
- .4 Price Industries Inc.

2.03 Slack Cable Restraints

- .1 Aircraft cable galvanized slack cable restraints meeting current requirements of Building Code, sized to suit the application and complete with required cable ties, anchor hardware (selected for a load equal to twice the weight of the equipment), and similar connection accessories.

2.04 Anchor Bolts

- .1 Equal to Mason Industries type SAB seismic anchor bolts.

2.05 Flexible Piping Connections

- .1 Flexible piping connectors are to be supplied with seismic restraint materials. Where flexible connections are not specified with piping in other Sections they are to be equal to Mason Industries twin sphere, non-metallic connectors with hose lengths preset in strict accordance with manufacturer's instructions and to approval of Seismic Consultant, each rated for continuous operation at 1725 kPa at 87.7°C (250 psi at 190°F) or 1380 kPa at 121°C (200 psi at 250°F), and complete with:
 - .1 nylon tire cord reinforced EPDM body;

- .2 ductile iron reinforcing ring and ductile iron screwed or flanged connections as required and to suit piping system operating pressure.

2.06 Vibration Isolation Products

- .1 Refer to Section 20 05 48.13 – Vibration Controls for Mechanical Systems.

3 Execution

3.01 Installation of Seismic Restraint Materials

- .1 Provide seismic restraint for mechanical equipment, piping, and ductwork, including diffusers, grilles, etc., as per requirements of current edition of Building Code and this Section of the Specification.
- .2 Following Mechanical Components Restraint Guide is to be used as a general guide only to establish appropriate restraint methods, hardware, and attachments, however, due to differences in construction, size, weight, and configuration of different manufacturer's equipment and variety of ways and means that equipment and components can be installed, specific restraint methods are to be confirmed in the field. Seismic restraint materials and methods are to be reviewed and approved by Seismic Consultant.
- .3 Mechanical Component Restraint Guide:

Item	Type of Restraint	Minimum no. of Restraints	Notes
In-line Pumps	SCR	2	Pipe mounted type pump
Pumps Non-Isolated	BTHP	4	Base mount type pump
Pumps Isolated	SNBR	4	Base mount type pump
Expansion Tanks	SCR	4	
D.H.W. Tanks	SCR	4	Attach to removable steel strap yoke
Glycol Tanks	SCR	4	Attach to removable steel strap yoke
Boilers			
- With Base	BTHP	4	
- Without Base	CSSB	4	
Chillers			
- Isolated	SNBR	4	
- Non-Isolated	BTHP	4	
Cooling Towers Closed Circuit Coolers			
- Isolated	SNBR	4	
- Non-Isolated	BTSLPR	4	
Heat Exchangers	BTHP	4	Bolt to custom support frame
Radiant Panels	SCR	4	Per panel section
Unit Heaters	TSR-SCR	4	
Force Flow Heaters	TSR-SCR	4	

Item	Type of Restraint	Minimum no. of Restraints	Notes
AHU's and A/C Units Free Standing			
- With Base	BTHP	4	
- Without base	CSSB	4	
AHU's and A/C Units Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Packaged Rooftop Air Units (all types)			
On roof curb	BTRC	4	Roof curb bolted to roof.
Humidifiers	BTHP	4	Bolt unit to custom stand.
Electronic		4	Bolt stand to housekeeping pad or structure.
Fans – Suspended			
- Isolated	SCR	4	
- Non-Isolated	SCR	4	
Fans – Freestanding			
- Isolated	SNBR	4	
- Non-Isolated	BTHP	4	
Grilles, Registers, Diffusers	SCR	4	Where not bolted to duct (i.e. in tee-bar ceilings)
Airflow Control Valves	SCR	4	Where suspended
Air Compressor Receiver Sets			
- Isolated	BTHP	4	
- Non-Isolated			
Piping	SCR TSR	As required	As per Specification
Ductwork	SCR TSR	As required	As per Specification

.4 Legend

Legend	
SCR	Slack cable restraint (bolted to structure)
SNBR	Seismic snubber (bolted to structure)
TSR	Threaded support rod (bolted or clamped to structure)
BTSLPR	Bolt to sleeper (sleeper bolted to structure)
BTHP	Bolt to concrete housekeeping pad (pad to be keyed to structure)
CSSB	Custom steel shoe base (bolted to structure)
BTRC	Bolt to roof curb (roof curb bolted to roof structure)

- .5 Provide structural steel bases for equipment unless equipment manufacturer certifies direct attachment capabilities.
- .6 Space restraints under equipment so minimum distance between adjacent corner restraints is at least equal to the height of the centre of gravity of the equipment. Include the height of the centre of gravity on shop drawings, otherwise, design for increased forces on supports and submit design calculations with shop drawings. In particular, chillers are to meet this requirement.
- .7 Floor mounted isolated equipment is to be installed on 100 mm (4") high concrete housekeeping pads with at least 200 mm (8") clearance between drilled inserts and edges of pads. Ensure housekeeping pads are keyed to structure to resist seismic displacement.
- .8 Requirements pertaining to seismic control work are as follows:
- .1 execute seismic control and restraint work in accordance with drawing details, reviewed shop drawings, ANSI/SMACNA Seismic Restraint Manual, PIPC Manual: Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems, and National Uniform Seismic Installation Guidelines (NUSIG);
 - .2 seismic control systems are to work in all directions;
 - .3 fasteners and attachment points are to resist same maximum load as the seismic restraint;
 - .4 drilled or power driven anchors and fasteners are not permitted;
 - .5 no equipment, equipment supports or mounts are to fail before failure of structure;
 - .6 supports of cast iron or threaded pipe are not permitted;
 - .7 seismic control measures are not to interfere with integrity of firestopping;
 - .8 equipment is to be bolted to structure, and bolts are to be fitted with isolation washers;
 - .9 number, size, type, and installation of anchor bolts are to be as recommended by anchor bolt manufacturer and seismic design consultant;
 - .10 where more than a 3 mm (1/8") differential exists between an anchor or attachment bolt diameter, an anchor and attachment point hole, or an isolator gap attachment bolt and equipment anchor attachment hole, pack air gap with Mason type 0.5 FastSteel reinforced epoxy putty;
 - .11 hung equipment and pipe hangers are to be fitted with a means of preventing upward movement, and non-isolated equipment and pipe hanger rods are to be fitted with oversized steel washers

- and nuts above and below hanger or equipment attachment point, locked tight to prevent uplift of equipment or hanger;
- .12 where suspended equipment hanger rod length exceeds 50 rod diameters between structure and equipment attachment point, reinforce rods with angle iron to prevent bending due to uplift forces;
 - .13 seismic control measures are not to jeopardize noise and vibration isolation systems, and 6 mm (¼") to 9 mm (3/8") clearance during normal operation of equipment and systems is to be provided between seismic restraint and equipment;
 - .14 where hold-down bolts for seismic restraint equipment penetrate roofing membranes coordinate with roofing trade for installation of pitch pockets/"gum cups" and sealing compound to maintain water-tight integrity of roof;
 - .15 where friction type clamps are used for support of equipment and connecting services, secure clamps to steel work by means of welding or other positive means to prevent slippage or loosening of clamps due to seismic forces.
- .9 Provide slack cable restraint assemblies for:
- .1 steam piping 32 mm (1-¼") dia. and larger;
 - .2 fuel gas, fuel oil, medical gas, compressed air and service piping 25 mm (1") dia. and larger;
 - .3 piping 32 mm (1-¼") dia. and larger located in boiler, fan, chiller, and similar equipment rooms;
 - .4 horizontal and vertical piping 65 mm (2-½") dia. and larger;
 - .5 ductwork and duct mounted equipment;
 - .6 isolated and non-isolated ceiling hung fans, tanks, equipment, etc.;
 - .7 generator exhaust system(s).
- .10 Installation requirements for slack cable restraints include following:
- .1 connect slack cable restraints to ceiling hung equipment in such a way that axial projection of wires passes through the centre of gravity of the equipment;
 - .2 orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), and tie back to the ceiling slab at an angle not exceeding 45° to slab;
 - .3 install cables using appropriate grommets, shackles, and other hardware to ensure alignment of restraints and to avoid bending cables at connection points, and, where feasible, wrap cables directly around pipes as opposed to using collars;
 - .4 for piping systems, provide transverse slack cable restraints at a maximum spacing of 12.5 m (40'), and longitudinal restraints at 25 m (80') maximum spacing, or as limited by anchor/slack cable performance;
 - .5 for piping less than 250 mm (10") dia., reduce transverse restraint spacing to 6 m (20'), and note that smaller piping may be rigidly tied to larger piping for restraint, but not the reverse;
 - .6 vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonance;
 - .7 transverse bracing for one pipe section may also act as longitudinal bracing for piping connected perpendicular to it if bracing is installed within 600 mm (24") of elbow or tee, and if connected piping is same or smaller dia., and note that branch lines are not to be used to restrain main lines;

- .8 provide flexibility in piping joints or sleeves where piping penetrates building seismic or expansion joints;
- .9 wherever possible, support weight of vertical piping risers at a point or points above the centre of gravity of riser, and provide lateral guides at top and bottom of riser, and at intermediate points not to exceed the transverse spacing specified above for horizontal pipes, with guide clearance not exceeding 3 m (10');
- .10 install restraints at least 50 mm (2") clear of other equipment and services;
- .11 adjust restraint cables such that they are not visibly slack, or such that flexibility is approximately 40 mm (1-½") under thumb pressure for a 1.5 m (5') cable length, with an equivalent ratio for other cable lengths, and adjust clearance of cable strap/spacer piece restraints so as not to exceed 6 mm (0.23");
- .12 provide transverse and axial restraints within 4 m (12') of a vertical bend;
- .13 at steel trusses, connect to top chords at panel points and follow truss manufacturer's instructions;
- .14 diffusers and grilles mounted in t-bar ceilings or which are not positively secured to ductwork or structure are to be fitted with slack cable restraints to prevent them from falling in the event the ceiling t-bar grid is displaced;
- .15 do not bridge vibration isolators with slack cable restraints;
- .16 other approved restraint systems are conventional pipe guides, rigid restraint where piping passes through a block or concrete wall, or a cable strap and spacer piece attached to structure and used where piping is adjacent to a wall and conventional slack cable restraints cannot be used.

3.02 Installation of Flexible Piping Connectors

- .1 Supply flexible piping connectors for connections (including plumbing) to seismically restrained equipment. Hand connectors to appropriate piping trade at site for installation.

3.03 Site Inspection and Letters of Certification

- .1 When seismic control products have been installed, arrange for seismic control product manufacturer and Seismic Consultant to examine installation of seismic control products and to certify in writing (separate letters) that products have been properly installed in accordance with governing Codes and Regulations, and recommendations and instructions. Seismic Consultant is to apply his professional stamp to the letter.

End of Section

1 General

1.01 Section Includes

- .1 Nameplates.
- .2 Tags.
- .3 Pipe Markers.

1.02 References

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

1.03 Submittals

- .1 Submit list of wording, symbols, letter size, and colour coding for mechanical identification.
- .2 Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- .3 Product Data: Provide manufacturers catalogue literature for each product required.
- .4 Samples: Submit two labels, tags samples to Consultant for approval.
- .5 Manufacturer's Installation Instructions: Indicate special procedures, and installation.

1.04 Closeout Submittals

- .1 Section 01 77 00: Project Closeout.
- .2 Record actual locations of tagged valves.

2 Products

2.01 Mechanical Work Identification Materials

- .1 Confirm with the Owner if an existing mechanical work identification system is in place and, if so, match accordingly.
- .2 If an existing mechanical work identification system is not in place, the following is to be used:
 - .1 Equipment nameplates are to be minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1" x 2-½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:
 - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved wording to completely identify equipment and its use with no abbreviations;
 - .2 wording is generally to be as per drawings, i.e. Fan EF-1, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
 - .3 supply stainless steel screws for securing nameplates in place;

- .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level.
- .2 Valve tags are to be coloured, 40 mm (1-1/2") square, 2-ply laminated plastic with bevelled edges, red-white, green-white, yellow-black, etc., to match piping identification colour, each complete with a 3.2 mm (1/8") diameter by 100 mm (4") long brass plated steel bead chain, and four lines of engraved maximum size identification wording, i.e.:

VALVE V12 200 mm (8") CHILL. WATER NORMALLY OPEN

- .3 Standard pipe identification is to be equal to Smillie McAdams Summerlin Ltd., Brady or Primark Manufacturing Inc. vinyl plastic with indoor/outdoor type vinyl ink lettering and directional arrows, as follows:
 - .1 for pipe less than or equal to 150 mm (6") diameter, coiled type snap-on markers of a length to wrap completely around pipe or pipe insulation;
 - .2 for pipe larger than 150 mm (6") diameter, saddle type strap-on markers with 2 opposite identification locations and complete with nylon cable ties.
- .4 Identification wording and colours for pipe identification materials are to be as follows:

Pipe Service	Identification Colour	Legend
domestic cold water	green	DOM. COLD WATER
domestic hot water supply	green	DOM. HW SUPPLY
domestic hot water recirculation	green	DOM. HW RECIRC.
tempered domestic water	green	TEMP. DOM. WATER
chilled drinking water	green	CH. DRINK WTR.
storm drainage	green	STORM
sanitary drainage	green	SAN.
plumbing vent	green	SAN. VENT
acid sanitary drainage	yellow	ACID DRAIN
acid drainage vent	yellow	ACID VENT
fire protection standpipe	red	F.P. STANDPIPE
fire protection sprinklers	red	F.P. SPRINKLER
natural gas	to Code	to Code, c/w pressure
natural gas vent	to Code	to Code
propane gas	to Code	to Code, c/w pressure
propane gas vent	to Code	to Code
fuel oil supply	yellow	FUEL OIL SUPPLY
fuel oil return	yellow	FUEL OIL RETURN

Pipe Service	Identification Colour	Legend
fuel oil vent	yellow	FUEL OIL VENT
heating water supply	yellow	HTG. WTR. SUPPLY
heating water return	yellow	HTG. WTR. RETURN
heating water drain	yellow	HTG. WTR. DRAIN
glycol heating supply	yellow	GLY. HTG. SUPPLY
glycol heating return	yellow	GLY. HTG. RETURN
glycol heating drain	yellow	GLY. HTG. DRAIN
glycol heat reclaim return	yellow	GLY. HTG. RECLAIM R.
glycol heat reclaim supply	yellow	GLY. HTG. RECLAIM S.
heat pump geothermal loop – source side supply	green	GEO. LOOP SOURCE SUPPLY
heat pump geothermal loop – source side return	green	GEO. LOOP SOURCE RETURN
heat pump geothermal loop – load side supply	green	GEO. LOOP LOAD SUPPLY
Heat pump geothermal loop – load side return	green	GEO. LOOP LOAD RETURN
condenser water supply	green	COND. WTR. SUPPLY
condenser water return	green	COND. WTR. RETURN
chilled water supply	green	CH. WTR. SUPPLY
chilled water return	green	CH. WTR. RETURN
chilled water drain	green	CH. WTR. DRAIN
low pressure steam	yellowkPa STEAM
medium pressure steam	yellowkPa STEAM
high pressure steam	yellowkPa STEAM
low pressure condensate	yellow	L.P. CONDENSATE
medium pressure condensate	yellow	M.P. CONDENSATE
high pressure condensate	yellow	H.P. CONDENSATE
pumped condensate	yellow	PUMPED CONDENSATE
steam vent	yellow	STEAM VENT
boiler feedwater	yellow	BLR. FEEDWATER
boiler blowdown	yellow	BLR. BLOW-OFF
refrigerant suction	yellow	REFRIG. SUCTION
refrigerant liquid	yellow	REFRIG. LIQUID
refrigerant hot gas	yellow	REFRIG. HOT GAS
diesel engine exhaust	yellow	ENGINE EXHAUST

Pipe Service	Identification Colour	Legend
gasoline	yellow	GASOLINE
distilled water	green	DISTILL. WATER
demineralized water	green	DEMIN. WATER
compressed air (< 700 kPa)	greenkPa COMP. AIR
compressed air (>700 kPa)	yellowkPa COMP. AIR
control air	green	CONTROL AIR

.5 Colours for pipe identification legends and directional arrows are to be as follows:

Identification Colour	Legend and Arrow Colour
yellow	black
green	white
red	white

.6 Duct identification is to be custom made Mylar stencils with 50 mm (2") high lettering to accurately describe duct service, i.e. "AHU-1 SUPPLY", complete with a directional arrow, and coloured ink with ink pads and roller applicators. Ink colour is generally to be black but must contrast with lettering background.

3 Execution

3.01 Preparation

.1 Degrease and clean surfaces to receive adhesive for identification materials.

3.02 Installation

.1 Identify new exposed piping and ductwork as per Part 2 of this Section in locations as follows:

- .1 at every end of every piping or duct run;
- .2 adjacent to each valve, strainer, damper and similar accessory;
- .3 at each piece of connecting equipment;
- .4 on both sides of every pipe and duct passing through a floor, wall or partition, unless otherwise specified;
- .5 at 6 m (20') intervals on pipe and duct runs exceeding 6 m (20') in length;
- .6 at least once in each room, and at least once on pipe and duct runs less than 6 m (20') in length.

.2 Unless otherwise specified identify new concealed piping and ductwork as per Part 2 of this Section in locations as follows:

- .1 at points where pipes or ducts enter and leave rooms, shafts, pipe chases, furred spaces, and similar areas;
- .2 at maximum 6 m (20') intervals on piping and ductwork above suspended accessible ceilings, and at least once in each room;

- .3 at each access door location;
- .4 at each piece of connected equipment, automatic valve, etc.
- .3 Provide an identification nameplate for equipment provided as part of this project, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place, approximately at eye level if possible, with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate nameplates in the most conspicuous and readable location.
- .4 Paint new natural and/or propane gas piping with primer and 2 coats of yellow paint in accordance with Code requirements. Identify piping at intervals as specified above.
- .5 Provide an identification nameplate for each motor starter or disconnect switch located in a motor control centre or on a motor starter panel, and on each individually mounted starter provided as part of mechanical work, and on each disconnect switch provided as part of the electrical work for motorized equipment provided as part of mechanical work.
- .6 For electrically traced mechanical work, identification wording is to include "ELECTRICALLY TRACED".
- .7 Tag valves and prepare a valve tag chart in accordance with following requirements:
 - .1 attach a valve tag to each new valve, except for valves located immediately at equipment they control;
 - .2 prepare a digital valve tag chart to list tagged valves, with, for each valve, the tag number, location, valve size, piping service, and valve attitude (normally open or normally closed);
 - .3 if an existing valve tag chart is available at site, valve tag numbering is to be an extension of existing numbering and new valve tag chart is to incorporate existing chart;
 - .4 include a copy of valve tag chart in each copy of operating and maintenance instruction manuals.
- .8 Where shut-off valves, control dampers, sensors, and similar items which will or may need maintenance and/or repair are located above accessible suspended ceilings, provide round coloured ceiling tacks in ceiling panel material, or stickers equal to Brady "Quick Dot" on ceiling grid material to indicate locations of items. Unless otherwise specified, ceiling tack or sticker colours are to be as follows:
 - .1 HVAC piping valves and equipment: yellow
 - .2 fire protection valves and equipment: red
 - .3 plumbing valves and equipment: green
 - .4 HVAC ductwork dampers and equipment: blue
 - .5 control system hardware and equipment: orange

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies mechanical system testing, adjusting, and balancing requirements that are common to mechanical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

1.02 Definitions

- .1 “Agency” – means agency to perform testing, adjusting, and balancing work.
- .2 “TAB” – means testing, adjusting, and balancing to determine and confirm quantitative performance of equipment and systems and to regulate specified fluid flow rate and air patterns at terminal equipment, e.g., reduce fan speed, throttling, etc.
- .3 “hydronic systems” – includes heating water, chilled water, glycol-water solution, condenser water, and any similar system.
- .4 “air systems” – includes outside air, supply air, return air, exhaust air, and relief air systems.
- .5 “flow rate tolerance” – means allowable percentage variation, minus to plus, of actual flow rate values in Contract Documents.
- .6 “report forms” – means test data sheets arranged for collecting test data in logical order for submission and review, and these forms, when reviewed and accepted, should also form permanent record to be used as basis for required future testing, adjusting, and balancing.
- .7 “terminal” – means point where controlled fluid enters or leaves the distribution system, and these are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.
- .8 “main” – means duct or pipe containing system’s major or entire fluid flow.
- .9 “submain” – means duct or pipe containing part of the systems’ capacity and serving 2 or more branch mains.
- .10 “branch main” – means duct or pipe servicing 2 or more terminals.
- .11 “branch” – means duct or pipe serving a single terminal.

1.03 Submittals

- .1 Within 30 days of work commencing at site, submit name and qualifications of proposed testing and balancing agency in accordance with requirements of article entitled Quality Assurance below.
- .2 Submit sample test forms, if other than those standard forms prepared by Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), are proposed for use.
- .3 Submit a report by Agency to indicate Agency’s evaluation of mechanical drawings with respect to service routing and location or lack of balancing devices. Include set of drawings used and marked-up by Agency to prepare report.

1.04 Closeout Submittals

- .1 Submit a report by Agency after each site visit made by Agency during construction phase of this Project.
- .2 Submit a draft report, as specified in Part 3 of this Section.

- .3 Submit a final report, as specified in Part 3 of this Section.
- .4 Submit a testing and balancing warranty as specified in Part 3 of this Section.
- .5 Submit reports listing observations and results of post construction site visits as specified in Part 3 of this Section.

1.05 Quality Assurance

- .1 Employ services of an independent testing, adjusting, and balancing agency meeting qualifications specified below, to be single source of responsibility to test, adjust, and balance building mechanical systems to produce design objectives. Agency is to have successfully completed testing, adjusting, and balancing of mechanical systems for a minimum of 5 projects similar to this Project within past 3 years, and is to be certified as an independent agency in required categories by one of following:
 - .1 AABC – Associated Air Balance Council;
 - .2 NEBB – National Environmental Balancing Bureau.
- .2 NBCTA certification in lieu of the above noted organizations is not permitted.
- .3 Testing, adjusting, and balancing of complete mechanical systems is to be performed over entire operating range of each system in accordance with one of following publications:
 - .1 National Standards for a Total System Balance published by Associated Air Balance Council;
 - .2 Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems published by National Environmental Balancing Bureau;
 - .3 Chapter 37, Testing, Adjusting, and Balancing of ASHRAE Handbook HVAC Applications.

2 Products – Not Used

3 Execution

3.01 Scope of Work

- .1 Perform total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of fluid quantities of mechanical systems as required to meet design specifications and comfort conditions, and recording and reporting results.
- .2 Mechanical systems to be tested, adjusted, and balanced include:
 - .1 TAB of domestic water systems (all piping extended from Municipal main) is to include:
 - .1 domestic hot water recirculation piping;
 - .2 tempered water piping flows.
 - .2 TAB of swimming pool systems is to include all pool piping water flows.
 - .3 TAB of laboratory systems is to include flows through piping, fittings including bench work fittings, and associated equipment including special ventilation systems.
 - .4 TAB of medical gas systems is not part of TAB work and is specified in Section entitled Medical Gas Piping Systems.

- .5 TAB of fuel oil system is to include supply and return oil flows as applicable, and is to be in accordance with requirements of CAN/CSA B139.
- .6 TAB of heating systems is to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .7 TAB of cooling systems is also to include piping and equipment fluid temperatures, flows and control, and if TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .8 TAB of air handling systems is to include equipment and ductwork air temperatures, capacities, and flows.

3.02 Testing, Adjusting, and Balancing

- .1 Conform to following:
 - .1 as soon as possible after award of Contract, Agency is to carefully examine a set of mechanical drawings with respect to routing of services and location of balancing devices, and is to issue a report listing results of the evaluation;
 - .2 set of drawings examined by Agency is to be returned with evaluation report, with red line mark-ups to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices;
 - .3 after review of mechanical work drawings and specification, Agency is to visit site at frequent, regular intervals during construction of mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting, and balancing;
 - .4 after each site visit, Agency is to report results of site visit indicating date and time of visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing;
 - .5 testing, adjusting, and balancing is not to begin until:
 - .1 building construction work is substantially complete and doors have been installed;
 - .2 mechanical systems are complete in all respects, and have been checked, started, adjusted, and then successfully performance tested.
 - .6 mechanical systems to be tested, adjusted and balanced are to be maintained in full, normal operation during each day of testing, adjusting, and balancing;
 - .7 obtain copies of reviewed shop drawings of applicable mechanical plant equipment and terminals, and temperature control diagrams and sequences;
 - .8 Agency is to walk each system from system "head end" equipment to terminal units to determine variations of installation from design, and system installation trades will accompany Agency;
 - .9 Agency is to check valves and dampers for correct and locked position, and temperature control systems for completeness of installation before starting equipment;
 - .10 wherever possible, Agency is to lock balancing devices in place at proper setting, and permanently mark settings on devices;

- .11 Agency is to leak test ductwork as specified in Section entitled HVAC Air Distribution in accordance with requirements of SMACNA "HVAC Air Duct Leak Test Manual", coordinate work with work of aforementioned Sections, provide detailed sketch(es) to Sheet Metal Contractor and Consultant identifying ductwork not in accordance with acceptable leakage values specified in aforementioned Sections, and retest corrected ductwork;
 - .12 Agency is to balance systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting air quantities, and should objectionable noise occur at design conditions, Agency is to immediately report problem and submit data, including sound readings, to permit an accurate assessment of noise problem to be made;
 - .13 Agency is to check supply air handling system mixing plenums for stratification, and where variation of mixed air temperature across coils is found to be in excess of $\pm 5\%$ of design requirements, Agency is to report problem and issue a detail sketch of plenum baffle(s) required to eliminate stratification;
 - .14 Agency is to perform testing, adjusting, and balancing to within $\pm 5\%$ of design values, and make and record measurements which are within $\pm 2\%$ of actual values;
 - .15 for air handling systems equipped with air filters, test and balance systems with simulated 50% loaded (dirty) filters by providing a false pressure drop;
 - .16 test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 2.8°C (5°F) wet bulb temperature of maximum summer design condition, and within 5.5°C (10°C) dry bulb temperature of minimum winter design condition, and take final temperature readings during seasonal operation.
- .2 Prepare reports as indicated below.
- .1 Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on AABC or NEBB forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in same manner specified for final reports and submit for review.
 - .2 Upon verification and approval of draft reports, prepare final reports organized and formatted as specified below. Use units of measurement (SI or Imperial) as used on Project Documents.
 - .3 Report forms are to be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Report forms complete with schematic systems diagrams and other data are to be consolidated in electronic format as a PDF. PDF file to be indexed and organized into sections, as it applies to the project, as follows:
 - .1 General Information and Summary;
 - .2 Air Systems;
 - .3 Hydronic Systems;
 - .4 Temperature Control Systems;
 - .5 Special Systems.
 - .4 Agency is to provide following minimum information, forms, and data in report:

- .1 inside cover sheet to identify Agency, Contractor, and Project, including addresses, and contact names and telephone numbers and a listing of instrumentation used for procedures along with proof of calibration;
 - .2 remainder of report is to contain appropriate forms containing as a minimum, information indicated on standard AABC or NEBB report forms prepared for each respective item and system;
 - .3 Agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic "as-built" diagram indicating and identifying equipment, terminals, and accessories;
 - .4 Agency is to include report sheets indicating building comfort test readings for all rooms.
- .3 After final testing and balancing report has been submitted, Agency is to visit site with Contractor and Consultant to spot check results indicated on balancing report. Agency is to supply labour, ladders, and instruments to complete spot checks. If results of spot checks do not, on a consistent basis, agree with final report, spot check procedures will stop and Agency is to then rebalance systems involved, resubmit final report, and again perform spot checks with Contractor and Consultant.
- .4 When final report has been accepted, Contractor is to submit to Owner, in name of Owner, a certificate equal to AABC National Guaranty Certification or a NEBB Quality Assurance Program Bond, and in addition, Contractor is to submit a written extended warranty from Agency covering one full heating season and one full cooling season, during which time any balancing problems which occur, with exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by Agency and reported on to Owner, and if it is determined that problems are a result of improper testing, adjusting, and balancing, they are to be immediately corrected without additional cost to Owner.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies insulation requirements common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly.

1.02 Definitions

- .1 "concealed" – means mechanical services and equipment above suspended ceilings, in non-accessible chases, in accessible pipe spaces, and furred-in spaces.
- .2 "exposed" – means exposed to normal view during normal conditions and operations.
- .3 "mineral fibre" – includes glass fibre, rock wool, and slag wool.
- .4 "domestic water" or "potable water" – means piping extended from building Municipal supply main.

1.03 Submittals

- .1 At least 4 weeks prior to insulation work commencing, submit a sample of each type of insulation (and insulation accessories and finish), in applied form, for review. Mount samples on a plywood board. Identify each product with manufacturer's name and insulation type, and proposed use of insulation. When sample board has been approved, mechanical insulation work is to conform to approved sample board.
- .2 Submit a product data sheet for each insulation system product.
- .3 Submit a fabrication drawing for each custom made cover to indicate material and fabrication details, and a 300 mm (12") square sample of proposed cover material.
- .4 Submit a colour chart for coloured lagging adhesive for canvas jacketed insulation.

1.04 Closeout Submittals

- .1 In accordance with Part 3 of this Section, submit a letter from fire rated duct wrap supplier to certifying duct wrap has been properly installed.

1.05 Quality Assurance

- .1 Mechanical insulation is to be applied by a licensed journeyman insulation mechanic, or by an apprentice under direct, daily, on-site supervision of a journeyman mechanic.
- .2 Do not apply insulation unless leakage tests have been satisfactorily completed.
- .3 Ensure surfaces to be insulated are clean and dry.
- .4 Ensure ambient temperature is minimum 13°C (55°F) for at least 1 day prior to application of insulation, and for duration of insulation work, and relative humidity is and will be at a level such that mildew will not form on insulation materials.
- .5 Company with sub-contract for mechanical insulation work is to be a member in good standing of Thermal Insulation Association of Canada.
- .6 Insulation materials must be stored on site in a proper and dry storage area. Any wet insulation material is to be removed from site.

2 Products

2.01 Fire Hazard Ratings

- .1 Unless otherwise specified, insulation system materials inside building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.

2.02 Thermal Performance

- .1 Unless otherwise specified, thermal performance of insulation is to meet or exceed values given in Tables entitled Minimum Piping Insulation Thickness Heating and Hot Water Systems and Minimum Piping Insulation Thickness Cooling Systems, as stated in ANSI/ASHRAE/IES Standard 90.1 version referenced in Ontario Building Code.

2.03 Pipe Insulation Materials

- .1 Horizontal pipe insulation at hangers and supports are to be equal to Belform Insulation Ltd. "Koolphen K-Block" insulated pipe support inserts consisting of minimum 150 mm (6") long, pre-moulded, rigid, sectional phenolic foam insulation (of same thickness as adjoining insulation) with a reinforced foil and kraft paper vapour barrier jacket and a captive galvanized steel saddle.
- .2 Flexible foam elastomeric is to be closed cell, sleeve type, longitudinally split self-seal, foamed plastic pipe insulation with a water vapour transmission rating of 0.10 in accordance with ASTM E96, Procedure B, and required installation accessories.
 - .1 Manufacturers:
 - .1 Armacell AP/Armaflex SS;
 - .2 IK Insulation Group K-Flex "LS" Self-Seal Pipe Insulation.
- .3 Closed cell foamed glass is to be Owens Corning "FOAMGLASS", expanded, sectional, rigid sleeve type insulation with a liquid or vapour permeability rating (as per ASTM C240) of 0.00, and a factory applied "PITWRAP SSII" self-sealing jacket and protective metal cladding.
- .4 Premoulded mineral wool is to be rigid, sectional, sleeve type, non-combustible, longitudinally split mineral wool, or basalt pipe insulation with a reinforced vapour barrier jacket.
 - .1 Manufacturers:
 - .1 Roxul "Tecton 1200";
 - .2 IIG (Johns Manville Inc.) MinWool-1200;
 - .3 Paroc 1200.
- .5 Fire rated pre-moulded mineral wool is to be non-combustible, fire-rated, rigid, sectional, longitudinally split mineral wool or basalt pipe insulation with a reinforced vapour barrier jacket and compatible with CAN/ULC-S115 and CAN/ULC-S101 firestopping.
 - .1 Manufacturers:
 - .1 Roxul "Tecton 1200";
 - .2 IIG (Johns Manville Inc.) MinWool-1200;
 - .3 Paroc 1200.

- .6 Pre-moulded mineral fibre is to be rigid, sectional, sleeve type insulation to ASTM C547, with a factory applied vapour barrier jacket.
 - .1 Manufacturers:
 - .1 Johns Manville Inc. "Micro-Lok AP-T Plus";
 - .2 Knauf Fiber Glass "Pipe Insulation" with "ASJ-SSL" jacket;
 - .3 Manson Insulation Inc. "ALLEY K APT";
 - .4 Owens Corning "Fiberglas" Pipe Insulation.
- .7 Blanket mineral fibre is to be blanket type roll insulation to CGSB 51-GP-11M, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing.
 - .1 Manufacturers:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
- .8 Pre-moulded weatherproof jacketed mineral fibre is to be Knauf Insulation "Redi-Klad 1000" sectional, sleeve type pipe insulation with a self-sealing weather-proof jacket and a 100 mm (4") butt joint sealing strip with each section.

2.04 Barrier-Free Lavatory Piping Insulation Kits

- .1 Removable, flexible, reusable, white moulded plastic insulation kits for barrier-free lavatory drain piping and potable water supplies exposed under lavatory.
- .2 Manufacturers:
 - .1 Truebo "Lav-Guard 2" E-Z Series;
 - .2 Zeston "SNAP-TRAP";
 - .3 McGuire Manufacturing Co. Inc. "ProWrap".

2.05 Equipment Insulation Materials

- .1 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, with a factory applied vapour barrier facing.
 - .1 Manufacturers:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.

- .2 Semi-rigid mineral fibre board is to be roll form, moulded insulation to ASTM C1393, with a factory applied vapour barrier facing consisting of laminated aluminum foil and kraft paper.
 - .1 Manufacturers:
 - .1 Knauf Fiber Glass Pipe and Tank Insulation;
 - .2 Manson Insulation Inc. "AK FLEX";
 - .3 Johns Manville Inc. Pipe and Tank Insulation "Micro-Flex";
 - .4 Multi-Glass Insulation Ltd. "MULTI-FLEX MF";
 - .5 Owens Corning Pipe and Tank Insulation;
 - .6 Glass-Cell Fabricators Ltd. "R-Flex".
- .3 Semi-rigid mineral wool blanket is to be equal to Roxul "Enerwrap MA 960" flexible, black fibrous scrim faced mineral wool blanket insulation to ASTM C553.
- .4 Closed cell foamed glass is to be Owens Corning "FOAMGLAS" expanded, rigid board and block type insulation with a liquid or vapour permeability rating (as per ASTM C240) of 0.00.

2.06 Removable/Reusable Insulation Covers

- .1 Valve, etc. covers are to be NO SWEAT reusable insulation wraps with vapour barrier jacket and self-sealing ends and longitudinal seam, with a length to suit the application and an insulation thickness equal to adjoining insulation.
- .2 Custom manufactured equipment covers conforming to shape of item to be insulated, designed to be easily removable and replaceable to suit use and maintenance procedures of particular item, and to provide adequate personnel protection. Covers are to be complete with minimum 95 kg/m³ (6 lb/ft³) density ceramic fibre insulation sewn between minimum 542.5 g/m² (1.8 oz/ft²) weight silicone impregnated fibreglass fabric in a quilted pattern using double stitches made with Kelvar or Teflon coated fibreglass thread. Overlap flaps are to be secured using laces, snaps, or Velcro double stitched in place.
- .3 Manufacturers:
 - .1 Crosby Dewar Inc.;
 - .2 Insufab Systems Inc.;
 - .3 ADL Insulflex Inc.;
 - .4 Firwin Corp.;
 - .5 GlassCell Isofab Inc.

2.07 Ductwork System Insulation Materials

- .1 Rigid mineral fibre board is to be pre-formed board type insulation to ASTM C612, 48 kg/m³ (3 lb/ft³) density, with a factory applied reinforced aluminum foil and kraft paper facing.
 - .1 Manufacturers:
 - .1 Knauf Fiber Glass Insulation Board with FSK facing;
 - .2 Manson Insulation Inc. "AK BOARD FSK";

- .3 Johns Manville Inc. Type 814 "Spin-Glas";
- .4 Owens Corning 703.
- .2 Semi-rigid mineral fibre board is to be roll form insulation to ASTM C1393, consisting of cut strips of rigid mineral board insulation glued to an aluminium foil and kraft paper facing.
 - .1 Manufacturers:
 - .1 Multi-Glass Insulation Ltd. "Multi-Flex MKF";
 - .2 Glass-Cell Fabricators Ltd. "R-FLEX";
 - .3 Owens Corning Pipe and Tank Insulation;
 - .4 Johns Manville Inc. Pipe and Tank Insulation.
 - .3 Blanket mineral fibre is to be blanket type roll form insulation to ASTM C553, 24 kg/m³ (1-½ lb/ft³) density, 40 mm (1-½") thick, with a factory applied vapour barrier facing.
 - .1 Manufacturers:
 - .1 Johns Manville Inc. Microlite FSK Duct Wrap Type 150;
 - .2 Knauf Fiber Glass Blanket Insulation FSK Duct Wrap Type III;
 - .3 Manson Insulation Inc. ALLEY WRAP FSK Duct Wrap Type III;
 - .4 Certainteed Corporation Softtouch FSK Duct Wrap Type 150.
 - .4 Pre-moulded calcium silicate is to be rigid block and sheet insulation.
 - .1 Manufacturers:
 - .1 Johns Manville Inc. "Thermo-12 Gold";
 - .2 Industrial Insulation Group "Thermo-12 Gold".
 - .5 Flexible foam elastomeric sheet is to be sheet form, CFC free, closed cell, self-adhering elastomeric nitrile rubber insulation with a water vapour permeability rating of 0.08 in accordance with ASTM E96 Procedure A.
 - .1 Manufacturers:
 - .1 Armacell "AP/Armaflex SA";
 - .2 IK Insulation Group "K-Flex Duct Wrap", S2S.
 - .6 Extruded polystyrene tapered insulation – equal to Soprema Sopra-ISO Tapered, closed cell polyisocyanurate foam core with organic facers reinforced with glass fibres, 172 kPa compressive strength as per ASTM D1621, 32 kg/m³ density, 50 mm minimum thickness, 2% slope. Thickness shall increase if width of duct work is larger than 1200 mm to maintain 2% slope.

2.08 Fire Rated Duct Wrap

- .1 Flexible, non-combustible, blanket type mineral fibre duct wrap completely encapsulated in reinforced foil, suitable for installation with zero clearance to combustibles (for grease ducts), and ULC tested and listed (ULC Designs FRD-17 & 23 for ventilation ducts, ULC Design FRD-19 for kitchen exhaust/grease duct) to facilitate a 2 hour fire resistance rating (76 mm (3") thick) to kitchen grease exhaust duct in accordance

with requirements of NFPA 96, and/or a 1 hour or 2 hour fire resistance rating (38 mm (1-½") thick) to ventilation or pressurization ductwork in accordance with requirements of ISO 6944.

- .2 Manufacturers:
 - .1 3M Fire Barrier Duct Wrap 615;
 - .2 CL4 Inc. "CL4Fire";
 - .3 Unifrax Corp. "FyreWrap Elite 1.5";
 - .4 Morgan Thermal Ceramics "FireMaster FastWrap XL".

2.09 Insulating Coatings

- .1 Equal to Robson Thermal Manufacturing Ltd. insulating coatings as follows:
 - .1 anti-condensation coating, "No Sweat-FX";
 - .2 thermal insulating coating, "ThermaLite".

2.10 Insulation Fastenings

- .1 Wire – minimum 15 gauge galvanized annealed wire.
- .2 Wire with Mesh – minimum 15 gauge galvanized annealed wire factory woven into 25 mm (1") hexagonal mesh.
- .3 Aluminium Banding – equal to ITW Insulation Systems Canada "FABSTRAPS" minimum 12 mm (½") wide, 0.6 mm (1/16") thick aluminium strapping.
- .4 Stainless Steel Banding – equal to ITW Insulation Systems Canada "FABSTAPS" 0.6 mm (1/16") thick, minimum 12 mm (½") wide type 304 stainless steel strapping.
- .5 Duct Insulation Fasteners – weld-on 2 mm (3/32") diameter zinc coated steel spindles of suitable length, complete with minimum 40 mm (1-½") square plastic or zinc plated steel self-locking washers.
- .6 Tape Sealant – equal to MACtac Canada Ltd. self-adhesive insulation tapes, types PAF, FSK, ASJ, or SWV as required to match surface being sealed.
- .7 Mineral Fibre Insulation Adhesive – clear, pressure sensitive, brush consistency adhesive, suitable for a temperature range of -20°C to 82°C (-4°F to 180°F), compatible with type of material to be secured, and WHMIS classified as non-hazardous.
- .8 Flexible Elastomeric Insulation Adhesive – Armacell "Armaflex" #520 air-drying contact adhesive.
- .9 Closed Cell Foamed Glass Insulation Adhesive – Pittsburgh Corning PC88 multi-purpose 2-component adhesive.
- .10 Lagging Adhesive – white, brush consistency, ULC listed and labelled, 25/50 fire/smoke rated lagging adhesive for canvas jacket fabric, suitable for colour tinting, complete with fungicide and washable when dry.
- .11 Screws – No. 10 stainless steel sheet metal screws.

2.11 Insulation Jackets and Finishes

- .1 Canvas Jacket Material – ULC listed and labelled, 25/50 fire/smoke rated, roll form, minimum 170 g (6 oz).

- .2 Roll Form Sheet and Fitting Covers – minimum 15 mm (1/2") thick white PVC, 25/50 fire/smoke rated tested in accordance with CAN/ULC-S102, complete with installation and sealing accessories.
 - .1 Manufacturers:
 - .1 Proto Corp. "LoSMOKE";
 - .2 The Sure-Fit System "SMOKE-LESS 25/50";
 - .3 Johns Manville Inc. "Zeston" 300.
 - .3 Rigid Aluminium Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.406 mm (0.016") thick embossed aluminum jacket material to ASTM B209, factory cut to size and complete with polysurlyn moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to weatherproof the end to end joints, and 2-piece epoxy coated pressed aluminum fittings with weather locking edges.
 - .4 Stainless Steel Jacket – equal to ITW Insulation Systems Canada "Lock-on" 0.254 mm (0.010") thick type 304 embossed stainless steel jacket material to ASTM A240, factory cut to size and complete with moisture barrier and continuous modified Pittsburgh Z-Lock, butt straps with "Fabstraps" to cover end to end joints, and 2-piece pressed stainless steel fittings with weather locking edges.
 - .5 Adhesive backed flexible aluminium is to be MFM Building Products Corp. "Flex-Clad 400" roll form sheet material with an aggressive rubberized asphalt adhesive backing, high density polyethylene reinforcement, and an embossed aluminum facing.
 - .6 Heat resistant, trowel consistency thermal insulating and finishing cement to CAN/CGSB 51.12, and suitable for the application.
 - .7 Foamed glass insulation protective coating is to be Pittsburgh Corning "PITTCOTE 300e" flexible acrylic latex weather barrier coating, white unless otherwise specified.
 - .8 UV and moisture resistant flexible foam insulation with protective jacket equal to Armacell "ArmaFlex Shield".
 - .9 Self adhesive multilayer jacketing - equal to 3M Ventureclad 1577CW. Multi-ply laminate flexible jacketing, acrylic adhesive, zero permeability vapor barrier, 480 N/mm tensile strength, 22N/25 mm peel adhesion strength, 15.2 kPa shear adhesion after 72 hours, 147 N puncture resistance, 0.2 mm thickness.

3 Execution

3.01 General Insulation Application Requirements

- .1 Unless otherwise specified, do not insulate following:
 - .1 factory insulated equipment and piping;
 - .2 heating piping within radiation unit enclosures, including blank filler sections of enclosures;
 - .3 heating piping in soffits and/or overhang spaces and connected to bare element radiation in spaces;
 - .4 branch potable water piping located under counters to serve counter mounted plumbing fixtures and fittings, except barrier-free lavatories;
 - .5 exposed chrome plated potable water angle supplies from concealed piping to plumbing fixtures and fittings, except barrier-free lavatories;

- .6 heated liquid system pump casings, valves, strainers and similar accessories;
 - .7 heating system expansion tanks;
 - .8 fire protection pump casings;
 - .9 manufactured expansion joints and flexible connections;
 - .10 acoustically lined ductwork and/or equipment;
 - .11 factory insulated flexible branch ductwork;
 - .12 fire protection system water storage tanks;
 - .13 piping unions, except for unions in "cold" category piping.
- .2 Install insulation directly over pipes and ducts, not over hangers and supports.
 - .3 Install piping insulation and jacket continuous through pipe openings and sleeves.
 - .4 Install duct insulation continuous through walls, partitions, and similar surfaces except at fire dampers.
 - .5 When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect insulation jacketing from the action of condensation at its junction with metal.
 - .6 Insulate, vapour seal, and finish seismic restraints, braces, anchors, hanger rods, and similar hardware directly connected to "cold" piping and/or equipment, for a distance of 300 mm (12") clear of adjacent pipe or equipment finish, to match piping and/or equipment insulation.
 - .7 When insulating vertical piping risers 75 mm (3") diameter and larger, use insulation support rings welded directly above lowest pipe fitting, and thereafter at 4.5 m (14.7') centres and at each valve and flange. Insulate as per Thermal Insulation Association of Canada National Insulation Standards, Figure No. 9.
 - .8 Where piping and/or equipment is traced with electric heating cable, ensure cable has been tested and accepted prior to application of insulation, and ensure cable is not damaged or displaced during the application of insulation.
 - .9 Where existing insulation work is damaged as a result of mechanical work, repair damaged insulation work to Project work standards.
 - .10 Where mineral fibre rigid sleeve type insulation is terminated at valves, equipment, unions, etc., neatly cover exposed end of insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket material on "hot" piping.
 - .11 Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.
 - .12 Where thermometers, gauges, and similar instruments occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in insulation and provide a suitable grommet in the opening.

3.02 Insulation for Horizontal Pipe at Hangers and Supports

- .1 At each hanger and support location for piping 50 mm (2") diameter and larger and scheduled to be insulated, except where roller hangers and/or supports are required, and unless otherwise specified, supply a factory fabricated section of phenolic foam pipe insulation with integral vapour barrier jacket and

captive galvanized steel shield. Supply insulation sections to piping installers for installation as pipe is erected.

- .2 For 100 mm (4") diameter and larger heating system piping where roller type hangers and supports are provided, a steel saddle will be tack welded to pipe at each roller hanger or support location. Pack saddle voids with loose mineral wool insulation.

3.03 Pipe Insulation Requirements – Mineral Fibre

- .1 Insulate following pipe inside building and above ground with mineral fibre insulation of thickness indicated:
 - .1 domestic cold water piping, less than 100 mm (4") dia. – 25 mm (1") thick;
 - .2 domestic cold water piping, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
 - .3 domestic hot water piping, less than 40 mm (1-½") dia. – 25 mm (1") thick;
 - .4 domestic hot water piping, greater than or equal to 40 mm (1-½") dia. – 40 mm (1-½") thick;
 - .5 tempered domestic water piping, supply and return, less than 40 mm (1-½") dia. – 25 mm (1") thick;
 - .6 tempered domestic water piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
 - .7 storm drainage piping from roof drains to the point where main vertical risers extend straight down, without offsets, and connect to horizontal underground mains – 25 mm (1") thick;
 - .8 condensate drainage piping from fan coil unit or any other air conditioning system/unit drain pans to main vertical drain risers or to indirect drainage point – 25 mm (1") thick;
 - .9 drainage piping from refrigerated drinking fountains to nearest 75 mm (3") dia. or larger drain pipe – 25 mm (1") thick;
 - .10 chilled water piping, supply and return, less than 100 mm (4") dia. – 25 mm (1") thick;
 - .11 chilled water piping, supply and return, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
 - .12 chilled glycol solution piping, supply and return, less than 100 mm (4") dia. – 25 mm (1") thick;
 - .13 chilled glycol solution piping, supply and return, greater than or equal to 100 mm (4") dia. – 40 mm (1-½") thick;
 - .14 hot water heating piping, supply and return, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;
 - .15 hot water heating piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
 - .16 glycol solution heating or heat reclaim piping, supply and return, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;
 - .17 glycol solution heating or heat reclaim piping, supply and return, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
 - .18 low pressure (to 140 kPa (20 psi)) steam piping, less than 100 mm (4") dia. – 65 mm (2-½") thick;

- .19 low pressure (to 140 kPa (20 psi)) steam piping, greater than or equal to 100 mm (4") dia. – 80 mm (3") thick;
 - .20 medium pressure (140 kPa to 415 kPa (20 psi to 60 psi)) steam piping, less than 40 mm (1-½") dia. – 100 mm (4") thick;
 - .21 medium pressure (140 kPa to 415 kPa (20 psi to 60 psi)) steam piping, greater than or equal to 40 mm (1-½") dia. – 112 mm (4-½") thick;
 - .22 low pressure condensate piping, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;
 - .23 low pressure condensate piping, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
 - .24 medium pressure condensate piping, less than 40 mm (1-½") dia. – 40 mm (1-½") thick;
 - .25 medium pressure condensate piping, greater than or equal to 40 mm (1-½") dia. – 50 mm (2") thick;
 - .26 boiler feedwater piping complete – 25 mm (1") thick;
 - .27 boiler blowdown piping complete – 40 mm (1-½") thick;
 - .28 chilled domestic cold water piping from remote water cooler(s) to drinking fountain(s) – 40 mm (1-½") thick;
 - .29 piping indicated to be traced with electric heating cable – minimum 50 mm (2") thick;
 - .30 drum drip(s) in dry zone standpipe and/or sprinkler system piping – 50 mm (2") thick;
 - .31 air compressor set fresh air intake piping – 25 mm (1") thick;
 - .32 heat pump equipment earthloop piping – 25 mm (1") thick.
-
- .2 Secure overlap flap of the sectional insulation jacket tightly in place. Cover section to section butt joints with tape sealant.
 - .3 Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation, secure in place with adhesive and/or wire, and cover with PVC fitting covers.
 - .4 Unless otherwise specified, insulate unions, valves, strainers, and similar piping system accessories in "cold" piping with cut and tightly fitted segments of sectional pipe insulation with joints covered with tape sealant, or, alternatively, wrap piping union, valve, strainer, etc., with blanket mineral fibre and cover with PVC covers as for paragraph above.
 - .5 Terminate sectional insulation approximately 50 mm (2") from flange or coupling on each side of flange or coupling. Cover flange or coupling with a minimum 50 mm (2") thickness of blanket mineral fibre insulation wide enough to butt tightly to ends of adjacent sectional insulation. Secure blanket insulation in place and cover with a purpose made PVC coupling cover.
 - .6 Drum drips in dry zone sprinkler and/or standpipe system piping will be traced with electric heating cable as part of electrical work, and are generally not shown on drawing(s). Confirm number and size of drum drips required with trade providing piping and include for insulation to suit. Wherever possible drum drips will be located in heated areas.
 - .7 Take special care at concealed water rough-in piping at plumbing fixtures to ensure piping is properly insulated. If necessary due to space limitations, use 12 mm (½") thick sectional pipe insulation in lieu of 25 mm (1") thick insulation.

- .8 Insulate seismic restraint hardware such as hanger rods, braces, anchors, etc., directly connected to "cold" category piping and equipment for a distance of 300 mm (12") from piping or equipment with insulation and finish to match pipe or equipment insulation. Coat seismic restraint hardware for a distance of 300 mm (12") from the termination of insulation with Robson Thermal "NO-SWEAT-FX" water based anti-condensation coating.

3.04 Pipe Insulation Requirements – Mineral Wool

- .1 Insulate following pipe inside building and above ground with high temperature mineral wool insulation of thickness indicated:
 - .1 high pressure (above 415 kPa (60 psi)) steam piping, less than 40 mm (1-½") dia. – 100 mm (4") thick;
 - .2 high pressure (above 415 kPa (60 psi)) steam piping, greater than or equal to 40 mm (1-½") dia. – 115 mm (4-½") thick;
 - .3 high pressure condensate piping – 50 mm (2") thick;
 - .4 engine-generator set exhaust system piping – 75 mm (3") thick.
- .2 Generally, install insulation on piping as specified above for mineral fibre insulation.
- .3 Generally, install insulation on fittings as specified above for mineral fibre insulation but cover with canvas, not PVC fitting covers.

3.05 Pipe Insulation Requirements – Flexible Foam Elastomeric

- .1 Install flexible elastomeric pipe insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants, and finish to produce a water-tight installation. Insulate following pipe with flexible elastomeric pipe insulation of thickness indicated:
 - .1 refrigerant piping inside and outside building – 25 mm (1") thick.

3.06 Pipe Insulation Requirements – Closed Cell Foamed Glass

- .1 Install closed cell foamed glass insulation in strict accordance with manufacturer's published instructions to suit the application, and using adhesive, joint sealants, and jacketing to produce a water-tight installation. Insulate following pipe with closed cell foamed glass of thickness indicated:
 - .1 piping located outside building and indicated to be heat traced – minimum 50 mm (2") thick.

3.07 Pipe Insulation Requirements – Fire Rated Insulation

- .1 Where pipe (inside building and above ground) which is to be insulated as specified above penetrates fire rated construction, provide fire-rated, non-combustible sectional insulation on portion of pipe in fire barrier and for a distance of 50 mm (2") on either side of fire barrier. Insulation thickness is to be as specified, but in any case minimum 25 mm (1").

3.08 Installation of Weather-Proof Jacketed Insulation

- .1 Install sectional weather-proof jacketed pipe insulation in strict accordance with manufacturer's instructions to produce a water-tight weather-proof installation. Insulate fittings with blanket type glass fibre insulation of a thickness and insulating value equal to the sectional insulation and secured in place with adhesive and wire. Jacket fittings with manufactured aluminium fitting covers sealed water-tight.

3.09 Installation of Barrier Free Lavatory Insulation Kits

- .1 Provide manufactured insulation kits to cover exposed drainage and water piping under barrier free lavatories.

3.10 Equipment Insulation Requirements – Blanket Type Mineral Fibre

- .1 Insulate following equipment with mineral fibre blanket type insulation of thickness indicated:
 - .1 chilled water and/or domestic cold water pump casings – 40 mm (1-½") thick;
 - .2 roof drain sumps where inside the building – 25 mm (1") thick;
 - .3 water meter(s) – 40 mm (1-½") thick;
 - .4 top of radiant ceiling panels – per manufacturer's recommendation or minimum 50 mm (2") thick, whichever is greater.
- .2 Unless otherwise noted, wrap equipment to a thickness and insulating value equal to an equivalent thickness of rigid sectional pipe insulation. Laminate insulation in place with a full coverage of adhesive and secure with wire. Apply a jacket of insulation vapour barrier material secured in place with adhesive or sealant tape.
- .3 Cover roof drain sumps with purpose made PVC fitting covers.
- .4 Lay fibreglass blanket on radiant ceiling panels after testing is complete.

3.11 Equipment Insulation Requirements – Semi-Rigid Mineral Fibre

- .1 Insulate following equipment with semi-rigid mineral fibre board insulation of thickness indicated:
 - .1 refrigeration machine water chiller(s) and suction elbow(s) – 50 mm (2") thick;
 - .2 uninsulated domestic hot water storage tank(s) – 40 mm (1-½") thick;
 - .3 shell and tube type heat exchangers – 40 mm (1-½") thick;
 - .4 condensate receiver(s) – 40 mm (1-½") thick;
 - .5 flash tanks – 40 mm (1-½") thick;
 - .6 hot well tank – 40 mm (1-½") thick;
 - .7 deaerating feedwater heater – 40 mm (1-½") thick;
 - .8 blow-down tank – 40 mm (1-½") thick;
 - .9 chilled water or chilled glycol solution storage tank – 50 mm (2") thick;
 - .10 heating main air separator – 40 mm (1-½") thick;
 - .11 chilled water expansion tank – 40 mm (1-½") thick.
- .2 Install insulation as required to fit shape and contour of equipment. Secure insulation in place with adhesive, and with aluminum straps on 450 mm (18") centres. Apply a 6 mm (¼") thick skim coat of insulating cement, then, when insulating cement has dried, apply a 6 mm (¼") thick coat of cement trowelled smooth.

- .3 For "cold" equipment, prime insulation with suitable sealer and apply a jacket of glass thread reinforced foil and kraft paper vapour barrier jacket material laminated in place with a full coverage of adhesive.
- .4 Provide removable and replaceable insulated metal covers for equipment with removable heads to permit heads to be removed and replaced without damaging adjacent insulation work.

3.12 Equipment Insulation Requirements – Semi-Rigid Mineral Wool

- .1 Insulate following equipment with calcium silicate equipment insulation of thickness indicated:
 - .1 engine-generator set exhaust system silencer(s) – 75 mm (3") thick;
 - .2 uninsulated boiler breeching where inside the building – 75 mm (3") thick.
- .2 Cut or mitre insulation (or use factory scored type insulation) to fit shape and contour of equipment and secure insulation in place with aluminum straps on 450 mm (18") centres. Point joints, mitres, scores and gaps with insulating cement. Apply a 12 mm (½") thick coat of insulating cement and trowel smooth.

3.13 Equipment Insulation Requirements – Closed Cell Foamed Glass

- .1 Install insulation in strict accordance with manufacturer's published instructions using adhesive, wrap, sealant, etc., to secure insulation in place, to secure and seal joints, and to produce a 100% water-tight installation.

3.14 Equipment Insulation Requirements – Removable/Reusable Type

- .1 Provide custom designed and manufactured removable and reusable insulation covers for following:
 - .1 plate type heat exchanger(s);
 - .2 150 mm (6") dia. and larger piping strainers, backflow preventers, etc.;
 - .3 diesel engine exhaust manifolds;
 - .4 150 mm (6") dia. and larger steam traps and similar equipment.
- .2 Provide "wrap type" removable and reusable insulation covers for "cold" circuit balancing valves, backflow preventers, and similar items, and for steam traps and similar items requiring service in piping less than 150 mm (6") dia.

3.15 Ductwork Insulation Requirements – Mineral Fibre

- .1 Insulate following ductwork systems inside building and above ground with mineral fibre insulation of thickness indicated:
 - .1 Outdoor air and combustion air intake ductwork, casings and plenums from fresh air intakes to and including mixing plenums or sections, or, if mixing plenums or sections are not provided, to first heating coil, or if both mixing plenums or sections and heating coil sections are not provided, and fresh air is not tempered, then the fresh air ductwork system complete – minimum 40 mm (1-½") thick as required;
 - .2 mixed supply air or preheated supply air casings, plenums and sections to and including the fan section where not factory insulated – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .3 supply air ductwork outward from fans, except for supply ductwork exposed in area it serves – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;

- .4 exhaust discharge ductwork for a distance of 3 m (10') downstream (back) from exhaust openings to atmosphere, including any exhaust plenums within the 3 m (10') distance – minimum 25 mm (1") thick rigid board or minimum 40 mm (1-½") thick flexible blanket as required;
 - .5 any other ductwork, casings, plenums, or sections specified or detailed on drawings to be insulated – thickness as specified.
- .2 Provide rigid board type insulation for casings, plenums, and exposed rectangular ductwork. Provide blanket type insulation for round ductwork and concealed rectangular ductwork.
 - .3 Liberally apply adhesive to surfaces of exposed rectangular ducts and/or casings. Accurately and neatly press insulation into adhesive with tightly fitted butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom and side surfaces. Secure and seal joints with 75 mm (3") wide tape sealant. Additional installation requirements as follows:
 - .1 at trapeze hanger locations, install insulation between duct and hanger;
 - .2 provide drywall type metal corner beads on edges of ductwork, casings and plenums in equipment rooms, service corridors, and any other area where insulation is subject to accidental damage, and secure in place with tape sealant.
 - .4 Liberally apply adhesive to surfaces of concealed rectangular or oval ductwork, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Provide pin and washer insulation fasteners at 300 mm (12") centres on bottom surfaces. Secure and seal joints with 75 mm (3") tape sealant. At each trapeze type duct hanger, provide a 100 mm (4") wide full length piece of rigid mineral fibre board insulation between duct and hanger.
 - .5 Accurately cut sections of insulation to fit tightly and completely around exposed and concealed round or oval ductwork. Liberally apply adhesive to surfaces of duct, and wrap insulation around duct with a top butt joint and tight section to section butt joints. Seal joints with tape sealant. At duct hanger locations install insulation between duct and hanger. At each hanger location for concealed ductwork where flexible blanket insulation is used, provide a 100 mm (4") wide full circumference strip of semi-rigid board type duct insulation between duct and hanger.
 - .6 Insulation application requirements common to all types of rigid ductwork are as follows:
 - .1 at duct connection flanges, insulate flanges with neatly cut strips of rigid insulation material secured with adhesive to side surfaces of flange with a top strip to cover exposed edges of the side strips, then butt the flat surface duct insulation up tight to flange insulation, or, alternatively, increase insulation thickness to depth of flange and cover top of flanges with tape sealant;
 - .2 installation of fastener pins and washers is to be concurrent with duct insulation application;
 - .3 cut insulation fastener pins almost flush to washer and cover with neatly cut pieces of tape sealant;
 - .4 accurately and neatly cut and fit insulation at duct accessories such as damper operators (with standoff mounting) and pitot tube access covers;
 - .5 prior to concealment of insulation by either construction finishes or canvas jacket material, patch vapour barrier damage by means of tape sealant.

3.16 Ductwork Insulation Requirements – Flexible Elastomeric

- .1 Insulate exposed exterior ductwork (except outdoor air intake ductwork) and associated plenums and/or casings outside building with minimum 75 mm (3") thick flexible elastomeric sheet insulation as required, applied in 2 minimum 40 mm (1 ½") thick layers with staggered tightly butted joints.

- .2 Install with adhesive in strict accordance with manufacturer's instructions to produce a weather-proof installation. Ensure sheet metal work joints are sealed watertight prior to applying insulation.
- .3 Provide Calcium Silicate insulation between ductwork and duct supports. Tightly butt flexible elastomeric insulation to Calcium Silicate insulation. Cover Calcium Silicate insulation with a continuous sheet of self-adhesive multilayer jacketing which overlaps 75 mm past the Calcium Silicate insulation to the adjacent flexible elastomeric insulation.
- .4 Provide extruded polystyrene tapered insulation between flexible elastomeric insulation and jacketing to allow for water runoff on all exterior duct work.

3.17 Ductwork Insulation Requirements – Calcium Silicate

- .1 Insulate following kitchen exhaust ductwork with minimum 40 mm (1-½") thick calcium silicate block insulation:
 - .1 kitchen exhaust ductwork from exhaust hood to masonry shaft – 2 hour rating;
 - .2 stairwell pressurization ductwork from fan to stairwell – 1 hour rating;
 - .3 Trauma Room and Operating Room supply and exhaust ductwork complete – 1 hour rating.
- .2 Secure insulation in place with adhesive and with wire on 450 mm (18") centres. Point gaps and joints with insulating cement. Where ductwork is exposed, cover insulation with wire mesh secured to wire and with edges laced together and apply a coat of finishing cement trowelled smooth. Use drywall type metal corner bead for duct edges where finishing cement is applied.

3.18 Duct Wrap Requirements – Fire Rated Material

- .1 Provide blanket type fire rated duct wrap system material for following ductwork to produce fire rating indicated:
 - .1 kitchen exhaust ductwork from exhaust hood to masonry shaft – 2 hour rating;
 - .2 stairwell pressurization ductwork from fan to stairwell – 1 hour rating;
 - .3 Trauma Room and Operating Room supply and exhaust ductwork complete – 1 hour rating.
- .2 Install duct wrap material in accordance with ULC design requirements and supplier's/manufacturer's instructions.
- .3 Coordinate installation of duct wrap with installation of ductwork.
- .4 Arrange and pay for duct wrap supplier to examine completed duct wrap system at site. Submit a letter from supplier to certifying duct wrap system has been properly installed.

3.19 Application of Insulating Coatings

- .1 Apply, in accordance with manufacturer's instruction, insulating coatings to following bare metal surfaces:
 - .1 paint bare metal surfaces clear of "cold" piping and/or equipment insulation for a distance of from 300 mm (12") to 600 mm (24") clear of pipe or equipment insulation, with "No Sweat-FX" anti-condensation coating;
 - .2 paint bare metal surfaces associated with mechanical systems with an operating temperature 60°C (140°F) with "ThermaLite" insulating coating.
- .2 Apply coatings with a brush. Remove any splatter or excess coating from adjacent surfaces.

3.20 Insulation Finish Requirements

- .1 Unless otherwise shown and/or specified, jacket exposed mineral fibre insulation, and calcium silicate duct insulation work inside building with canvas secured in place with a full covering coat of lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent uninsulated surfaces.
- .2 Unless otherwise shown or specified, jacket exposed mineral fibre insulation listed below with canvas jacket secured in place with a full covering coat of coloured lagging adhesive. Accurately cut canvas with scissors or a knife. Do not rip or tear canvas to size. Remove lagging adhesive splatter from adjacent surfaces. Insulated services to receive coloured lagging adhesive are as follows:
 - .1 Chilled Water Piping;
 - .2 Chilled Glycol Piping
 - .3 Condenser Water Piping;
 - .4 Domestic Cold Water Piping;
 - .5 Domestic Hot Water Piping;
 - .6 Domestic Hot Water Recirculation Piping;
 - .7 High Temperature Heating Water Piping;
 - .8 High Temperature Heating Glycol Piping;
 - .9 Heating Water Piping;
 - .10 Condensate Drain Piping;
 - .11 Low Pressure Steam Piping;
 - .12 High Pressure Steam Piping;
 - .13 Indoor Ductwork;
- .3 Jacket exposed pipe insulation work inside building with white sheet PVC and fitting covers. Install sheet PVC and fitting covers tightly in place with overlapped circumferential and longitudinal joints arranged to shed water. Seal joints to produce a neat water-tight installation. Provide slip-type expansion joints where required by manufacturer's instructions.
- .4 Install rigid aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket. Provide aluminum jacket for following insulation:
 - .1 Chilled Water Piping;
 - .2 Chilled Glycol Piping
 - .3 Condenser Water Piping;
 - .4 High Temperature Heating Water Piping;
 - .5 High Temperature Heating Glycol Piping;
 - .6 Heating Water Piping;

- .7 Condensate Drain Piping;
- .8 Refrigerant Piping;
- .9 Outdoor Ductwork;
- .5 Install adhesive backed flexible aluminum to cleaned and primed metal surfaces which are between -23°C and 74°C (-10°F and 165°F) in strict accordance with manufacturer's published instructions and details, including shingle type overlap joints to shed water, and use of a hand roller to concentrate pressure on seams. Provide adhesive backed flexible aluminum jacket for following insulation:
 - .1 Chilled Water Piping;
 - .2 Chilled Glycol Piping
 - .3 Condenser Water Piping;
 - .4 High Temperature Heating Water Piping;
 - .5 High Temperature Heating Glycol Piping;
 - .6 Heating Water Piping;
 - .7 Condensate Drain Piping;
 - .8 Refrigerant Piping;
 - .9 Outdoor Ductwork;
- .6 Install rigid stainless steel jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with jacket. Provide stainless steel jacket for following:
 - .1 Chilled Water Piping;
 - .2 Chilled Glycol Piping
 - .3 Condenser Water Piping;
 - .4 High Temperature Heating Water Piping;
 - .5 High Temperature Heating Glycol Piping;
 - .6 Heating Water Piping;
 - .7 Condensate Drain Piping;
 - .8 Refrigerant Piping;
 - .9 Outdoor Ductwork;
- .7 Apply 2 heavy coats of "PITTCOTE 300e" coating with 24 hr between coats to foamed glass insulation exposed above grade.
- .8 Apply 2 coats (with 24 hr between coats) of specified coating to flexible elastomeric insulation outside building.
- .9 Install 3M Ventureclad series 1577CW on insulated ductwork and ensure supports are installed on the outside of the jacketing. Jacketing shall be finished as Aluminum. Provide necessary insulation and

jacketing materials at the time of duct work installation. Do not penetrate jacketing or install jacketing around duct supports. Provide 24GA G90 38 mm x 38 mm steel angle to protect all corners of rectangular ductwork and install between insulation and jacketing. Steel angle shall be continuous on entire duct work run. Provide additional steel angle between jacketing and duct support. Ensure jacketing is continuous with minimum 75 mm (or as required by manufacturer) overlapping on all joints. Provide jacketing on the following duct work:

- .1 Exposed exterior duct work including outdoor air intake duct work, plenums and casings installed outside;
 - .2 Exposed interior insulated duct work;
 - .3 Interior outdoor air intake duct work, plenums, and casings;
 - .4 Single wall plenum casings (intake or exhaust) field insulated;
 - .5 Wherever indicated on drawings;
- .10 Install 3M Ventureclad series 1577CW on exposed piping and ensure supports are installed on the outside of the jacketing. Do not penetrate or install jacketing around pipe supports. Jacketing shall be finished as Aluminum. Provide galvanized insulation shield between insulation and jacketing at support points. Ensure jacketing is continuous with minimum 75 mm (or as required by manufacturer) overlapping on all joints. Provide jacketing on the following piping:
- .1 Chilled water;
 - .2 Chilled glycol;
 - .3 High Temperature Heating Water;
 - .4 High Temperature Heating Glycol;
 - .5 Heating Water;
 - .6 Heating glycol;
 - .7 Low pressure steam (<104 kPa);
 - .8 Low pressure steam (<104 kPa) condensate;
 - .9 Domestic cold water piping;
 - .10 Domestic hot water piping;
 - .11 Coil condensate drain piping;
 - .12 Wherever indicated on drawings.

End of Section

1 General

1.01 Section Includes

- .1 This Section specifies commissioning requirements that are common to Mechanical Divisions work Sections and it is a supplement to each Section and is to be read accordingly. When requirements of this Section contradict requirements of Division 00 or Division 01, conditions of Division 00 or Division 01 to take precedence.

1.02 References

- .1 Refer to commissioning requirements specified in Division 01.

1.03 Commissioning Agent Involvement Versus Warranty Obligations

- .1 Involvement of Commissioning Agent performing duties as described in this Section is not in any way to void or alter any Contractual warranty obligations.

1.04 Submittals

- .1 Submit to Commissioning Agent, at same time as submittal to the Consultant, one copy of each shop drawing or product data sheet associated with equipment or systems to be commissioned.
- .2 Submit for review, a Commissioning Plan with schedule, commissioning procedures for commissioning events, and a copy of Commissioning Agent's commissioning data sheets for equipment/systems to be commissioned.
- .3 Submit a list of commissioning instruments and for each instrument, indicate purpose of instrument and include a recent calibration certificate.
- .4 Submit equipment and system manufacturer's start-up and test report sheets for review a minimum of 1 month prior to equipment and system start-up procedures.

1.05 Closeout Submittals

- .1 After start-up and successful pre-functional performance testing and submittal of completed forms, submit, for each system or subsystem, a letter confirming pre-functional performance testing has been successfully completed and system or subsystem is ready for functional performance testing and commissioning process to commence.

1.06 Definitions

- .1 Commissioning: process of demonstrating to Owner and Consultant, for purpose of final acceptance, by means of successful and documented functional performance testing, that systems and/or subsystems are capable of being operated and maintained to perform in accordance with requirements of Contract Documents, all as further described below.
- .2 Commissioning Agent: commissioning authority who will supervise commissioning process, and who will recommend final acceptance of commissioned mechanical work.
- .3 Start-Up and Adjusting: process of equipment manufacturer's/supplier's technical personnel, with Contractor, starting and operating equipment and systems, making any required adjustments, documenting process, and submitting manufacturer's/supplier's start-up reports to confirm equipment has been properly installed and is operational as intended.
- .4 Pre-Functional Performance Testing: testing, adjusting and operating of components, equipment, systems and/or subsystems, by Contractor, after start-up but before functional performance testing, to confirm components, equipment, systems and/or subsystems operate in accordance with requirements of

Contract Documents, including modes and sequences of control and monitoring, interlocks, and responses to emergency conditions, and including submittal of pre-functional performance testing documentation sheets.

- .5 Functional Performance Testing: a repeat of successful pre-functional performance testing by Contractor, in presence of Commissioning Agent and the Consultant with completed Commissioning Agent's commissioning documentation sheets to document, validate and verify equipment, systems and subsystems are complete in all respects, function correctly, and are ready for acceptance.
- .6 Commissioning Documentation Sheets: prepared sheets for pre-functional performance testing and for functional performance testing supplied by Commissioning Agent for each piece of equipment/system to be commissioned, each sheet or set of sheets complete with Project name and number, date of commissioning, equipment/system involved, equipment/system name and model number, equipment tag in accordance with drawings, and, for each commissioning procedure listed, a column giving expected data in accordance with Contract Documents, a column to fill in observed data during commissioning, and space for signatures of Contractor and Commissioning Agent.
- .7 Systems Operating Manual: a manual prepared by Commissioning Agent to present an overview of building mechanical systems and equipment to be used by building maintenance personnel to assist them in daily operation of systems.
- .8 Validate: to confirm by examination and witnessing tests correctness of equipment and system operation.

1.07 Quality Assurance

- .1 Commissioning work is to be in accordance with requirements of following:
 - .1 CSA Z320, Building Commissioning Standard and Check Sheets;
 - .2 CSA Z8001, Commissioning of Health Care Facilities;
 - .3 ASHRAE Guideline 0, The Commissioning Process;
 - .4 ASHRAE Guideline 1.1, The HVAC Commissioning Process;
 - .5 ASHRAE Guideline 1.2, The Commissioning Process for Existing HVAC&R Systems;
 - .6 ASHRAE Guideline 1.5, Commissioning Smoke Control Systems;
 - .7 Owner designated Commissioning Agent.

1.08 Commissioning Objectives

- .1 Objectives of commissioning process:
 - .1 to support quality management by means of monitoring and checking installation;
 - .2 to verify equipment/system performance by means of commissioning of completed installation;
 - .3 to move completed equipment/systems from "static completion" state to "dynamic" operating state so as to transfer a complete and properly operating installation from Contractor to Owner.

1.09 Testing Equipment

- .1 Supply instruments and test equipment required to conduct start-up, testing and commissioning procedures.

2 Products – Not Used

3 Execution

3.01 Commissioning

- .1 Commission work in accordance with requirements of this Section and as required by Commissioning Agent.
- .2 Prerequisites to successful completion of commissioning:
 - .1 submittal of signed start-up and test reports;
 - .2 completion of system testing, adjusting and balancing (TAB), and acceptance of TAB reports;
 - .3 permanent electrical and control connections of equipment;
 - .4 successful completion and documentation of pre-functional performance testing;
 - .5 submittal of letters to the Consultant certifying systems and subsystems have been started, tested, adjusted, successfully pre-functional performance tested, are ready for functional performance testing, and are in accordance with requirements of Contract Documents.

3.02 Phasing of Commissioning

- .1 If Project will be constructed in phases, phase commissioning accordingly to suit progress and phases of Work.

3.03 Deficiencies Listed During Commissioning

- .1 Correct deficiencies listed by the Consultant and Commissioning Agent during commissioning process within 15 calendar days of notification unless agreed otherwise with the Consultant, and when deficiencies have been corrected, notify the Consultant and Commissioning Agent immediately.

3.04 Systems to be Commissioned

- .1 Mechanical systems to be commissioned include, but are not to be limited to, systems described below. Specific commissioning procedures are to be as directed by Commissioning Agent.
- .2 Commissioning of drainage systems includes:
 - .1 commissioning of drainage pumps and controls by means of tests recommended by manufacturer to confirm proper operation and performance;
 - .2 commissioning of equipment such as interceptors and backflow preventers.
- .3 Commissioning of fire protection systems will be considered complete upon preparation and submittal by Contractor of completion certificates required by applicable NFPA Standards, demonstration of proper system operation to local Fire Chief and any other authorities, including Owner's insurance underwriter as required, and coordination and cooperation with fire alarm system commissioning procedures, in particular smoke control systems and other such fan system control sequences.
- .4 Commissioning of water systems (all piping extended from Municipal main) includes:
 - .1 commissioning of pumps and controls;
 - .2 commissioning of water heaters;

- .3 commissioning of piping specialties such as backflow preventers, mixing valves, and similar components;
- .4 commissioning of trap seal primer units, including adjustment of water flows and confirmation of water flow at each connected trap;
- .5 commissioning of plumbing fixtures.
- .5 Commissioning of swimming pool systems includes pool piping and fittings, pumping equipment and controls, filtering equipment, and chemical treatment equipment, as well as any specialized equipment for pool area such as dehumidifiers.
- .6 Commissioning of laboratory systems includes piping, fittings including bench work fittings, and associated equipment including special ventilation systems.
- .7 Commissioning of compressed air system includes "head end" compressor equipment, pressure reducing equipment, and outlets.
- .8 Commissioning of natural gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.1, and any supplemental requirements of governing authorities.
- .9 Commissioning of propane gas system includes pressure regulating equipment. Perform commissioning in accordance with requirements of CAN/CSA B149.2, and any supplemental requirements of governing authorities.
- .10 Perform commissioning of fuel oil system in accordance with requirements of CAN/CSA B139.
- .11 Commissioning of heating systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during heating season, a follow-up site visit during heating season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .12 Commissioning of cooling systems includes piping, piping specialties, equipment, and control, as well as checking and validating temperature and flow documentation contained in TAB reports. If TAB is not done during cooling season, a follow-up site visit during cooling season will be required to confirm proper flows and temperatures, and any required system "fine tuning".
- .13 Commissioning of HVAC chemical treatment systems includes feed and monitoring equipment, and testing of system fluids to confirm proper concentration of chemical.
- .14 Commissioning of air handling systems includes equipment, ductwork, ductwork specialties, controls, interlocks, and checking and validating air capacities and flows in accordance with TAB reports.
- .15 Control work commissioning includes confirmation of proper operation of individual control components, and overall operation of controls in conjunction with operation of connected building systems, including heating season/cooling season testing requirements specified above.
- .16 Commissioning of BAS includes confirmation of proper operation of components, input/output points, hardware and software, and demonstration of system performing required procedures.
- .17 Commissioning of special usage room controls includes confirmation of proper operation of individual components, and proper operation of overall control system, all in accordance with governing Codes and Standards.
- .18 Commissioning of noise and vibration control equipment includes noise and vibration measurements to confirm proper operation of equipment.

3.05 Commissioning Process

- .1 Perform commissioning process in stages and include, but not be limited to, following:
 - .1 Stage 1: Commissioning of equipment/systems as listed in this Section, which is a prerequisite to an application for Substantial Performance of the Work and includes supervising and validating results of functional performance testing, and submittal of reviewed Systems Operating Manual.
 - .2 Stage 2: Commissioning work performed 12 months after issue of a Certificate of Substantial Performance and which includes supervision of Contractor's "fine tuning" of equipment/systems through seasonal occupancy, and any other such work to achieve optimal comfort and performance conditions.
 - .3 Stage 3: Successful completion of satisfactory equipment/system operation during 1st month after issue of a Certificate of Total Performance of the Work.
 - .4 Stage 4: Successful completion of satisfactory equipment/system operation during 3rd month after issue of a Certificate of Total Performance of the Work.
 - .5 Stage 5: Successful seasonal commissioning of building.

3.06 Responsibilities of Contractor

- .1 During construction phase, Contractor is to:
 - .1 prepare and submit an installation schedule which includes a time schedule for each activity with lead and lag time allowed and indicated, shop drawing and working detail drawing submissions, and major equipment factory testing and delivery dates;
 - .2 prepare and submit a commissioning schedule which is to include a time schedule coordinated with installation schedule referred to above and Commissioning Agent, and allowances for additional time for re-tests as may be required, and update schedule on a monthly basis as required;
 - .3 when requested by Commissioning Agent, arrange site commissioning meetings with Owner, the Consultant, and applicable subcontractors present, to be chaired by Commissioning Agent who will also prepare and distribute meeting minutes;
 - .4 promptly correct reported deficient work, and report when corrective work is complete;
 - .5 where required by Codes and/or Specification, retain equipment manufacturers/suppliers or independent 3rd parties to certify correct installation of equipment/systems;
 - .6 under supervision of equipment manufacturers/suppliers, start-up and adjust equipment to design requirements, and submit start-up sheets which include equipment data such as manufacturer and model number, serial number where applicable, and performance parameters, all signed by equipment manufacturer/supplier and Contractor;
 - .7 complete Commissioning Agent's commissioning data sheets for multiple items of smaller equipment such as air terminal boxes, fan coil units, backflow preventers, etc., submit sheets to Commissioning Agent, accompany Commissioning Agent for an on-site check of 30% of data sheet information for each type of equipment, and perform any corrective action required as a result of site checks;
 - .8 perform system testing, adjusting and balancing and, when complete, issue a copy of final report to Commissioning Agent for review and a site check of results, and perform any corrective work required as a result of site checks by Commissioning Agent;

- .9 in accordance with updated commissioning schedule and actual progress at site, certify in writing to the Consultant and Commissioning Agent that equipment and/or systems are complete, have been checked, started and adjusted, successfully pre-functional performance tested and documented, and are ready for functional performance testing and commissioning procedures, giving the Consultant and Commissioning Agent a minimum of 5 working days' notice;
- .10 perform system and subsystem functional performance testing under supervision of Commissioning Agent, and submit to the Consultant and Commissioning Agent, completed and signed functional performance testing and commissioning data sheets (issued by Commissioning Agent) and also signed by Commissioning Agent.
- .2 During post construction phase, Contractor is to:
 - .1 optimize system operation in accordance with building occupant's needs and comments using System Operation Manual prepared by Commissioning Agent as reference;
 - .2 complete commissioning procedures, activities, and performance verification procedures that were delayed or not concluded during construction phase;
 - .3 accompanied by Commissioning Agent, complete system checks and "fine tuning" with signed documentation as follows:
 - .1 once during 1st month of building operation;
 - .2 once during 3rd month of building operation;
 - .3 once between 4th and 10th months in a season opposite to 1st and 3rd month visits.
 - .4 correct deficiencies revealed by system checks described above, and, where required, involve equipment manufacturers/suppliers during corrective actions, and report completion of corrective work;
 - .5 3 months after Substantial Completion conduct a question and answer session(s) at building with Owner's operating and maintenance personnel, with duration of session(s) dictated by number of questions and concerns that have to be addressed.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets to regulatory authority for review and approval prior to submitting to the Consultant. Conform to following requirements:
 - .1 submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings;
 - .2 sprinklers shall be referred to on drawings and product submittals, and be specifically identified by the manufacturer's listed model or series designation. Trade names and other abbreviated listings are not allowed;
 - .3 submit complete CAD layout drawings indicating source of water supply with test flow and pressure, "head-end" equipment piping schematic, pipe routing and sizing, and zones, all signed and sealed by a qualified professional mechanical engineer registered in jurisdiction of the work as specified below;
 - .4 submit copies of all calculations, including hydraulic calculations, stamped and signed by same engineer who signs layout drawings, and a listing of all design data used in preparing the calculations, system layout and sizing, including occupancy-hazard design requirements;
 - .5 in addition to submitting shop drawings to regulatory authority as specified above, shop drawings must be approved by Owner's insurer prior to being submitted to the Consultant for review.

1.02 Closeout Submittals

- .1 Submit a complete sprinkler system test certificate as specified in Part 3 of this Section.

1.03 Spare Parts

- .1 Fill spare sprinkler head cabinet complete with spare heads.

1.04 Quality Assurance

- .1 Fire protection sprinkler system work is to be in accordance with following Codes and Standards:
 - .1 NFPA 13-2019, Standard for the Installation of Sprinkler Systems;
 - .2 CSA B137.2, Polyvinylchloride (PVC) Injection-Moulded Gasketed Fittings for Pressure Applications;
 - .3 CSA B137.3, Rigid Polyvinylchloride (PVC) Pipe for Pressure Applications;
 - .4 ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless;
 - .5 ASTM A135, Standard Specification for Electric-Resistance-Welded Steel Pipe;
 - .6 ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service;
 - .7 ASTM A536, Standard Specification for Ductile Castings;
 - .8 ASTM A795, Standard Specification for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use;
 - .9 ANSI/ASME B16.4, Grey Iron Threaded Fittings (Classes 125 and 250);

- .10 CAN/CSA B64.10, Backflow Preventers and Vacuum Breakers.
- .2 Fire protection sprinkler work is to be performed by a sprinkler company who is a member in good standing of the Canadian Automatic Sprinkler Association. Site personnel are to be licensed in jurisdiction of the work and under the continuous supervision of a foreman who is an experienced fire protection system installer and a journeyman pipe fitter licensed in jurisdiction of the work.
- .3 Check and verify dimensions and conditions at site and ensure work can be performed as indicated. Coordinate work with trades at site and accept responsibility for and cost of making adjustments to piping and/or spacing to avoid interference with other building components.
- .4 Verify working condition of existing sprinkler system equipment which has direct interface with project work and is to remain. Replace with new equipment where necessary.
- .5 System components must be ULC listed and labelled.
- .6 All grooved couplings, and fittings, valves and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- .7 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.05 Design Requirements

- .1 Fire protection sprinkler work is to be designed in accordance with NFPA 13 and Provincial Standards, and, where required, local building and fire department requirements and standards of Owner's Insurer. If water supply flow and pressure test data is not available, conduct Municipal main water flow and pressure tests at nearest fire hydrant to obtain criteria to be used in system design. Include hydrant location and flow and pressure test data with system design calculations.
- .2 Include for a qualified mechanical professional engineer registered and licensed in the jurisdiction of the work to design the fire protection standpipe work. For requirements regarding Contractor retained engineers, refer to Section 20 05 10 – Mechanical Work General Instructions.
- .3 Sprinkler /System Occupancy – Hazard Design requirements: In accordance with NFPA 13 occupancy-hazard density requirements, unless otherwise specified.

2 Products

2.01 Pipe, Fittings, and Joints

- .1 Pipe, fittings, and joints are to be as follows, with exceptions as specified in Part 3 of this Section:
 - .1 PVC
 - .1 Class 200, DR14, rigid, hub and spigot pattern PVC pipe and CSA certified fittings to CAN/CSA B137.2 and B137.3 and complete with gasketed joints.
 - .2 Schedule 40 Steel – Grooved Coupling Joints
 - .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and mechanical fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints. Strap type outlet fittings such as Victaulic "Snap-Let" are not acceptable.
 - .3 Schedule 40 Steel – Screwed and Welded Joints

- .1 Schedule 40 mild black carbon steel, ASTM A53, Grade B. Screwed piping complete with Class 125 cast iron screwed fittings to ANSI/ASME B16.4. Welded piping complete with factory made seamless carbon steel butt welding fittings to ASTM A234, Grade WPB, long sweep pattern wherever possible.
- .4 Schedule 10 Steel – Grooved Coupling Joints
 - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with grooved ends and fittings and couplings equal to Victaulic "FireLock" fittings and Victaulic Style 009N, 107H, and 107N QuickVic and 005 rigid coupling joints.
- .5 Schedule 10 Steel – Screwed Joints
 - .1 Schedule 10 mild black carbon steel, ASTM A53, Grade B, complete with mill or site threaded ends, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
- .6 "Lightwall" Steel – Grooved Coupling Joints
 - .1 Commercial quality. "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, complete with a galvanized exterior, grooved ends, and fittings and couplings equal to Victaulic "Fire Lock" grooved fittings and Victaulic Style 009N QuickVic or 005 rigid coupling joints.
- .7 "Lightwall" Steel – Screwed Joints
 - .1 Commercial quality, "Lightwall" rolled mild carbon steel pipe to ASTM A135, Grade A, ULC listed, mill or site threaded, complete with galvanized exterior, Class 125 cast iron screwed fittings to ANSI/ASME B16.4, and screwed joints.
- .8 Flexible Pipe – Equal to Victaulic "VicFlex"
 - .1 The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel 1" NPT Male threaded nipple for connection to branch-line piping, and a zinc plated steel reducer with a 1/2" or 3/4" NPT female thread for connection to the sprinkler head.
 - .2 Option: Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.
 - .3 The drop shall include a cULus/FM approved Series AH2 braided hose with a bend radius to 2" to allow for proper installation in confined spaces.
 - .4 The hose shall be listed for:
 - .1 (4) bends at 31" length;
 - .2 (5) bends at 36" length;
 - .3 (8) bends at 48" length;
 - .4 (10) bends at 60" length;
 - .5 (12) bends at 72" length.
 - .5 Union joints shall be provided for; ease of installation, prevention of hose torque stresses and on site changing of factory 5.75" straight reducing nipple in reduced spaces under

obstructions (optional reducing nipples; 4.83" or 6.57" reducing 90 and 9" or 13" straight reducer x ½ or ¾" outlet) All VicFlex assemblies and related accessories to be installed as per the guidelines and listings in Victaulic submittal 10.85.

- .6 On T Bar ceiling grid with drop in tile application, the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 bracket. The bracket shall allow installation before the ceiling tile is in place.
 - .7 On T Bar ceiling grid designed for hard lid drywall application; the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB2 bracket. The bracket shall allow for the vertical adjustment of the reducer/head from below the drywall, post drywall installation.
 - .8 On Hat Furring Channel grid with hard lid drywall application; the flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB4 bracket. The bracket shall allow for the vertical adjustment of the reducer/head from below the drywall, post drywall installation.
 - .9 The braided drop system shall be cULus listed and FM Approved for sprinkler services to 175 psi (1206 kPa).
 - .10 For dry sprinkler heads Victaulic VicFlex dry sprinkler model VS1. The sprinkler shall provide a vertical or horizontal flexible connection with a bend radius to 2", and allow for up to 4 bends. The sprinkler body shall be die cast brass with brass deflector, supplied finished to match application and to architectural direction, and glass bulb with glycerin solution. The product shall consist of a braided type 300 stainless steel flexible hose with a swivel type branch line threaded connection, EPDM gasket seal, with PTFE-coated Beryllium Nickel and stainless-steel spring-seal assembly. The bracket shall be open gate or metal strap to provide for sprinkler placement and alignment. The flexible dry sprinkler and bracket system is UL listed for sprinkler services to 175 psi.
- .9 Copper – Solder Joint
- .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints.
- .10 CPVC Pipe
- .1 Equal to IPEX BlazeMaster solvent weld, orange, SDR 13.5 pipe and Schedule 80 fittings, ULC listed for use in wet pipe automatic sprinkler systems, with a flame spread rating less than 25 and a smoke developed rating less than 50 when tested in accordance with CAN/ULC S102.2, and in accordance with NFPA 13 requirements.
 - .2 Victaulic Standard Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183. Couplings shall comply with ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
 - .3 Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with NFPA 13. Couplings shall be fully installed at visual pad-to-pad offset contact. Couplings that require exact gapping of bolt pads at specific torque ratings are not permitted.

- .4 Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 177 (Quick-Vic), Installation ready flexible coupling.

2.02 Service Main Double Check Valve Assemblies

- .1 Minimum 1205 kPa (175 psi) rated dual check valve backflow preventer assembly to CAN/CSA B64, complete with tight-closing resilient seated shut-off valves, test cocks and strainer.
- .2 Manufacturers:
 - .1 Watts Industries Canada;
 - .2 Zurn/Wilkins;
 - .3 Apollo Valves (Conbraco Industries).

2.03 Shut-Off Valves

- .1 Minimum 2070 kPa (300 psi) rated full port brass or bronze body screwed ball valves and lug body or grooved end type butterfly valves.
- .2 Butterfly valves shall include a pressure responsive seat, and the stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating.
- .3 Basis of Design: Victaulic Style 705.
- .4 OS&Y Gate Valves: 1725 kPa (250 psi), grooved ends. Ductile iron body, yoke, and handwheel conforming to ASTM A-536; EPDM coated ASTM A-126-B cast iron disc; ASTM B16 brass rising stem; flanged and epoxy coated ductile iron bonnet; EPDM O-ring stem seals and body gasket. Victaulic Series 771H (Grooved ends) and Series 771F (Grooved x Flanged).
- .5 Supervised closed applications:
 - .1 Basis of Design: Victaulic Series 707C supervised closed butterfly valve.

2.04 Check Valves

- .1 Minimum 1725 kPa (250 psi) resilient seat check valves, suitable for vertical or horizontal installations.
- .2 Basis of Design: Victaulic Series 717.
- .3 Check valves associated with Fire Department connections and fire pump test connection are to be tapped for site installation of a 20 mm (¾") diameter ball drip.

2.05 Ball Drips

- .1 Equal to National Fire Equipment Ltd. Model #A58, 20 mm (¾") diameter automatic ball drip.

2.06 Shut-Off Valve Supervisory Switches

- .1 Tamper-proof supervisory switches, each arranged to activate a fire alarm system trouble alarm condition if the valve is closed or tampered with, each suitable in all respects for the application, and each complete with all required mounting and connection hardware.
- .2 Actuator housings shall be weatherproof.

2.07 Fire Department Connections

- .1 Wall mounting polished brass clapper type dual inlet Fire Department connection with two 65 mm (2-½") diameter inlets threaded to Fire Department hose requirements and equipped with caps and chains, an outlet sized as shown, and a faceplate.
- .2 Faceplate is to be polished brass and complete with "AUTO-SPKR" "STANDPIPE" cast-in raised lettering.
- .3 Exposed metal parts of Fire Department connection are to be chrome plated.
- .4 At the low point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing.
- .5 Basis of Design: Victaulic #10-DR.

2.08 Sprinkler Main "Loss of Pressure" Alarm Sensors

- .1 Piping mounted adjustable pressure sensor designed to actuate an alarm upon sensing a loss of pressure in the fire protection main. Switch is to be low voltage or line voltage as required.

2.09 Water Flow Alarm Switches

- .1 Pipe mounting water flow alarm switch, minimum 1725 kPa (250 psi) rated, designed to actuate two 7 A rated (at 125/250 VAC) SPDT snap action switches when water flow exceeds 0.758 L/sec. (10 Imp gpm), complete with a tamper-proof cover with conduit connection opening, a piping saddle and U-bolt, and an automatic reset pneumatic retard device with field adjustable (0 to 70 second) switch actuation delay to reduce false alarms caused by a single or series of transient water flow surges.

2.10 Dry Pipe Valves

- .1 Equal to a Victaulic Series 768-NXT:
 - .1 Series 746-LPA accelerator quick opening device;
 - .2 Series 757 regulated air maintenance trim assembly;
 - .3 Required air pressure shall be 90 kPa (13 psig);
 - .4 The valve shall be externally resettable;
 - .5 Provide valve complete with internal components that are replaceable without removing valve from installed position;
 - .6 Systems requiring a quick opening device must use a regulated, tank mounted air supply;
 - .7 Series 757 Regulated Air Maintenance Trim Assembly.

2.11 Dry Pipe Zone Air Compressor

- .1 Equal to a Victaulic 7C7 CSA certified, oil-less, piston type direct driven compressor with a motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, and a mounting bracket.
- .2 Equal to General Air Products OLT Series, package type, oil-free, piston type, tank mounted air compressor set complete with horizontal, ASME rated and stamped steel tank with support feet, pressure gauge with gauge cock, tank drain, flexible compressor to tank and tank to piping flexible connections supplied loose for field installation, and a motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical.

- .3 Compressor set capacity and performance must suit final dry pipe system design and reviewed piping and sprinkler head layout shop drawings. If a larger compressor set than that specified is required, provide larger set at no additional cost, and include any additional costs for a larger size motor starter and associated wiring.

2.12 Zone Control Riser Modules

- .1 Equal to Victaulic Co. "Series UM" factory assembled zone control riser modules, each complete with a painted cast ductile iron grooved end body, a ball type shut-off valve, a test and drain combination with properly sized orifice, a flow alarm switch, a pressure gauge with cock, and a pressure relief valve kit.
- .2 Zone flow test and drain assembly cabinets are to be equal to National Fire Equipment Ltd. Model CV-200 recessed cold rolled steel cabinets, sized to suit assemblies, with a baked enamel finish, 18 gauge with universal knockouts for tubs, 14 gauge for doors and trim, with all metal edges ground and rounded. Doors are to be complete with:
 - .1 hollow channel reinforcement;
 - .2 full length semi-concealed piano hinge with paint stop feature and designed to permit 180° door opening;
 - .3 flush stainless steel door latch.

2.13 Sprinkler Heads

- .1 Sprinkler heads, unless otherwise specified, are to be as scheduled in Part 3 of this Section.
- .2 Sprinkler body shall be die-cast, with a hex-shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss.
- .3 For locations where corrosive resistant coatings are required, body shall be coated with UL listed and FM approved anti-corrosion VC-250 coating (silver coloring).
- .4 Provide quick response sprinkler heads unless standard response required to suit the hazard class.
- .5 Recessed sprinkler heads in finished areas are to be chrome plated unless otherwise specified. Concealed sprinkler head ceiling plates are to match ceiling colour.
- .6 Where exposed pendent heads occur in areas with suspended ceilings, they are to be complete with chrome plated escutcheon plates. Similarly, sidewall heads with concealed piping are to be complete with chrome plated escutcheon plates.
- .7 Sprinkler heads which are exposed in areas where they may be subject to damage are to be complete with wire guards, chrome plated where in finished areas.
- .8 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
- .9 Sprinkler heads located in areas or over equipment where high ambient temperature is present are to be, unless otherwise specified, 74°C (165°F) heads. All other heads, unless otherwise specified or required, are to be 57°C (135°F) rated.
- .10 Manufacturers:
 - .1 The Reliable Automatic Sprinkler Co;
 - .2 The Viking Corporation;

- .3 Tyco Fire Suppression & Building Products;
- .4 Victaulic Co.

2.14 Spare Sprinkler Head Cabinets

- .1 Surface wall mounting, red enamelled steel, identified cabinet with hinged door, shelves with holes for mounting sprinkler heads, a wrench or wrenches suitable for each type of sprinkler head, and a full complement of spare sprinkler heads.
- .2 Cabinet is to be sized to accommodate a minimum of 4 spare heads for each type of head used on the project, however, each cabinet is to be full of spare heads.

2.15 Indicator Post and Valves

- .1 Cast iron, bronze trim, resilient seat, OS&Y gate valve with non-rising stem in accordance with AWWA 200W, minimum 1380 kPa (200 psi) cold water rated and complete with a square operating nut and ends to suit connecting piping.
- .2 Adjustable indicator post assembly with a cast iron valve box of a length to suit valve depth and flange bolted to the valve, a cast iron lower barrel bolted to the valve box and of a length to suit valve location, and a cast iron upper housing bolted to the lower barrel and complete with wrench and operating mechanism with steel extension shaft and coupling nut sized to suit, operating handle, and valve "OPEN" and "CLOSED" identification visible through a clear polycarbonate window.

3 Execution

3.01 Monitoring of Systems

- .1 Daily monitor and supervise existing sprinkler system serving renovated areas to ensure that each respective system is left in proper operating condition at end of each working day. Include for but not be limited to performing following:
 - .1 Under presence of Owner's representative, check each morning and evening (start and end of work) of each day, sprinkler system to ensure that it is in proper working condition;
 - .2 If portions of sprinkler system is not in proper working order, provide temporary provisions subject to approval of local fire authority or local governing authority, to ensure that proper sprinkler coverage is provided and/or provide supervisory personnel to monitor areas where sprinkler system is not operational;
 - .3 Document and sign off with Owner's representative signing off also, each respective daily check condition;
 - .4 Ensure that work to sprinkler system does not affect portion of system serving areas outside of renovation areas.

3.02 Demolition

- .1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.03 Piping Installation Requirements

- .1 Provide required sprinkler system piping.
- .2 Perform piping work in accordance with requirements of NFPA 13, governing regulations, and "Reviewed" shop drawings.

- .3 Piping, unless otherwise specified, is as follows:
 - .1 for underground piping inside or outside building – Class 200, DR14 rigid PVC, braced and secured at bends and tees with concrete blocks in accordance with Municipal standards and details;
 - .2 for piping inside building and above ground except as noted below – Schedule 40 grooved end black steel with Victaulic or equal fittings and coupling joints, or, for piping to and including 50 mm (2") diameter, screwed fittings and joints, or, for piping 65 mm (2-½") diameter and larger, welding fittings and welded joints;
 - .3 for wet system piping inside building and above ground – at your option, CPVC sprinkler pipe and fittings;
 - .4 for piping downstream of "head end" zone control riser modules and equipment – Schedule 10 or "Lightwall" black steel pipe with Victaulic or equal fittings and coupling joints or screwed fittings and joints;
 - .5 for branch piping to heads in suspended ceilings, etc. – at your option, flexible piping installed in accordance with manufacturer's instructions;
- .4 Exceptions to piping requirements specified above are as follows:
 - .1 dry pipe zone steel piping, fittings, unions, couplings and flanges are to be galvanized;
 - .2 wet zone steel piping, fittings, unions, couplings and flanges for sprinkler work exposed to weather either inside or outside building (including parking garages), are to be galvanized;
 - .3 PVC piping is not to be used above grade;
 - .4 ferrous pipe hangers, supports, and similar hardware used for galvanized steel piping are to be electro-galvanized.
- .5 Pipe sizes, pipe routing, sprinkler head quantities and locations, and layout of work shown on drawings are to assist during the tendering period. Ensure adequate head coverage, head quantities and pipe sizing as specified in Part 1 of this Section. Do not reduce size of sprinkler main or re-route the main unless approved by consultant.
- .6 Pipe, fittings, couplings, flanges and similar components are to be clean after erection is complete. Wire brush clean any ferrous pipe, fitting, coupling, flange, hanger, support and similar component which exhibits rust and carefully coat with suitably coloured primer.
- .7 Where sprinklers are not protected by a dry system and may be subject to freezing, provide non-freeze, glycol-water solution filled sprinkler piping. Install piping complete with a CSA certified reduced pressure backflow preventer, valves, and glycol solution fill facilities in accordance with requirements of Chapter 3 of NFPA 13. Fill piping with a solution of 50% Union Carbide Canada Ltd. "UCAR THERMO-FLUID 17" or Dow Chemical Co. "Dowtherm SR1" propylene glycol with corrosion inhibitors, and 50% clean water. Prior to filling piping, check the specific gravity of the solution using a hydrometer with proper scale. Specific gravity is to be approximately 1.069 at 15.6°C.
- .8 When sprinkler work is complete, test system components and overall system(s) and submit completed test certificate and other documentation in accordance with Chapter 8 of NFPA 13.
- .9 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks. Gaskets shall be molded and produced by the coupling manufacturer and shall be verified as suitable for the intended service. A factory-trained field representative of the mechanical joint manufacturer shall provide

on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review the product installation and ensure best practices are being followed. Contractor shall remove and replace any improperly installed products.

3.04 Installation of Double Check Valve Assembly

- .1 Provide a double check valve assembly in sprinkler main inside the building.
- .2 Equip assembly with inlet and outlet shut-off valves with supervisory switches as specified below.
- .3 Support each end of assembly from floor by means of flanged pipe supports with saddles.

3.05 Installation of Shut-Off Valves and Check Valves

- .1 Provide shut-off valves and check valves in piping where shown and wherever else required.
- .2 Locate valves for easy operation and maintenance.
- .3 Confirm exact locations prior to roughing-in.

3.06 Installation of Shut-Off Valve Supervisory Switches

- .1 Equip each shut-off valve with a supervisory switch.
- .2 Identify each supervised valve with a 150 mm (6") square, engraved, laminated red-white plastic tag to correspond with supervised valve numbering specified and/or shown as part of the electrical work fire alarm system.

3.07 Installation of Fire Department Connection

- .1 Provide an exterior Fire Department connection. Confirm exact location prior to roughing-in. Confirm finish prior to ordering.
- .2 Equip connection with a check valve. Equip check valve with a ball drip to drain piping between Fire Department connection and check valve, and extend drainage piping from outlet of ball drip to nearest suitable floor drain.

3.08 Installation of Loss of Pressure Sensor

- .1 Supply and mount a pressure sensor in the fire protection piping main to activate a "LOSS OF PRESSURE" trouble alarm should Municipal water service pressure fall below the acceptable level.
- .2 Locate sensor for easy access and maintenance, and set alarm pressure to suit site conditions. Confirm setting on site.
- .3 Identify pressure sensor and its normal setting with a 150 mm (6") square red-white laminated plastic tag engraved to read "LOSS OF WATER PRESSURE SENSOR - NORMAL SETTING 210 kPa". Confirm wording prior to engraving.

3.09 Installation of Flow Alarm Switches

- .1 Provide water flow alarm switches in accessible locations in zone piping.
- .2 Adjust to suit site water pressure conditions. Check and test operation.
- .3 Identify each switch with a 150 mm (6") square red-white laminated engraved plastic tag. Confirm wording prior to engraving.

3.10 Installation of Dry Pipe Valves

- .1 Provide dry pipe valves for zones.
- .2 Connect compressed air piping to each valve, as well as all compressed air piping trim.
- .3 When installation is complete, check and test valve operation and adjust as required.
- .4 Provide drum drips in dry type fire protection sprinkler zone piping where shown or required. Wherever possible locate drum drips in heated areas. Where drum drips are in unheated areas ensure trades performing thermal insulation work and electric heating cable pipe tracing work are aware of the number of drum drips required, and the size and location. Identify each drum drip. Locate drum drips in heated areas wherever possible.

3.11 Installation of Dry Zone Air Compressors

- .1 Provide an air compressor with air maintenance device and pressure control for the dry pipe zone and dry pipe valve. Secure compressor to a piping main by means of a mounting bracket supplied with compressor. Adjust to suit site conditions.
- .2 Provide an air compressor set with receiver and secure in place on rubber-steel-rubber vibration isolation pads on a concrete housekeeping pad.
- .3 Install flexible piping connections supplied loose with set.
- .4 Extend valved drain piping from receiver to a floor drain.
- .5 Connect receiver and control panel pressure switch with copper tubing.
- .6 When installation is complete, check and test air compressor set, including automatic operation, and adjust as required.

3.12 Installation of Zone Control Riser Modules

- .1 Provide zone control riser modules with drain piping where required. Terminate drainage piping over a funnel floor drain unless otherwise shown or specified. Identify each assembly.

3.13 Installation of Zone Control Riser Module Cabinets

- .1 Provide flush wall mounting cabinets for zone control and inspector’s test connection assemblies where required in finished areas. Confirm exact locations prior to roughing-in.
- .2 Identify each cabinet with a nameplate in accordance with requirements of Section 20 05 00 – Common Work Results for Mechanical.

3.14 Installation of Sprinkler Heads

- .1 Provide required sprinkler heads in accordance with following schedule:

Application	Sprinkler Head Type
Rooms/areas with a suspended ceiling	Victaulic V38/V39 or Tyco Series RFII "Royal Flush II" concealed pendent Victaulic V27 or Tyco Series TY-FRB recessed pendent Victaulic V27 or Tyco Series TY-FRB pendent with escutcheon plates

Application	Sprinkler Head Type
Rooms/areas without a suspended ceiling	Victaulic V27 or Tyco Series TY-FRB upright
Elevator shafts	Victaulic V27 or Tyco Series TY-FRB horizontal sidewall
Unheated exterior stairwells	Victaulic V36 or Tyco Series DS-1 dry pipe horizontal sidewall Victaulic V36 or Tyco Series DS-3 wet pipe horizontal sidewall
Air handling system outdoor air and relief air plenums (unheated)	Tyco Series DS-3 ECOH dry horizontal sidewalls in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe
Unheated and unfinished areas	Victaulic V36 or Tyco Series DS-3 ECOH dry horizontal sidewall in wet piping Victaulic V27 or Tyco Series TY-FRB upright or horizontal sidewall in dry pipe
Heated areas with overhead doors	Victaulic V27 or Tyco Series TY-FRB horizontal sidewall
At non-rated windows in rated walls	Tyco Model WS horizontal and pendent vertical sidewall

- .2 Sprinkler head manufacturers indicated on schedule are for type indication purposes. Manufacturers are listed in Part 2 of this Section.
- .3 Coordinate sprinkler head locations with all drawings, including architectural reflected ceiling plan drawings, and, where applicable, electrical drawings. Coordinate sprinkler head locations in areas with suspended ceilings with the location of lighting, grilles, diffusers, and similar items recessed in or surface mounted on the ceiling as per the reflected ceiling plans. In areas with lay-in tile, centre the sprinkler head both ways in the lay-in tile wherever possible. Confirm locations prior to roughing-in.
- .4 Maintain maximum headroom in areas with no ceilings.
- .5 Provide guards for heads where they are subject to damage.
- .6 Provide high temperature heads in equipment rooms and similar areas over heat producing or generating equipment.

3.15 Installation of Spare Sprinkler Head Cabinets

- .1 Supply a full complement (to fill cabinet) of spare sprinkler heads of types used (minimum 4 of each type) and place in a wall mounting storage cabinet located adjacent to sprinkler system "head end" equipment where later directed.

3.16 Installation of Indicator Post Valves

- .1 Provide a shut-off valve in underground sprinkler main piping outside building. Equip valve with a valve box and an indicator post assembly.
- .2 Confirm valve box length and steel shaft length prior to ordering and confirm exact location prior to roughing-in.

- .3 When installation is complete, check and test operation of assembly and adjusts as required.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this section except pipe and fittings.

1.02 Closeout Submittals

- .1 Submit a copy of the plumbing inspection certificate prior to application for Substantial Performance of the Work.
- .2 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.
- .3 Record Documentation
 - .1 Retain services of a land surveyor, registered in jurisdiction of the work, to maintain an accurate record of all underground site services. Surveyor is to measure, verify and record size, location, invert elevation, pipe material, and slope of site service piping and connected products on site.
 - .2 When site services work is complete, surveyor is to prepare an original signed and sealed drawing, using same size and format as Contract Drawings, indicating all site services as-built information. Submit a copy of drawing to the Consultant. Include this drawing with Contract as-built record drawings.

1.03 Soils Test Report

- .1 Carefully examine soils test report and include for requirements applicable as a result of the report.

2 Products

2.01 Pipe, Fittings, and Joints

- .1 Concrete
 - .1 Circular bell and spigot pattern pipe and fittings with rubber gasket joints to CAN/CSA A257 Series, produced by a member of Ontario Concrete Pipe Association in a plant which is currently approved under O.C.P.A. Plant Pre-qualification Program. Pipe less than or equal to 375 mm (15") dia. is to be non-reinforced Class 3. Pipe greater than 375 mm (15") dia. is to be reinforced Class III.
- .2 PVC Sewer
 - .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
- .3 PVC Water Service
 - .1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars in accordance with Part 3 of this section.
- .4 Soft Copper Water Service
 - .1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

- .5 Flexible Polyethylene
 - .1 Flexible polyethylene pipe to CAN/CSA B137.1, 690 kPa (100 psi) rated, complete with insertion type fittings secured with Series 300 stainless steel gear type clamps.
- .6 Perforated Weeper Drainage Piping
 - .1 Flexible, 150 mm (6") dia. PVC perforated piping supplied in rolls and complete with a geodesic sock.

2.02 Catch Basins

- .1 Pre-cast, water-tight reinforced concrete catch basins manufactured to ASTM C478 and Municipal standards, each sized and arranged to suit drainage pipe size and arrangement, and complete with:
 - .1 cast iron frame and cover to Municipal standards;
 - .2 required masonry work to raise top of catch basins flush with finished grade or pavement surfaces.
- .2 Masonry work is to consist of cement mortar and clay or shale bricks to ASTM C32 Grade M5, or Oaks Precast Industries "MODULOC" or equal pre-cast interlocking concrete members and accessories.

2.03 Manholes

- .1 Pre-cast, water-tight reinforced concrete manholes manufactured to ASTM C478 and Municipal standards, each sized and arranged to suit drainage pipe size and arrangement, and complete with:
 - .1 poured-in-place or pre-cast concrete base;
 - .2 cast-in-place "Safety" type aluminum steps on 300 mm (12") centres, each step coated with 2 coats of static asphalt paint;
 - .3 unperforated cast iron cover with lifting holes, and a matching frame;
 - .4 as required by manhole depth and safety regulations, cast-in-place hinged aluminum safety grating with SG 1 1 R-T6 aluminum alloy bearing bars, aluminum grate to CAN/CSA S157, and self-locking type stainless steel hinges and fasteners with galvanized steel safety chain and snap hook;
 - .5 required masonry work to raise top of manholes flush with finished grade.
- .2 Masonry work is to consist of cement mortar and clay or shale bricks to ASTM C32 grade M5, or Oaks Precast Industries "MODULOC" or equal pre-cast interlocking concrete members and accessories.

2.04 Water Meter Chamber

- .1 Pre-cast, water-tight reinforced concrete chamber manufactured to ASTM C478 and Municipal standards, each sized and arranged as shown and complete with:
 - .1 poured-in-place or pre-cast concrete base with a drain hole;
 - .2 cast-in-place "Safety" type aluminum steps on 300 mm (12") centres, each step coated with 2 coats of static asphalt paint;
 - .3 unperforated cast iron cover with lifting holes, and a matching frame;

- .4 as required by chamber depth and safety regulations, cast-in-place hinged aluminum safety grating with SG 1 1 R-T6 aluminum alloy bearing bars, aluminum grate to CAN/CSA S157, and self-locking type stainless steel hinges and fasteners with galvanized steel safety chain and snap hook;
- .5 required masonry work to raise top of chamber flush with finished grade.
- .2 Masonry work is to consist of cement mortar and clay or shale bricks to ASTM C32 grade M5, or Oaks Precast Industries "MODULOC" or equal pre-cast interlocking concrete members and accessories.

2.05 Water Meters

- .1 Equal to Neptune Technologies Group (Canada) Ltd. "Neptune High Performance Turbine" tamper-proof, in-line serviceable meter suitable for connection of a remote automatic reading and billing unit and complete with a cast bronze main case, a roll-sealed magnetic drive register, and a turbine measuring element.
- .2 Equip meter with a Neptune Technologies Group (Canada) Ltd. or equal "ARB-V" surface wall mounting automatic meter reading and billing unit with encoder register, polycarbonate housing, roll-sealed copper shell, and ABS plastic receptacle.
- .3 Equip meter with Neptune Technologies (Canada) Ltd. or equal "Tricon" hardware for interface connection to building automation system for water flow and consumption monitoring.

2.06 Water Meter Valves

- .1 Shut-Off Valves
 - .1 Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated, flanged butterfly valves, each complete with a coated cast iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with valve in position and either side of connecting piping removed. Equip butterfly valves less than or equal to 100 mm (4") dia. with lever handles. Equip butterfly valves greater than 100 mm (4") dia. with worm gear operators.
 - .2 Manufacturers:
 - .1 DeZurik #632L Series;
 - .2 Bray Valve and Controls Canada Series 34;
 - .3 Apollo Valves #143 Series;
 - .4 Centerline #L2000L or #G200L depending on size;
 - .5 Watts Industries (Canada) Inc. #BF-03.
- .2 Check Valve
 - .1 Class 125, non-corrosive, 1380 kPa (200 psi) WOG rated horizontal swing type check valves, each approved for domestic water service and complete with flanged ends.
 - .2 Manufacturers:
 - .1 Toyo Valve Co.;
 - .2 Milwaukee Valve Co.;
 - .3 Kitz Corporation;

.4 Apollo Valves.

2.07 Fire Hydrants

- .1 FM approved and ULC listed, compression type, dry top, non-freeze hydrants manufactured to meet or exceed requirements of AWWA C502, designed for a 1035 kPa (150 psi) service pressure and a hydrostatic test pressure of 2070 kPa (300 psi), and complete with:
 - .1 flanged intermediate section painted with a bituminous black coating, and with a length to suit depth of underground water main;
 - .2 Two 65 mm (2-½") dia. hose connections, each with a cap and chain and threaded to CSA B89.2 (Ontario thread) to suit local Fire Department and pumper connection requirements;
 - .3 operating nut which opens in a counter-clockwise direction and a 140 mm (5-½") dia. compression type main valve;
 - .4 bronze to bronze interface between removable parts of main valve assembly and hydrant body;
 - .5 hydrant barrel complete with breakaway section at ground line, with exposed bolts and nuts of rust and corrosion resistant alloy;
 - .6 150 mm (6") dia. elbow inlet connection to suit underground piping;
 - .7 2 coats of weatherproof enamel with colour(s) to local Municipal requirements.
- .2 Manufacturers:
 - .1 Clow Canada;
 - .2 Mueller Canada "Century".

2.08 Fire Hydrant Shut-Off Valves

- .1 Resilient seated, 1380 kPa (200 psi) rated, non-rising stem, FM approved and ULC listed wedge gate valves to AWWA C509, each with hub ends suitable for mechanical joint pipe connection, and an adjustable cast iron valve box (length to suit) with cover.
- .2 Manufacturers:
 - .1 Clow Canada #F6100 Series valve with box and cover;
 - .2 Mueller #2360 Series with box and cover.

3 Execution

3.01 Underground Municipal Service Connections

- .1 Make required arrangements with Municipality for installation of underground service piping from Municipal main(s) to property line.
- .2 Pay charges levied by Municipality for service connection work.
- .3 Municipal charges for underground street service connection work will be paid out of a prime cost allowance. Submit original copies of invoices issued by Municipality for street service connection work.

3.02 Excavation and Backfill

- .1 Locate general reference points and take necessary precautions to prevent damage or destruction to these points. Be responsible for site services work lines, elevations, and measurements.
- .2 Ensure locations of existing underground services, mechanical and electrical, are properly and accurately located and marked. Be responsible for any damage to existing services caused as a result of site services work.
- .3 Excavate to a minimum of 150 mm (6") below bottom of pipe. Support pipe, unless otherwise specified, on a well compacted bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted sand or granular B material as specified.
- .4 Where unstable soil is present at bottom of trench, provide concrete saddles, pies, or other approved and suitable foundations.
- .5 Retain and pay for the services of an independent testing agency to test and report on the compaction of backfill. Upon completion, obtain from testing agency and submit to the Consultant a signed and sealed report confirming all specified backfill compaction was achieved at all locations.

3.03 Concrete Work

- .1 Provide poured concrete work, including reinforcing and formwork, required for site services work.
- .2 Concrete is to be minimum 20 700 kPa (3 000 psi) ready-mix concrete in accordance with CAN/CSA A23.1 and the Building Code.

3.04 Drainage Service Piping Installation Requirements

- .1 Provide required underground drainage service piping to within 1.5 m (5') of building. Pipe, unless otherwise specified, is to be concrete or rigid PVC sewer pipe.
- .2 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
- .3 At the end of each working day temporarily plug and/or cap open piping ends to prevent entry of debris or dirt.

3.05 Weeper System Piping Installation Requirements

- .1 Provide sub-soil and building footing weeper system piping.
- .2 Lay pipe on a 150 mm (6") bed of granular A material, then backfill 150 mm (6") above and around pipe with granular A material. Backfill remainder of trench as specified in this section.

3.06 Connection of Building Weeper System Piping

- .1 Provide piping required to extend building weeper system piping into storm drainage piping system from connection point(s).

3.07 Water Service Piping Installation Requirements

- .1 Provide required underground water service piping to within 1.5 m (5') of building.
- .2 Piping, unless otherwise specified, is as follows:
 - .1 for service piping greater than or equal to 100 mm (4") dia. - rigid PVC;

- .2 for service piping less than 100 mm (4") dia. - Type "K" soft copper;
- .3 for distribution piping to exterior fixtures/outlets at grade level – flexible polyethylene, snaked in trench and in a continuous length wherever possible.
- .3 Brace and secure underground water service pipe at bends, tees, and similar fittings with restraint devices, and provide concrete thrust blocks in accordance with Municipal or Provincial standards and details. Regardless of what is specified elsewhere in this Specification regarding provisions of concrete, provide thrust block concrete. Paint restraint devices with 2 coats of corrosion resistant black asphalt base coating and allow time to dry prior to backfilling.
- .4 Lay pipes true to line and grade with bells upgrade. Fit sections together so, when complete, pipe has a smooth and uniform invert. Keep pipe thoroughly clean so jointed compound will adhere. Inspect pipe for defects before being lowered into trench.
- .5 Slope piping so it can be completely drained.
- .6 At the end of each working day, temporarily plug and/or cap all open piping ends to prevent entry of debris or dirt.

3.08 Installation of Manholes

- .1 Provide pre-cast concrete manholes. Properly bed each unit and set to required invert.
- .2 Provide a reinforced pre-cast concrete base slab and bottom section for each manhole, or provide a poured-in-place concrete base. Ensure each manhole is sized to suit pipe size and arrangement. Conform to Municipal installation standards.
- .3 Perform masonry work required to raise top of each assembly flush with finished grade level.
- .4 When work is substantially complete, clean out each manhole.

3.09 Installation of Catch Basins

- .1 Provide pre-cast concrete catch basins. Properly bed each unit and set to required invert.
- .2 Ensure each catch basin is sized to suit pipe size and arrangement. Conform to Municipal installation standards.
- .3 Perform masonry work required to raise top of each assembly flush with finished grade level.
- .4 When work is substantially complete, clean out each catch basin.

3.10 Installation of Water Meter Chamber

- .1 Provide a pre-cast concrete water meter chamber. Properly bed unit and set to required invert. Ensure base drain hole is placed over a granular A material soak-away area.
- .2 Provide a reinforced pre-cast concrete base slab and bottom section for chamber. Ensure each chamber is properly sized and conforms to Municipal installation standards.
- .3 Perform masonry work required to raise top of assembly flush with finished grade level.
- .4 Provide PVC conduit with pull boxes as required and conductors from chamber to building for meter reading/BAS connections. Terminate conductors in a junction box.
- .5 When work is substantially complete, clean out chamber.

3.11 Supply of Water Meter

- .1 Supply domestic water service meter and hand (inside meter room) to trade installing the meter.

3.12 Installation of Water Meter

- .1 Provide domestic water service meter in meter pit. Secure meter in place on a concrete housekeeping pad and connect with piping, including a 3-valve bypass.
- .2 Refer to drawing detail.

3.13 Installation of Fire Hydrants

- .1 Provide fire hydrants. Confirm exact locations and orientations prior to roughing-in.
- .2 Equip each hydrant with a shut-off valve and connect with piping. Piping is to be rigid PVC.
- .3 Conform to Municipal installation standards, including provision of concrete thrust blocks at piping elbows and similar fittings.
- .4 Set each valve box cover flush with finished grade in a formed 300 mm x 300 mm x 100 mm (12" x 12" x 4") thick concrete pad with a sack rubbed finish.
- .5 Regardless of what is specified elsewhere in this Specification regarding provision of concrete, provide thrust block and valve box pad concrete.
- .6 When installation is complete, remove hydrant nozzle caps and fully open to completely flush assembly and test operation.
- .7 Touch-up paint any damaged hydrant finish.

3.14 Testing and Inspection of Services

- .1 Prior to backfilling, test new service piping for leakage and flow in the presence of the Consultant and Plumbing Inspector. Give a minimum of 72 hours' notice for scheduled tests.
- .2 Drainage Piping Leakage
 - .1 Perform infiltration or exfiltration tests on drainage piping as directed by the Consultant with leakage not to exceed values issued by the Consultant. Where leakage exceeds values issued, refit piping, and re-apply tests until acceptable results are obtained.
- .3 Drainage Piping Flow
 - .1 When directed by the Consultant and/or Plumbing Inspector, perform ball flow tests on all drainage piping.
- .4 Drainage Piping Interior Inspection
 - .1 Provide video inspection and documentation of drainage service piping after piping has been flushed and leakage tested. Give the Consultant a minimum of 72 hours' notice of inspections. Perform video inspections using an experienced specialist company in accordance with following requirements:
 - .1 video equipment specially designed for the purpose and videos are to be high-resolution colour videos recorded on DVD's with audio documentation;

- .2 each DVD is to be identified according to a piping segment marked on a site services drawing print by personnel performing the video work;
 - .3 report documenting all conditions discovered during video procedures is to be prepared by specialist company and submitted to the Consultant along with original video DVD's.
- .5 Water Mains Leakage
- .1 Leakage test new water mains using clean water at 1400 kPa (200 psi) for a minimum period of 8 hours with no pressure drop.

3.15 Flushing and Disinfecting Water Service Piping

- .1 Thoroughly flush domestic water service piping after leakage and flow testing is complete.
- .2 Flush piping with clean water at a minimum velocity of 1.2 m/s (240 ft./min.) at 205 kPa (30 psi) minimum pressure until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required.
- .3 When flushing is complete, disinfect piping with a solution of chlorine in accordance with AWWA C601.
- .4 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill systems.

End of Section

1 General

1.01 References

- .1 Domestic water piping and valves are to comply with following codes, regulations, and standards (as applicable):
 - .1 applicable local codes and regulations.
 - .2 CAN/CSA B64, Backflow Preventers and Vacuum Breakers.
 - .3 CAN/CSA B125.1, Plumbing Supply Fittings.
 - .4 CAN/CSA B125.3, Plumbing Fittings.
 - .5 CAN/CSA B137 Series, Thermoplastic Pressure Piping Compendium.
 - .6 NSF/ANSI 14, Plastics Piping System Components and Related Materials.
 - .7 NSF/ANSI 61, Drinking Water System Components – Health Effects.
 - .8 NSF/ANSI 372, Drinking Water System Components – Lead Content.

1.02 Submittals

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this Section except for pipe, fittings, and chlorine solution.

1.03 Closeout Submittals

- .1 Submit laboratory water purity test results indicating chlorine residual prior to application for Substantial Performance of the Work.
- .2 Prior Substantial Performance of the Work, submit a minimum of 3 identified keys for key operated hydrants.
- .3 Submit signed test results and inspection and test log cards for each backflow preventer as specified in Part 3 of this Section.
- .4 Submit anchor drawing(s) to detail fabrication and installation of water piping anchors. Drawing(s) are to be prepared and stamped by a professional structural engineer registered and licensed in jurisdiction of the work.
- .5 As specified in Part 3 of this Section, submit a letter from anchor design engineer stating anchor installation has been examined at site and anchors are properly fabricated and installed.

2 Products

2.01 Pipe, Fittings, and Joints

- .1 PVC
 - .1 ULC listed, rigid, Class 150, DR18, 1035 kPa (150 psi) pressure rated bell and spigot pattern PVC pipe to CAN/CSA B137.3, and CSA certified fittings to CAN/CSA B137.2, and AWWA C900, complete with gasket joints, and Ford "Uni-Flange" or equal restraint collars as per Part 3 of this Section.
- .2 Soft Copper

- .1 Type "K" soft copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.
- .3 Stainless Steel
 - .1 Schedule 10S type 304 stainless steel, ASTM A312, factory or site roll grooved, complete with Victaulic or equal type 304 stainless steel roll grooved end fittings and, unless otherwise specified, Victaulic Style 807, 877 or 889 couplings and coupling gaskets equal to Victaulic Grade P fluoroelastomer.
- .4 Copper - Solder Joint
 - .1 Type "L" hard drawn seamless copper to ASTM B88, complete with copper solder type fittings to ASME/ANSI B16.18 and soldered joints using The Canada Metal Co. Ltd. "SILVABRITE 100" or equal lead-free solder for cold water pipe, and 95% tin / 5% Antimony or "SILVABRITE 100" solder for other services.
- .5 Copper - Pressure Coupled Joint
 - .1 Type "L" hard drawn seamless copper to ASTM B88 with Viega "ProPress with Smart Connect feature" copper fittings with EDPM seals, and pressure type crimped joints made by use of manufacturer recommended tool.
- .6 Copper - Grooved
 - .1 Type "L" hard drawn seamless copper to ASTM B88 with Victaulic QuickVic Style 607 non-reducing, bolted connection type suitable and approved for application intended, 2" - 8" for copper tubing consisting of ductile iron cast housings, complete with a Grade P fluoroelastomer gasket of a pressure-responsive design, with plated nuts and bolts to secure unit together.
- .7 Semi-Rigid Polyethylene Tubing
 - .1 Versa Fittings and Mfg. Inc. 12 mm (½") dia., high density, semi-rigid polyethylene tubing, 1380 kPa (200 psi) rated.
- .8 Flexible Polyethylene
 - .1 Flexible polyethylene pipe to CAN/CSA B137.1, 690 kPa (100 psi) rated, complete with insertion type fittings secured with Series 300 stainless steel gear type clamps.
- .9 Cross-Linked Polyethylene (PEX) Tubing
 - .1 Non-barrier type PEX piping in accordance with CAN/CSA B137.5, ASTM F876 and tested for compliance by an independent third-party agency, 25/50 flame spread/smoke developed rated when tested to CAN/ULC S102.2 and complete with brass inserts and crimp-ring or cold-expansion joint fittings and couplings.

2.02 Shut-Off Valves

- .1 Ball Valves
 - .1 Class 600, 4140 kPa (600 psi) WOG rated, lead-free, full port ball type valves, each complete with a forged brass body with solder ends, forged brass cap, blowout-proof stem, 304 stainless steel ball, "Teflon" or "PTFE" seat, and a removable lever handle. Valves in insulated piping are to be complete with stem extensions.
 - .2 Manufacturers:

- .1 Toyo Valve Co.
- .2 Milwaukee Valve Co.
- .3 Kitz Corporation.
- .4 Apollo Valves.
- .5 Watts Industries (Canada) Inc.
- .2 Butterfly Valves - Flanged Joint
 - .1 Non-corrosive, minimum 1200 kPa (175 psi) cold water pressure rated, resilient seated butterfly valves, each complete with a coated cast ductile iron lug type body, stainless steel shaft, bronze disc, and EPDM seat, and each suitable for domestic water bubble-tight dead end service with valve in position and either side of connecting piping removed. Butterfly valves to and including 100 mm (4") dia. are to be equipped with lever handles. Butterfly valves larger than 100 mm (4") dia. are to be equipped with worm gear operators.
 - .2 Manufacturers:
 - .1 DeZurik #632L Series;
 - .2 Kitz Corporation Code #6122EL/EG;
 - .3 Toyo Valve Co. #918BESL/EG;
 - .4 Bray Valve and Controls Canada Series 31;
 - .5 Apollo Valves #141 Series;
 - .6 Watts Industries (Canada) Inc. #BF-03.
- .3 Butterfly Valves – Grooved End
 - .1 Equal to Victaulic Series 608N, for copper pipe rated to 300 psi and be both bi-directional and dead-end service capable to full rated pressure. Seat material shall be EPDM UL Classified in accordance with ANSI/NSF 61 for ambient +86°F and hot +180°F potable water service and ANSI/NSF 372.
 - .2 Victaulic Series 861, for stainless steel pipe rated to 300 psi and be both bi-directional and dead-end service capable to full rated pressure. Seat material shall be Grade P fluoroelastomer UL Classified in accordance with ANSI/NSF 61 for ambient +86°F and hot +180°F potable water service and ANSI/NSF 372.

2.03 Check Valves

- .1 Horizontal
 - .1 Lead-free, Class 125, bronze, 1380 kPa (200 psi) WOG rated horizontal swing type check valves with solder ends.
 - .2 Manufacturers:
 - .1 Toyo Valve Co. Fig. 237A-LF;
 - .2 Milwaukee Valve Co. #UP1509;
 - .3 Kitz Corporation Code 823;

- .4 Apollo Valves #61LF Series.
- .2 Vertical
 - .1 Equal to Kitz Corp. Code 826, lead-free, 1725 kPa (250 psi) WOG rated vertical lift check valve with soldering ends.

2.04 Drain Valves

- .1 Minimum 2070 kPa (300 psi) water rated, 20 mm (¾") dia., straight pattern full port bronze ball valves, each complete with a threaded outlet suitable for coupling connection of 20 mm (¾") dia. garden hose, and a cap and chain. Ball material to be 304 stainless steel.
- .2 Manufacturers:
 - .1 Toyo Valve Co.
 - .2 Dahl Brothers Canada Ltd.
 - .3 Kitz Corporation.
 - .4 Apollo Valves.
 - .5 Watts Industries (Canada) Inc.

2.05 Domestic Hot Water Piping Balancing Valves

- .1 Equal to Victaulic Series 76X Low Lead Balancing Valve, lead-free and compliant with NSF-61 and NSF-372 for use in potable water applications, automatic flow limiting balancing valve (±5% over rated operating pressure range), complete with removable flow cartridge. Sizes 12 – 20 mm (1/2 - 3/4") diameter, 2758 kPa (400 psi) rated.
- .2 Equal to Victaulic TA Series 790 manual balancing valve, lead-free and compliant with NSF-61 and NSF-372 for use in potable water applications. Balancing, pre-setting, measuring and shut-off. Sizes 25 mm – 50 mm (1" - 2") dia., 20°C to 120°C (-4°F to 248°F), 2758 kPa (400 psi) rated.

2.06 Partition Stops

- .1 Equal to Dahl Brothers Canada Ltd. Fig. E2300 Series or equal lead-free partition stops with EDPM packing, slotted spindles, extension tubes, stainless steel access plates, and 3 identified keys.

2.07 Pressure Reducing Valves

- .1 For piping less than or equal to 50 mm (2") diameter, lead-free, non-corrosive, non-ferrous direct spring acting pressure reducing valves to CAN/CSA B356, each factory set at 345 kPa (50 psi) unless otherwise specified or required, each field adjustable from 175 kPa (25 psi) to 520 kPa (75 psi) and each complete with an integral inlet strainer.
 - .1 Manufacturers:
 - .1 Apollo Valves #36HLF Series;
 - .2 Zurn/Wilkins #600XL Series;
 - .3 Watts Industries (Canada) Inc. #LF25AUB-Z3 Series;
 - .4 Cash-Acme EB-25 Series;
 - .5 Bermad Series 935-H.

- .2 For piping greater than or equal to 65 mm (2-½") diameter, lead-free, non-corrosive pilot operated pressure reducing valve to CAN/CSA B356, factory set at required pressure, field adjustable, and complete with screwed or flanged connections, and brass body pilot valve with stainless steel seat.

- .1 Manufacturers:

- .1 Singer Valve #106 PR;
- .2 Zurn/Wilkins #ZW209;
- .3 Watts Industries (Canada) Inc. #LFM115 Series;
- .4 Bermad Series 972.

2.08 Domestic Hot Water Thermostatic Mixing Valves

- .1 Lawler Manufacturing Co. Inc. 800 Series "High-Low Thermostatic Mixer" factory assembled rough bronze thermostatic mixing valve assembly complete with rotatable union end inlet piping with check stops and stainless steel strainer screens, union outlet piping with thermometer connection, all sized as shown, and following:

- .1 mixing valve with liquid motor, stainless steel piston and liner, tamper-resistant control adjustment, and 3-way protection against runaway temperatures, thermal shock, and scalding;
- .2 ball type outlet shut-off valve conforming to valve requirements specified in this section;
- .3 surface wall mounting enamelled steel cabinet with hinged door, key lock, and permanent identification;
- .4 recessed wall mounting type 304 stainless steel cabinet with a #4 finish, hinged door, key lock, and permanent identification.

- .2 Manufacturers:

- .1 Lawler Manufacturing Co. Inc.;
- .2 Leonard Valve Co.;
- .3 Symmons Industries Inc.

2.09 Chlorine

- .1 Sodium hypochlorite to AWWA B300.

2.10 Water Meter

- .1 Equal to Neptune Technology Group (Canada) Ltd. "Neptune T-10" tamper-proof, in line serviceable meter in accordance with requirements of AWWA C701 and NSF/ANSI 61, suitable for connection of a remote automatic reading and billing unit and complete with a cast bronze main case, a roll sealed register, and a positive displacement nutating disc measuring chamber.
- .2 Equal to Neptune Technology Group (Canada) Ltd. "Neptune High Performance Turbine" tamper-proof, in-line serviceable meter in accordance with requirements of AWWA C701 and NSF/ANSI 61, suitable for connection of a remote automatic reading and billing unit and complete with a cast bronze main case, a roll-sealed magnetic drive register, and a turbine measuring element.

- .3 Equip meter with a Neptune Technology Group (Canada) Ltd. or equal "ARB-V" surface wall mounting automatic meter reading and billing unit with encoder register, polycarbonate housing, roll-sealed copper shell, and ABS plastic receptacle.
- .4 Meter is also to be complete with Neptune Technology (Canada) Ltd. or equal "Tricon" hardware for interface connection to building automation system for water flow and consumption monitoring.

2.11 Interior Hose Bibbs

- .1 Flush-Concealed
 - .1 Recessed, 92 mm (3-5/8") deep, recessed, encased wall hydrant with lockable bronze or stainless steel box with hinged cover identified "WATER", bronze interior parts, a screwdriver operated stop in the supply, key operated control valve, 20 mm (3/4") dia. hose connection, and a vacuum breaker.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-330.
 - .2 Jay R. Smith #5509QT-CL-SAP;
 - .3 Zurn #Z1350;
 - .4 Mifab #MHY-55;
 - .2 Semi-Recessed - Finished Areas
 - .1 Anti-siphon type, 100 mm (4") deep hose bibb with stainless steel face with operating key, bronze interior parts, 20 mm (3/4") dia. solder inlet, 20 mm (3/4") dia. hose connection, and integral vacuum breaker.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-430.
 - .2 Jay R. Smith #5619-SAP-98;
 - .3 Zurn #Z1333 "ECOLOTRON";
 - .4 Mifab #MHY-30;
 - .3 Surface – Exposed – Cold Water – Unfinished Areas
 - .1 Brass or bronze hose bibb with hose end vacuum breaker.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #SC8-1;
 - .2 Jay R. Smith #5609QT-SAP.
 - .3 Zurn/Wilkins # Z1341 with hose end vacuum breaker;
 - .4 Chicago Faucets #293-E27CP;
 - .4 Exposed – Unfinished Areas – Hot and Cold Water

- .1 Mixing faucet for surface mounting.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-300-2-VB.
 - .2 Jay R. Smith #5560QT-LB-SAP;
 - .3 Zurn #Z841L1-RC;
 - .4 Delta Commercial #28T8083;

2.12 Exterior Non-Freeze Wall Hydrants / Exterior Non-Freeze Hose Bibbs

- .1 Flush-Concealed
 - .1 Recessed, encased, self-draining hydrants, each complete with a copper casing, operating rod assembly to suit wall thickness, polished nickel bronze box with hinged locking cover, 20 mm ($\frac{3}{4}$ " dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-725.
 - .2 Jay R. Smith #5519-98;
 - .3 Zurn #Z1320;
 - .4 Mifab #MHY-26;
- .2 Semi-Recessed
 - .1 Self-draining hydrants, each complete with a copper casing, operating rod assembly to suit the wall thickness, 20 mm ($\frac{3}{4}$ " dia. threaded hose connection outlet, vacuum breaker, and a loose tee handle operating key.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-420.
 - .2 Jay R. Smith #5619-98;
 - .3 Zurn #Z1321;
 - .4 Mifab #MHY-16;

2.13 Exterior Non-Freeze Ground Hydrants

- .1 Flush
 - .1 Flush with grade mounting, encased head, self-draining bronze hydrants, each complete with a casing and operating rod assembly to suit the depth of piping bury, valve housing with drain port, grade box with hinged lockable cover and drain port, 20 mm ($\frac{3}{4}$ " dia. threaded hose connection, and a loose tee handle operating key.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-500.

- .2 Jay R. Smith #5810-N-NV;
- .3 Zurn #Z1360;
- .4 Mifab #MHY-60;
- .2 Exposed
 - .1 Self-draining exposed head bronze post hydrants, each complete with a casing and operating rod assembly to suit the height of hose outlet above grade and the depth of piping bury, valve housing with drain port, 20 mm (¾") dia. threaded hose connection assembly with vacuum breaker and gravel guard, and a loose tee handle operating key.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. #HY-600.
 - .2 Jay R. Smith #5910-NV-H;
 - .3 Zurn #Z1385;
 - .4 Mifab #MHY-65;

2.14 Non-Freeze Roof Hydrant

- .1 Woodford Mfg. Model RHY2-MS non-freeze roof hydrant with 25 mm (1") diameter inlet connection, 20 mm (¾") diameter hose end outlet with dual check backflow preventer, a 3.2 mm (1/8") diameter inlet connection drain hole to automatically drain hydrant when shut-off, a mounting system with cast iron support and under deck flange, and required mounting hardware and accessories.

2.15 Hose Reel

- .1 Reel:
 - .1 Reelcraft model HS29000M (basis of design).
 - .2 Stainless steel hose reel with hand crank, wall mounting bracket, 20 mm inlet and reel connections, 23 m hose capacity, maximum pressure of 207 bar at up to 99°C.
 - .3 Manufacturers: Reelcraft, Cox, Hannay.
- .2 Hose:
 - .1 Goodall model N2613 Gray Washdown with built-on nozzle (basis of design).
 - .2 Low pressure water washdown hose, EPDM tube with high tensile wire braid reinforcement and Gray EPDM jacket. 20 mm diameter x 15 m length. Hose thread male inlet and built-in factory nozzle on outlet end. Abrasion resistant and non-marking cover. Max. 2.0 MPa water operating between -40°C and 185°C.
 - .3 Manufacturers: Goodall Rubber, Goodyear.

2.16 Floor Drain Trap Seal Primers

- .1 Primer Valve Type
 - .1 Precision Plumbing Products Inc. Model Prime Rite Series PR-500 primer valve, constructed of brass, complete with "O" ring seals, 12 mm (½") threaded inlet and outlet connections, air gap

fitting AG-500 and, for priming two traps from the same primer, a DU-U or DU-4 outlet distribution unit.

- .2 Electronic Type
 - .1 Precision Plumbing Products #PT Series surface wall mounting, CSA certified, 115 volt, 1-phase, 60 Hz., electronic, automatic trap priming manifolds, each sized to suit the number of drain traps or interceptors serviced, and each complete with:
 - .1 galvanized steel cabinet with door;
 - .2 20 mm ($\frac{3}{4}$ ") dia. NPT copper pipe inlet with shut-off valve and water hammer arrestor;
 - .3 solenoid valve, an atmospheric vacuum breaker, and a discharge manifold with 12 mm ($\frac{1}{2}$ ") dia. compression type copper tube connections on 40 mm (1- $\frac{1}{2}$ ") centres with quantity to suit the number of items to be primed;
 - .4 control panel with circuit breaker, 5 ampere fuse, 24 hour timer, and manual override toggle switch.

2.17 Shock Absorbers

- .1 Type 304 stainless steel piping shock absorbers, each complete with a nesting type bellows and a casing of sufficient displacement volume to dissipate kinetic energy generated in piping system, and each sized to suit connecting water pipe and equipment it is provided for.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. "SG" Series.
 - .2 Jay R. Smith 5000 Series "HYDROTROL";
 - .3 Zurn #Z1700 "SHOKTROL";
 - .4 Mifab "HAMMERGUARD" WHB Series;

2.18 Water Hammer Arrestors

- .1 Piston type, sealed, all stainless steel construction, pressurized water hammer arrestors suitable for either vertical or horizontal installation, each complete with a pressurized compression chamber, welded nesting-type expansion bellows surrounded by non-toxic mineral oil, and a male treaded nipple connection.
- .2 Manufacturers:
 - .1 Jay R. Smith 5000 Series;
 - .2 Precision Plumbing Products "SS" Series.
- .3 Piston type, sealed, pressurized water hammer arrestors suitable for either horizontal or vertical installation, each complete with a hard drawn copper body, "O"-ring piston seals, an air charge, and an inlet opening equal to diameter of pipe in which arrestor is required.
- .4 Manufacturers:
 - .1 Watts Industries (Canada) Inc. LF05 or LF15M2;
 - .2 Zurn #Z1260;

- .3 Precision Plumbing Products Inc. SC Series;
- .4 Mifab MWH Series.

2.19 Backflow Preventers

- .1 Double Check Valve Assembly
 - .1 Minimum 1205 kPa (175 psi) rated lead-free dual check valve assembly backflow preventer to CAN/CSA B64 (including supplements), complete with tight-closing resilient seated shut-off valves, test cocks and strainer.
 - .2 Manufacturers:
 - .1 Watts Industries Canada;
 - .2 Zurn/Wilkins;
 - .3 Apollo Valves (Conbraco Industries).
- .2 Reduced Pressure Zone Assembly
 - .1 Lead-free reduced pressure zone assembly backflow preventer in accordance with CAN/CSA B64 (including supplements), each of bronze or epoxy coated cast iron bronze fitted construction depending on size, and complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting.
 - .2 Manufacturers:
 - .1 Watts Industries #LF009QT-S for 12 mm (½") size, #LF909QT-S for 20 mm to 50 mm (¾" to 2") size, and #LF909-NRS-S for 65 mm (2-½") and larger size;
 - .2 Zurn/Wilkins 975XL2 and 375 Series;
 - .3 "Apollo" Valves manufactured by Conbraco Industries Inc. Series 4ALF;
 - .4 Danfoss Flomatic Corp. Series RPZ.

2.20 Piping Expansion Compensators and Guides

- .1 Pressurized type, selected to withstand system pressure and to suit calculated movement from -5°C (23°F) to maximum operating temperature plus 25% safety factor, complete with stainless steel bellows and shroud, copper tube sweat type female ends, anti-torque device, and proper and suitable alignment guides for both sides of each compensator.
- .2 Manufacturers:
 - .1 Senior Flexonics Series HB;
 - .2 Hyspan Precision Products Series 8500.

2.21 Pipe Anchors

- .1 Welded structural black steel anchors of a design, size, and type to securely anchor pipe at point shown. Each anchor is to withstand 150% axial thrust, and is to be designed and detailed by a professional structural engineer registered and licensed in jurisdiction of the work. Submit anchor design and fabrication shop drawings, stamped by design engineer.

2.22 Lavatory Supply Fitting Tempering Valves

- .1 Equal to Powers "HydroGuard" Series 490, model LM490 12 mm (½") dia. or model LM491 20 mm (¾") dia. as required, each CSA B125 certified, forged brass, tamper-proof thermostatic mixing valves, adjustable for water supply between 29°C and 49°C (85°F and 120°F), sized to suit number of lavatories in grouping, and complete with a stop and check valve and a lockable handle.
- .2 Each mixing valve is to be complete with a stainless steel flush wall mounting cabinet with vandal-proof hinged door.

2.23 Air Vents

- .1 Equal to ITT Hoffman Specialty No. 78 cast brass, 1035 kPa (150 psi) rated, 20 mm (¾") straight water main vent valves, each tapped at the top for a 3.2 mm (1/8") safety drain connection.

2.24 Domestic Water Thermal Expansion Tank

- .1 Pre-charged domestic water thermal expansion tank in accordance with Section VIII of the ASME Boiler and Pressure Code, carbon steel outer shell construction and complete with fixed butyl rubber bladder to prevent water from contacting shell interior, top NPT stainless steel system connection, 7.6 mm to 813 mm (0.301" to 32") charging valve connection and prime painted exterior.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. Series DETA;
 - .2 Zurn/Wilkins Model WTTA.

2.25 JUDO Filter

- .1 Equivalent to JUDO PROFIMAT "JPF-A/TP" self cleaning back-washable water filter and strainer for cold water applications. System should have no interruption to building's water supply or filtration process during backwash. Equipped with clear sight-glass, backwash alarm, 100-micron stainless steel filter screen.

3 Execution

3.01 Demolition

- .1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.02 Underground Municipal Service Connection

- .1 Make required arrangements with Municipality for installation of domestic water service piping from Municipal main to property line.
- .2 Pay charges levied by Municipality for service connection work.
- .3 Municipal charges for underground street service connection work will be paid out of a prime cost allowance. Submit original copies of invoices issued by Municipality for street service connection work.

3.03 Piping Installation Requirements

- .1 Provide required domestic water piping.
- .2 Piping, unless otherwise specified, is as follows:

- .1 for underground piping 100 mm (4") dia. and larger outside and/or inside the building – rigid PVC;
- .2 for underground piping less than 100 mm (4") dia. inside building – Type "K" soft copper;
- .3 for pipe 75 mm (3") dia. and larger inside building and above ground – Schedule 10 stainless steel;
- .4 for 12 mm (½") dia. trap seal primer tubing located underground or in concrete or masonry construction – semi-rigid polyethylene;
- .5 for pipe inside building and aboveground in sizes to 100 mm (4") dia., except in vertical shafts and through fire barriers – rigid CPVC;
- .6 for branch hot and cold piping aboveground from mains and risers to fixtures and equipment where fire rated construction is not penetrated – at your option, PEX tubing installed and joined in strict accordance with manufacturer's instructions; when installed in unfinished areas, ensure piping is protected from ultra-violet light exposure.
- .7 for underground piping outside building to fixtures/outlets at grade level – flexible polyethylene, snaked in the trench and in a continuous length wherever possible;
- .8 for pipe inside building and aboveground in sizes to 100 mm (4") dia. – Type "L" hard copper with solder joints.
 - .1 Option: Type "L" hard copper with pressure coupled mechanical joints.
 - .2 Option: Type "L" hard copper with grooved end mechanical joints.
 - .1 Grooved pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. All couplings will meet Victaulic standards for visual inspection sizes 2" to 8". The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Install in accordance with manufacturer's latest recommendations. A Victaulic factory trained representative shall periodically visit the job site and review the installation for best practices. The installing Contractor shall correct any identified deficiencies. Victaulic product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by Victaulic prior to the completion of the project.
- .3 Brace and secure underground water service pipe at bends, tees, and similar fittings with restraint devices, and provide concrete thrust blocks in accordance with Municipal standards and details. Regardless of what is specified elsewhere in this Specification regarding provisions of concrete, provide thrust block concrete. Paint restraint devices with 2 coats of corrosion resistant black asphalt base coating prior to backfilling.
- .4 Lay pipes true to line and grade with bells up grade. Fit sections together so that, when complete, pipe has a smooth and uniform invert. Keep pipe thoroughly clean so jointed compound will adhere. Inspect pipe for defects before being lowered into trench.
- .5 Slope piping so it can be completely drained.
- .6 Provide cast brass dielectric type adapters/unions at connections between ferrous and copper pipe or equipment.

3.04 Installation of Shut-Off and Check Valves

- .1 Refer to Part 3 of Section 20 05 00 – Common Work Results for Mechanical.
- .2 For shut off valves installed on solder joint copper piping up to and including 75 mm (3") diameter, provide ball type valves, and for flanged joints copper or stainless steel piping larger than 75 mm (3") diameter provide butterfly type valves.

3.05 Installation of Drain Valves

- .1 Provide a drain valve at the bottom of domestic water piping risers, at other piping low points, and wherever else shown.
- .2 Locate drain valves so they are easily accessible.

3.06 Installation of Domestic Hot Water Piping Balancing Valves

- .1 Provide balancing valves in domestic hot water recirculation piping where shown or required.
 - .1 for pipe 25 mm (3/4") dia. and less ground – equal to Victaulic Series 76X
 - .2 for pipe greater than 25 mm (3/4") dia. – equal to Victaulic TA Series 78BL
- .2 Locate each valve so it is easily accessible.

3.07 Installation of Partition Stops

- .1 Provide partition stops in domestic water piping to each group of suite washroom plumbing fixtures. Locate partition stops in piping near floor level in inconspicuous but accessible locations. Confirm exact locations prior to roughing-in.

3.08 Installation of Pressure Reducing Valves

- .1 Provide domestic water pressure reducing valves. Install so each valve is readily accessible. Whenever possible, provide pressure reducing valves factory pre-set to required pressures.
- .2 Check and test operation, and adjust as required.

3.09 Installation of Domestic Hot Water Thermostatic Mixing Valves

- .1 Provide a domestic hot water thermostatic mixing valve assembly and wall mount.
- .2 Adjust each valve to design requirements and check and test operation. Set maximum temperature limit stops.
- .3 Identify each valve and its water temperature delivery setting with an engraved nameplate.

3.10 Installation of Water Meter

- .1 Provide domestic water service meter. Secure meter in place on a concrete housekeeping pad and connect with piping, including required valve by-pass.
- .2 Installation of water meter must comply with local municipal requirement.

3.11 Installation of Hose Bibbs

- .1 Provide hose bibbs.

- .2 Unless otherwise shown, specified, or required, mount hose bibbs approximately 1 m (3') above floor. Confirm exact locations prior to roughing-in.

3.12 Installation of Exterior Non-Freeze Wall Hydrants

- .1 Provide non-freeze wall hydrants.
- .2 Install hydrants level and plumb such that hose outlets are approximately 600 mm (2') above grade level. Confirm exact locations prior to roughing-in.
- .3 Provide a shut-off valve inside building to each exterior non-freeze wall hydrant.

3.13 Installation of Exterior Non-Freeze Ground Hydrants

- .1 Provide non-freeze ground hydrants. Confirm exact locations prior to roughing-in.
- .2 Ensure length of piping to outlet box suits depth of underground piping, and underground piping elbow and valve housing is set in an envelope of clean sharp, 100% Proctor density compacted sand. Provide a length of small bore copper tubing from valve drain port into sand envelope.
- .3 Provide a shut-off valve inside building to each ground hydrant.

3.14 Installation of Non-Freeze Roof Hydrant

- .1 Provide non-freeze roof hydrants. Confirm exact locations prior to roughing-in.
- .2 Coordinate installation with trades providing roof opening and roofing work to ensure a water-tight roof penetration.
- .3 Provide 3.2 mm (1/8") diameter drain piping from inlet connection assembly inside building to a funnel floor drain or other suitable indirect connection location.

3.15 Installation of Trap Seal Primers

- .1 Provide required accessible trap seal primers to automatically maintain a water seal in floor drain traps, whether shown on drawings or not.
- .2 Water closet flush valves may be used for priming washroom floor drain traps if flush tube is properly tapped and primer tubing exposed in washroom is chrome plated.
- .3 Provide trap primer valves to prime single or multiple (1 to 6) traps. Install trap primer valves in domestic cold water piping to frequently used plumbing fixtures. Where from 2 to 6 traps are to be primed from same primer valve, provide appropriate supply and distribution tube assemblies. Ensure primer valves are accessible.
- .4 Provide 115 volt, electronic, surface wall mounting trap primer assemblies for multiple (4 to 30) traps. Include for a 115 volt 15 ampere panel breaker and wiring in conduit from closest panelboards to primer assembly, all to wiring standards of Electrical Division. Adjust primer water flow and timing to suit number of traps served.
- .5 Ensure trap primer piping is secured to floor drain primer tappings and not terminated through the tapping in the throat of the drain.

3.16 Installation of Shock Absorbers

- .1 Provide accessible shock absorbers in make-up water piping to equipment.
- .2 Ensure size of each shock absorber is properly selected to suit size of water pipe and equipment pipe is connected to.

- .3 Install down stream of backflow preventor.

3.17 Installation of Water Hammer Arrestors

- .1 Provide accessible water hammer arrestors in domestic water piping in locations as follows:
 - .1 in headers at groups of plumbing fixtures;
 - .2 at top of risers;
 - .3 at ends of long horizontal runs of piping;
 - .4 in piping connecting solenoid valves or equipment with integral solenoid valves;
 - .5 wherever else shown or required by Code.
- .2 Install each unit in a piping tee either horizontally or vertically in the path of potential water shock in accordance with manufacturer's instructions and details.

3.18 Installation of Backflow Preventers

- .1 Provide a reduced pressure zone assembly backflow preventer on incoming DCW service and in each direct domestic water connection to equipment other than plumbing fixtures and fittings.
- .2 Provide a double check valve assembly backflow preventer on incoming DCW service. Provide a reduced pressure zone assembly backflow preventer in each direct domestic water connection to equipment other than plumbing fixtures and fittings.
- .3 Locate each backflow preventer on floor or wall between 765 mm (30") and maximum 1.5 m (60") above floor such that it is easily accessible for maintenance and testing.
- .4 Equip each reduced pressure zone backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.
- .5 Test operation of each backflow preventer in accordance with requirements of CAN/CSA B64 by personnel certified for such testing by governing authorities, and submit signed test results and a properly and clearly identified and marked inspection and test record card for each backflow preventer.

3.19 Installation of Expansion Compensators, Guides, and Anchors

- .1 Provide expansion compensators in domestic water piping.
- .2 Ensure pipe ends are properly aligned. Provide alignment guides on each side of expansion compensators, properly secured to building structure.
- .3 Provide anchors to secure domestic water piping to structure. Locate anchors generally where shown but with exact locations to suit piping as installed and requirements of reviewed anchor shop drawings.
- .4 When installation of anchors is complete, arrange, and pay for anchor design engineer to visit site to review anchor installation. Submit a letter from design engineer confirming each anchor is properly installed.

3.20 Installation of Lavatory Supply Fitting Tempering Valves

- .1 Provide thermostatic water tempering valves for hot water supply to public washroom lavatory supply fittings. Conceal valves and piping.
- .2 Provide a flush wall mount panel for each valve. Confirm exact location prior to roughing-in.

- .3 Install in accordance with manufacturer's instructions and set mixing valves to deliver 32°C (90°F) tempered water.

3.21 Installation of Air Vents

- .1 Provide accessible air vents in domestic water piping to prevent air binding.
- .2 Extend copper indirect drain piping from top drain connection of each vent to nearest suitable drain.
- .3 Locate exact vent locations on as-built record drawings.

3.22 Installation of Domestic Water Thermal Expansion Tanks

- .1 Provide domestic water thermal expansion tanks.
- .2 Unless otherwise specified, mount at least 450 mm (18") from cold water inlet to domestic water heater.
- .3 Adjust pre-charge to match incoming water pressure after installation.
- .4 Install in accordance with manufacturer's instructions and as per local governing Codes and Regulations.

3.23 Flushing and Disinfecting Piping

- .1 Flush and disinfect all new and/or reworked domestic water piping after leakage testing is complete.
- .2 Isolate new piping from existing piping prior to flushing and disinfecting procedures.
- .3 Flush piping until all foreign materials have been removed and flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.
- .4 When flushing is complete, disinfect the piping with a solution of chlorine in accordance with AWWA C601.
- .5 When disinfecting is complete, submit water samples to a certified laboratory for purity testing and, when testing indicates pure water in accordance with governing standards, submit a copy of test results and fill the systems.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for all products specified in this Section except pipe and fittings.

1.02 Closeout Submittals

- .1 Submit a copy of plumbing inspection certificate prior to application for Substantial Performance of the Work.
- .2 Submit letters from product manufacturers/suppliers to certify correct installation of products as specified in Part 3 of this section.
- .3 Record Drawings: Indicate inverts of new below grade sanitary and storm piping on as-builts drawings.

2 Products

2.01 Pipe, Fittings, and Joints

- .1 PVC Sewer
 - .1 DR35 rigid, green PVC hub and spigot pattern sewer pipe and fittings to CAN/CSA B182.2, with gasket joints assembled with pipe lubricant.
 - .2 DR35 rigid, PVC sewer pipe and fittings, with solvent weld joints, all certified to CSA B182.1 and colour-coded as per local governing codes, regulations and standards.
- .2 PVC - DWV
 - .1 For Low Buildings: Equal to IPEX System 15 drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating not more than 25 when tested to CAN/ULC-S102.2, with solvent weld joints or MJ Grey mechanical joint couplings, and, for fire barrier penetration, approved firestop conforming to CAN/ULC S115.
 - .2 For High Buildings and Plenums: Equal to IPEX System XFR drain, waste and vent pipe and fittings to CAN/CSA B181.2, complete with a flame spread rating not more than 25 and a smoke developed classification not more than 50 when tested to CAN/ULC-S102.2, with solvent weld joints or MJ Grey mechanical joint couplings, and, for fire barrier penetration, approved firestop conforming to CAN/ULC-S115.
- .3 Copper - Solder Joint
 - .1 Type DWV hard temper to ASTM B306, with forged copper solder type drainage fittings and 50% lead - 50% tin solder joints.
- .4 Cast Iron
 - .1 Class 4000 cast iron pipe, fittings, and mechanical coupling joints to CAN/CSA B70.
- .5 Copper-Victaulic Coupling Joint
 - .1 Type DWV hard temper to ASTM B306, with factory or site rolled grooved ends (with grooving rolls designed for copper) and Victaulic "Copper Connection" wrought copper or cast bronze fittings and Style 606 gasket type couplings.
- .6 Galvanized Steel - Victaulic Coupling Joint

- .1 Schedule 40 mild steel, galvanized, ASTM A53, factory or site rolled grooved, complete with Victaulic galvanized ductile iron grooved end fittings and, unless otherwise specified, Victaulic Style 77 hot dip galvanized mechanical joint couplings with Grade M gaskets.
- .7 PVC Weeper Piping
 - .1 150 mm (6") dia. corrugated perforated PVC pipe with an integral geodesic sock, supplied in coils.
- .8 Stainless Steel – For Storm Drainage
 - .1 Schedule 10S type 304 stainless steel, ASTM A312, factory or site roll grooved, complete with Victaulic or equal type 304 stainless steel roll grooved end fittings and, unless otherwise specified, Victaulic Style 807, 877 or 889 couplings and coupling gaskets equal to Victaulic Grade P fluoroelastomer.

2.02 Shut-Off and Check Valves

- .1 Shut-off Valves
 - .1 Class 600, 4140 kPa (600 psi) WOG rated full port ball valves, each complete with a forged brass body, blowout-proof stem, chrome plated solid brass ball, solder or screwed ends as required, and removable lever handle.
 - .2 Manufacturers:
 - .1 Toyo Valve Co. Fig. 5049A or Fig. 5044A;
 - .2 Milwaukee Valve Co. #BA-155 or #BA -125;
 - .3 Kitz Corporation Code 58 or Code 59;
 - .4 Victaulic Co. of Canada Ltd. Series 722;
 - .5 Apollo Valves # 77-100 or # 77-200;
 - .6 Watts Industries (Canada) Inc. #FBVS-3C.
- .2 Check Valves
 - .1 Class 125, bronze, 1725 kPa (250 psi) WOG rated vertical lift check valve with solder or screwed ends as required, and, for horizontal piping, Class 125, bronze 1380 kPa (200 psi) WOG rated swing check valves with solder or screwed ends.
 - .2 Manufacturers:
 - .1 Toyo Valve Co. Fig. 231 or Fig. 236 or Fig. 237;
 - .2 Milwaukee Valve Co. #1510 or #510;
 - .3 Kitz Corporation Code 36 or Code 22 or Code 23.

2.03 Vent Stack Covers

- .1 Equal to Lexcor Model "Flash-Tite" seamless, spun aluminum, insulated vent stack covers with caps and a factory applied asphalt primer coating on top and bottom of flange.
- .2 Each vent stack cover is to be complete with a vandal-proof cap.

2.04 Cleanouts

- .1 Horizontal Piping
 - .1 TY pipe fitting with an extra heavy brass plug screwed into the fitting.
- .2 Vertical Piping
 - .1 Bronze or copper cleanout tees in copper piping, each complete with a bronze ferrule, and, for cast iron piping, "BARRETT" type cast iron cleanout tees, each gas and water-tight and complete with a bolted cover.
- .3 Urinal(s)
 - .1 Wall access cleanout assemblies, each complete with a tapered plug, threaded brass insert, urethane rubber seal, and polished stainless steel access cover with vandal-proof stainless steel securing screw.
 - .2 Manufacturers:
 - .1 Watts Industries (Canada) Ltd. #CO-590-RD.
 - .2 Jay R. Smith #SQ4-1819;
 - .3 Zurn #ZSS-1666-1;
 - .4 Mifab #C1440-RD;

2.05 Floor Cleanout Terminations

- .1 Factory finished cast iron terminations, each adjustable and complete with a cast iron body with neoprene sleeve, solid, gasketed, polished nickel-bronze scoriated top access cover to suit floor finish, a seal plug, and captive, vandal-proof, stainless steel securing hardware.
- .2 Adjustable floor cleanout with lacquered cast iron body and anchor flange, secondary "O" ring Test Seal, 4" diameter cleanout opening and heavy-duty stainless steel scoriated cover with surface membrane clamp, secondary closure plug and stainless-steel vandal proof allen key screws. 9" top assembly diameter, with TR25 Torx & pin security screws.
- .3 Manufacturers:
 - .1 Mifab # C1100-RFC-1 or #C1000-R-3;
- .4 Cleanout terminations in areas with a tile or sheet vinyl floor finish are to be as above but with a square top in lieu of a round top.

2.06 Floor Drains, Funnel Floor Drains, and Hub Drains

- .1 Unless otherwise specified or indicated, floor drains are to be vandal-proof drains in accordance with drawing symbol list, each complete with a cast iron body and a trap seal primer connection. Cast iron components are to be factory finished with latex-based paint coating.
- .2 Floor drains in areas with a tile finish are to be as above but with a square grate in lieu of a round grate.
- .3 Manufacturers:
 - .1 Mifab Inc.

- .4 Mifab Series FS1940-FL, 12" x 12" x 10" deep 16 gauge, All Type 304 (CF8) stainless steel sanitary floor area and indirect waste drain complete with cast stainless steel secured rim and grate with allen key vandal proof stainless steel screws, stainless steel anchor flange with weepholes and anti-splash dome strainer. Half grate. Refer to Zurn Z1755-2 for information on surface sheet clamping requirements.

2.07 Roof Drains

- .1 Unless otherwise specified or indicated, roof drains are to be cast iron body drains with aluminium domes, in accordance with the drawing symbol list. Cast iron components are to be factory finished with a latex based paint coating.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Ltd.;
 - .2 Jay R. Smith Manufacturing Co.;
 - .3 Zurn Industries Ltd.;
 - .4 Mifab Inc.

2.08 Drainage Trench Frames and Grating

- .1 Welded, hot dipped galvanized, 45 mm x 45 mm x 6.4 mm (1- $\frac{3}{4}$ " x 1- $\frac{3}{4}$ " x $\frac{1}{4}$ ") carbon steel angle frame, 300 mm (12") wide, with anchor straps and lengths as required, and baked epoxy coated cast iron slotted grating in 600 mm (24") long sections.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Ltd. #TD-910-B1-4;
 - .2 Jay R. Smith #2971VP.
 - .3 Zurn # Z796VP;

2.09 Trench Drains

- .1 Modular, pre-sloped, polyester fibreglass construction interlocking sections of drainage channel with overlapping joints, drain pipe connection outlets as required, end caps and covers to suit the application, integral anchor tabs for grate anchoring and trench levelling, heavy-duty coated steel angle top frames, and heavy-duty coated cast iron slotted grate supplied in 600 mm (24") long sections.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. "Dead Level" Series;
 - .2 Jay. R. Smith #9810 Series.
 - .3 Zurn "Flow-Thru" System;
 - .4 ACO Systems Ltd. "ACODrain";

2.10 Interior Catch Basin Frames and Covers

- .1 Heavy-duty, 508 mm (13") square, baked epoxy coated cast iron, non-removable, hinged slotted grate with coated steel frame with concrete anchors.
- .2 Manufacturers:

- .1 Watts Industries (Canada) Ltd. #FD-410;
- .2 Jay R. Smith #8915FC;
- .3 Zurn #Z-799-1;
- .4 Mifab #F1570.

2.11 Backwater Valves

- .1 Heat bonded powder epoxy coated cast iron in-line type, each complete with a bolted and gasketed cover, bronze flapper, stainless steel extension, and stainless steel hardware.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. BV-230-R Series;
 - .2 Jay R. Smith #7022-CAN.
 - .3 Zurn #Z-1095-15-MJ;

2.12 Extendable Backwater Valves

- .1 Equal to "Mainline Adapt-a-valve" ABS/PVC backwater valve cassette with ABS/PVC flush cap cleanout for use with ABS or PVC pipe. Provide extension piece cut to length to extend valve access to finished floor level. Provide flush cap cleanout cover to match backwater valve size and material.

2.13 Exterior Catch Basins

- .1 Pre-cast reinforced concrete catch basins manufactured to ASTM C478 and Municipal standards, each sized and arranged to suit drainage pipe size and arrangement, and complete with:
 - .1 cast iron frame and cover to Municipal standards;
 - .2 required masonry work to raise top of catch basins flush with finished grade or pavement surfaces.
- .2 Masonry work is to consist of cement mortar and clay or shale bricks to ASTM C32 Grade M5, or Oaks Precast Industries "MODULOC" pre-cast interlocking concrete members and accessories.

2.14 Exterior Manholes

- .1 Pre-cast reinforced concrete manholes manufactured to ASTM C478 and Municipal standards, each sized and arranged to suit drainage pipe size and arrangement, and complete with:
 - .1 poured-in-place or pre-cast concrete base;
 - .2 cast-in-place "Safety" type aluminum steps on 300 mm (12") centres, each step coated with 2 coats of static asphalt paint;
 - .3 unperforated cast iron cover with lifting holes and a matching frame;
 - .4 as required by manhole depth and safety regulations, cast-in-place hinged aluminum safety grating with SG 1 1 R-T6 aluminum alloy bearing bars, aluminum grate to CAN/CSA S157, and self-locking type stainless steel hinges and fasteners with galvanized steel safety chain and snap hook;
 - .5 required masonry work to raise top of manholes flush with finished grade.

- .2 Masonry work is to consist of cement mortar and clay or shale bricks to ASTM C32 grade M5, or Oaks Precast Industries "MODULOC" pre-cast interlocking concrete members and accessories.

2.15 Grease Interceptors

- .1 Grease intercepting and recovery unit of #11 gauge type 304 stainless steel construction with sensor controlled grease draw-off solenoid valve, automatic shut-down with audible/visual alarm if maximum grease capacity is exceeded, integral heating element with thermostat, gasketed stainless steel cover, stainless steel solids interceptor, and remote surface wall mounting indicator panel with status indicating lights, audible alarm, 115/24 volt control transformer and NEMA 2 enclosure.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. WD-E Series;
 - .2 Jay R. Smith #8000-ELECT series or #8400-ELECT series.
 - .3 Zurn #Z1172-UN series;

2.16 Oil Interceptors

- .1 Epoxy coated steel construction automatic oil interceptor with removable baffles, deep seal trap with cleanout, sediment bucket, aluminum frame and cover, and remote wall mounting indicating panel with status indicating lights, audible alarm, 115/24 volt control transformer, and NEMA 2 surface wall mounting enclosure.
- .2 Manufacturers:
 - .1 Watts Industries (Canada) Inc. OI-SS / HI 7873 Series;
 - .2 Jay R. Smith 8500-SC-ELECT-CAN Series.
 - .3 Zurn #Z1198 series;

3 Execution

3.01 Demolition

- .1 Refer to demolition requirements specified in Section 20 05 05 – Selective Demolition for Mechanical.

3.02 Underground Municipal Service Connection

- .1 Make required arrangements with Municipality for installation of drain service piping mains from Municipal main to property line.
- .2 Pay charges levied by Municipality for service connection work.
- .3 Municipal charges for underground street service connection work will be paid out of a prime cost allowance. Submit original copies of invoices issued by Municipality for street service connection work.

3.03 Drain and Vent Piping Installation Requirements

- .1 Provide required drainage and vent piping. Pipe, unless otherwise specified, as follows:
 - .1 for underground pipe inside building and to points 1.5 m (5') outside building lines – rigid PVC sewer pipe, minimum 75 mm (3") dia.;

- .2 for pipe inside building and aboveground in sizes less than or equal to 65 mm (2-½") dia. – type DWV copper;
 - .3 for pipe inside building and aboveground in sizes greater than or equal to 75 mm (3") dia. – Class 4000 cast iron;
 - .4 for all Storm Piping in Parking Level 1 draining to the Stormwater management tank – Schedule 40 galvanized steel or stainless steel with Victaulic fittings and couplings.
 - .5 for pipe inside building and aboveground in lieu of type DWV copper and cast iron, at your option and where permitted by governing Codes and Regulations – rigid PVC DWV;
 - .6 for drainage pump discharge pipe connections from pump to and including shut-off and check valve connections – Type "DWV" copper with Victaulic "Copper Connection" fittings and couplings, or Schedule 40 galvanized steel with Victaulic fittings and couplings.
- .2 Unless otherwise specified, slope horizontal drainage piping aboveground in sizes to and including 75 mm (3") dia. 25 mm (1") in 1.2 m (4'), and pipe 100 mm (4") dia. and larger 25 mm (1") in 2.4 m (8').
 - .3 Install and slope underground drainage piping to inverts or slopes indicated on drawings to facilitate straight and true gradients between points shown. Verify available slopes before installing pipes.
 - .4 Unless otherwise specified, slope horizontal branches of vent piping down to fixture or pipe to which they connect with a minimum pitch of 25 mm (1") in 1.2 m (4').
 - .5 Extend vent stacks up through roof generally where shown but with exact locations to suit site conditions and in any case a minimum of 3 m (10') from fresh air intakes. Terminate vent stacks a minimum of 330 mm (13") above roof (including roof parapets) in vent stack covers. Where not shown on drawings, route vent piping from source to building exterior as required in order to satisfy local governing codes and authority. Coordinate vent routing with other building services and ensure there is no architectural impact.
 - .6 Provide cast brass dielectric unions at connections between copper pipe and ferrous pipe or equipment.

3.04 Installation of Shut-Off and Check Valves

- .1 Provide a shut-off valve and a check valve in discharge piping of each drainage pump.
- .2 Locate valves so they are easily accessible without the use of ladders or other such devices.

3.05 Supply of Vent Stack Covers

- .1 Supply a properly sized vent stack cover for each vent stack penetrating roof.
- .2 Hand vent stack covers to roofing trade at site for installation and flashing into roof construction as part of roofing work. Coordinate installation to ensure proper locations. Provide waterproofing caps over vent stacks.

3.06 Installation of Cleanouts

- .1 Provide cleanouts in drainage piping in locations as follows:
 - .1 in building drain or drains as close as possible to inner face of outside wall, and, if a building trap is installed, locate cleanout on downstream side of building trap;
 - .2 at or as close as practicable to the foot of each drainage stack;
 - .3 at maximum 15 m (50') intervals in horizontal pipe 100 mm (4") dia. and smaller;
 - .4 at maximum 30 m (100') intervals in horizontal pipe larger than 100 mm (4") dia.;

- .5 in the wall at each new urinal or bank of urinals in a washroom;
- .6 wherever else shown on drawings.
- .2 Cleanouts are to be same diameter as pipe in piping to 100 mm (4") dia., and not less than 100 mm (4") dia. in piping larger than 100 mm (4") dia.
- .3 Where cleanouts in vertical piping are concealed behind walls or partitions, install cleanouts near floor and so cover is within 25 mm (1") of the finished face of the wall or partition.

3.07 Installation of Floor Cleanout Terminations

- .1 Where cleanouts occur in horizontal inaccessible underground piping, extend cleanout TY fitting up to floor, and provide a cleanout termination set flush with finished floor.
- .2 In waterproof floors, ensure each cleanout termination is equipped with a flashing clamp device. Cleanout terminations are to suit floor finish.
- .3 Where cleanout terminations occur in finished areas, confirm locations prior to rough-in and arrange piping to suit.
- .4 Ensure cleanout termination covers in tiled floor are square in lieu of round.

3.08 Installation of Floor Drains, Funnel Floor Drains and Hub Drains

- .1 Provide floor drains, funnel floor drains and hub drains.
- .2 Coordinate location of floor drains, funnel floor drains and hub drains with equipment provided by Mechanical Division and Owner's supplied equipment. Install in accordance with manufacturer's instructions.
- .3 Equip each drain with a trap.
- .4 In equipment rooms and similar areas, exactly locate floor drains to suit location of mechanical equipment and equipment indirect drainage piping. In washrooms, exactly locate floor drains to avoid interference with toilet partitions.
- .5 Confirm exact location of drains prior to roughing in. Where floor drains occur in washrooms coordinate locations with toilet partition installations.
- .6 Temporarily plug and cover floor drains during construction procedures. Remove plugs and covers during final clean-up work and when requested, demonstrate free and clear operation of each drain. Replace any damaged grates, and refinish any areas of the drain where cast iron finish has been damaged or removed, including rusted areas.

3.09 Installation of Roof Drains

- .1 Supply roof drains and place roof drain bodies in position for flashing into roof construction as part of roofing work. Connect with piping and provide accessories.
- .2 Protect roof drains from damage and entrance of debris until roofing work is complete, and refinish any areas where cast iron factory finish has been damaged or removed, including rusted areas.

3.10 Installation of Drainage Trench Frames and Grating

- .1 Supply frame and grating sections for drainage trench. Provide piping connections, traps, etc., as required.

- .2 Hand frames to concrete trade forming and pouring trenches. Ensure frames are properly and accurately installed.
- .3 Be present during concrete pour to ensure frames are not dislodged or damaged and remain straight and true. Immediately report any problems.
- .4 Install grates and secure in place. Temporarily cover grates during construction procedures. Clean trenches when work is complete.

3.11 Installation of Trench Drains

- .1 Provide pre-sloped sections of drainage channel and install so top frames are level and plumb in relation to floor finishes. Provide accessories, traps, etc., as required.
- .2 Be present during concrete pour to ensure trench drainage is not dislodged or damaged and remains straight and true. Immediately report any problems.
- .3 Install grating and secure in place.
- .4 Temporarily cover trench drainage openings during construction procedures. Clean trenches when work is complete.

3.12 Installation of Interior Catch Basin Frames and Covers

- .1 Supply frames and hinged grates for interior catch basins and provide sump inlet and outlet piping and accessories.
- .2 Hand frames to concrete trade pouring concrete sump, and coordinate installation of sump piping with the formwork installation.
- .3 Install grates and secure in place. Clean sumps when work is complete.

3.13 Installation of Backwater Valves

- .1 Provide backwater valves in drainage piping and connect with piping.
- .2 Set backwater valve assembly such that cover is flush with finished floor. Provide an extension piece if required due to depth of piping.

3.14 Installation of Exterior Manholes

- .1 Provide pre-cast concrete manholes. Properly bed each unit and set to required invert.
- .2 Provide a reinforced pre-cast concrete base slab and bottom section for each manhole, or provide a poured-in-place concrete base. Ensure each manhole is sized to suit pipe size and arrangement. Conform to Municipal installation standards.
- .3 Provide masonry work required to raise top of each assembly flush with finished grade level.
- .4 When work is substantially complete, clean out each manhole.

3.15 Installation of Exterior Catch Basins

- .1 Provide pre-cast concrete catch basins. Properly bed each unit and set to required invert.
- .2 Ensure each catch basin is sized to suit pipe size and arrangement. Conform to Municipal installation standards.
- .3 Provide masonry work required to raise top of each assembly flush with finished grade level.

- .4 When work is substantially complete, clean out each catch basin.

3.16 Installation of Drainage Interceptor

- .1 Provide an interceptor in drainage piping.
- .2 Ensure unit is easily accessible for maintenance. Confirm exact location prior to roughing-in.
- .3 Wall mount control panel and provide required 24 volt control wiring in conduit from control panel to interceptor.
- .4 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Submit a copy of the letter prior to Substantial Performance of the Work.
- .6 Include for 2 hours of on-site training for 2 groups of 6 people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

End of Section

1 General

1.01 Section Includes

- .1 Plumbing fixtures and related components.

1.02 Submittals

- .1 Submit product data sheets (fixture cuts) for all plumbing fixtures and fittings, including accessories.
- .2 Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- .3 Wiring Diagrams: Power, signal, and control wiring.
- .4 Submit fixture manufacturer's standard colour charts for all fixtures where colours are available, but a particular colour is not specified.

1.03 Closeout Submittals

- .1 Operation and maintenance data.

2 Products

2.01 Manufacturers

- .1 Subject to compliance with requirements, manufacturers that may be incorporated into the Work include, but are not limited to, following:
 - .1 Flush Valves:
 - .1 Sloan;
 - .2 Delta Commercial;
 - .3 Zurn Industries;
 - .4 Moen Commercial.
 - .2 Plumbing Brass:
 - .1 Sloan;
 - .2 Acorn Engineering;
 - .3 American Standard;
 - .4 Delta Commercial;
 - .5 Chicago Faucet;
 - .6 Moen Commercial.
 - .3 Stainless Steel Sinks:
 - .1 Franke Commercial;
 - .2 Novanni Commercial;

- .3 Aristaline;
- .4 Arch Metal Ind.
- .4 Mop Sinks:
 - .1 Stern Williams;
 - .2 Acorn Engineering;
 - .3 Zurn Industries.
- .5 Emergency Eye Wash and Emergency Showers:
 - .1 Haws;
 - .2 Speakman;
 - .3 Bradley.
- .6 Drain Fittings, Angle Supplies, and Traps:
 - .1 McGuire;
 - .2 American Standard;
 - .3 Delta Commercial;
 - .4 Zurn Industries.
- .7 Fixture Carriers:
 - .1 Watts Industries;
 - .2 Jay R. Smith;
 - .3 Zurn Industries.
- .8 Hose Bibbs:
 - .1 Jay R. Smith;
 - .2 Zurn Industries.
- .9 Water Closets, Lavatories, and Urinal:
 - .1 American Standard;
 - .2 Zurn Industries;
 - .3 Kohler.
- .10 Thermostatic Mixing Valves:
 - .1 Lawler;
 - .2 Delta Commercial;
 - .3 Leonard.

- .11 Shower and Associated Trim:
 - .1 American Standard;
 - .2 Delta Commercial;
 - .3 Zurn Industries;
 - .4 Moen Commercial.
- .12 Toilet Seats:
 - .1 Olsonite;
 - .2 Centoco;
 - .3 Bemis Commercial.
- .13 Electronic “No Touch” Flush Valves:
 - .1 Sloan;
 - .2 Delta Commercial;
 - .3 Zurn Industries;
 - .4 Moen Commercial.
- .14 Electronic “No Touch” Faucets:
 - .1 Sloan;
 - .2 Delta Commercial;
 - .3 Zurn Industries;
 - .4 Moen Commercial.

2.02 General Re: Plumbing Fixtures and Fittings

- .1 Fixtures and fittings, where applicable, are to be in accordance with requirements of CAN/CSA B45 Series, General Requirements for Plumbing Fixtures, including supplements, ASME A112.1.18.1/CSA B125.1, Plumbing Supply Fittings, and CSA B125.3, Plumbing Fittings.
- .2 Barrier-free fixtures and fittings are to be in accordance with governing Code requirements.
- .3 Unless otherwise specified, vitreous china, porcelain enamelled, and acrylic finished fixtures are to be white.
- .4 Unless otherwise specified, fittings and piping exposed to view are to be chrome plated and polished.
- .5 Fittings located in areas other than private washrooms are to be vandal-proof.
- .6 Fixture carriers are to be suitable in all respects for the fixture they support and construction in which they are located.
- .7 Floor flanges for floor mounted water closets are to be cast iron or brass, secured to floor to prevent movement and complete with a wax seal and brass or stainless steel bolts, nuts, and washers. Plastic floor flanges will not be acceptable.

- .8 Proper seal to mate with fixture carrier flange and produce a water-tight installation.
- .9 Exposed traps for fixtures not equipped with integral traps, such as lavatories, are to be adjustable chrome plated cast brass "P" traps with cleanouts, minimum 17 gauge chrome plated tubular extensions, and chrome plated escutcheons, all to suit fixture type and drain connection.
- .10 Concealed traps for fixtures not equipped with integral traps, such as counter sinks, are to be adjustable cast brass with cleanout plugs, all to suit fixture type and drain connection.
- .11 Exposed supplies for fixtures which do not have supply trim/fittings with integral stops, i.e. lavatories, are to be solid chrome plated brass angle vales with screwdriver stops for public areas, wheel handle stops for private areas, flexible stainless steel risers, and stainless steel or chrome plated steel escutcheons, all arranged and sized to suit fixture.
- .12 Water piping as specified, complete with ball type shut-off valves as specified with water piping, or Dahl Bros. Canada Ltd. ¼ turn Mini Ball Valves.

2.03 Plumbing Fixtures and Fittings

- .1 Plumbing fixtures and fittings are to be in accordance with the following:
- .2 WC-1 – Toilet - Wall Hung
 - .1 Toilet – American Standard 3351101.020 Toilet - AFWALL® MILLENNIUM™ FloWise®, Toilet, Wall-hung with wall outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), White finish Vitreous China, EverClean® antimicrobial surface, Elongated bowl, Concealed trap way design, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, 254 x 305 mm (10" x 12") water surface area, Fully-glazed 54 mm (2-1/8") trap way, Static load rating of 454 kg (1000 lb), this product is not recommended for bariatric use, Condensation channel, Toilet seat not included, 356 mm (14") wide, 660 mm (26") from finished wall, Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.
 - .2 Seat – Centoco 500STSCCFE-001 Seat - FAST-N-LOCK, for elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel, Dimensions:25 mm (1") high, 473 mm (18-5/8") long, 371 mm (14-5/8") wide.
 - .3 Flush Valve – Sloan SL-ROYAL 111-1.28-ESS Flush Valve - ROYAL® Automatic no-touch Exposed Water closet flushometer, High Efficiency 4.8 LPF (1.28 GPF), 38 mm (1-1/2") spud coupling For top spud toilet, Hardwired, constructed from Semi-red brass, Polished chrome finish, Chloramine resistant PERMEX® synthetic rubber diaphragm, OPTIMA® EL-1500 self-adaptive infrared sensor, Sensor located on die cast sensor plate with no visible fasteners (for 2-gang electrical box), Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, Adjustable tailpiece, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered fixed bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, Non-hold-open, no external volume adjustment, fixed volume accuracy is controlled by CID™ technology, 24 VAC input/output, With indicator light, Requires transformers 0345154 or 0345999, 103 - 552 kPa (15 - 80 PSI) operating water pressure, Compliances: cUPC compliant.
 - .4 Power Kit – Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve.
 - .5 Carrier – Watts ISCA-101-L/R-M11 Carrier - Closet Carrier, Industry Standard single Horizontal adjustable Closet Carrier, Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly,

epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Tiling frame, Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.

- .1 (Back to back installation) Watts ISCA-101-D Carrier - Horizontal, Closet Carrier, Industry Standard Back-to-Back Horizontal adjustable Closet Carrier, 500 lb (227 kg), Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.
- .6 Coupling – Champion MI-XHUB Coupling - Shielded Transition coupling, Unsized pipe, Four clamps for 2" to 4" pipe size, Six clamps for 5" to 15" pipe size, Type 304 stainless steel clamps, Type 304 AISI stainless steel Eyelets, Neoprene gasket gasket, Type 300 stainless steel shield painted red for easy identification, Type 305 stainless steel screw, 3/8" hex head screws, Type 304 AISI stainless steel screw housing, Codes and Compliances:, ASTM C-1540; ASTM standard 1460-2012, Comply to the FM 1680-1989 standard (except for markings), CAN/ULC S102.2-10.
- .3 WC-2 – Toilet - Wall Hung – Barrier Free
 - .1 Toilet – American Standard 3351101.020 Toilet - AFWALL® MILLENNIUM™ FloWise®, Toilet, Wall-hung with wall outlet, Toilet operates in the range of 4.2 to 6.0 LPF (1.1 - 1.6 GPF), White finish Vitreous China, EverClean® antimicrobial surface, Elongated bowl, Concealed trap way design, Direct-fed siphon jet flush action, 38 mm (1-1/2") top spud, Flush valve by others, 254 x 305 mm (10" x 12") water surface area, Fully-glazed 54 mm (2-1/8") trap way, Static load rating of 454 kg (1000 lb), this product is not recommended for bariatric use, Condensation channel, Toilet seat not included, 356 mm (14") wide, 660 mm (26") from finished wall, Compliances: ASME A112.19.2 compliant, CSA B45.1 compliant.
 - .2 Seat – Centoco 500STSCCFE-001 Seat - FAST-N-LOCK, for elongated bowl, Open front, Heavy-duty, For commercial applications, Polypropylene, Toilet seat, Less seat cover, Plastic commercial check hinges, and Stainless steel hinge pin, Specified in White finish, FAST-N-LOCK mounting system takes the guess work out when tightening the hardware. The specially designed fasteners in click" when the appropriate torque is reached. The bolt and nut material shall be stainless steel, Dimensions:25 mm (1") high, 473 mm (18-5/8") long, 371 mm (14-5/8") wide.
 - .3 Flush Valve – Sloan SL-ROYAL 111-1.28-ESS Flush Valve - ROYAL® Automatic no-touch Exposed Water closet flushometer, High Efficiency 4.8 LPF (1.28 GPF), 38 mm (1-1/2") spud coupling For top spud toilet, Hardwired, constructed from Semi-red brass, Polished chrome finish, Chloramine resistant PERMEX® synthetic rubber diaphragm, OPTIMA® EL-1500 self-adaptive infrared sensor, Sensor located on die cast sensor plate with no visible fasteners (for 2-gang electrical box), Courtesy Flush® electrical override button, Flush tube for 292 mm (11-1/2") rough-in, Adjustable tailpiece, 25 mm (1") I.P.S. screwdriver Bak-Chek® angle control stop with free spinning vandal-resistant stop cap, Dual-filtered fixed bypass, Sweat solder adapter kit with cover tube, High back pressure vacuum breaker, 25 mm (1") supply pipe, Cast wall flange with set screw, Non-hold-open, no external volume adjustment, fixed volume accuracy is controlled by CID™ technology, 24 VAC input/output, With indicator light, Requires transformers 0345154 or 0345999, 103 - 552 kPa (15 - 80 PSI) operating water pressure, Compliances: cUPC compliant.
 - .4 Power Kit – Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve.

- .5 Backrest – Franke Commercial CM-16104-WM Backrest - wall mounting, back rest, solid core plastic laminate panel back, Antique white, 305 mm (12") wide, 102 mm (4") high, 137 mm (5-3/8"), 18-gauge stainless steel bar with #4 gloss with flanges and covers, concealed snap flanges and mounting hardware included, provide adequate backing in wall for support and comply to local codes for barrier free requirements.
- .6 Carrier – Watts ISCA-101-L/R-M11 Carrier - Closet Carrier, Industry Standard single Horizontal adjustable Closet Carrier, Adjustable for standard and wheelchair height, 102 mm (4") no hub waste, 51 mm (2") no hub vent connections, patented compression seal faceplate assembly, epoxy coated cast iron, with incremental measurements embossed onto legs to easily adjust height of carrier to most commonly used fixture requirements, epoxy coated cast iron foot support, neoprene bowl gasket, epoxy coated cast iron, integral test cap, chrome cap nuts, Plated hardware, Adjustable ABS nipple, Tiling frame, Codes and Compliances: Carrier complies with requirements of ASME A112.6.1M up to a 500 lb (227 kg) static load.
- .7 Coupling – Champion MI-XHUB Coupling - Shielded Transition coupling, Unsized pipe, Four clamps for 2" to 4" pipe size, Six clamps for 5" to 15" pipe size, Type 304 stainless steel clamps, Type 304 AISI stainless steel Eyelets, Neoprene gasket gasket, Type 300 stainless steel shield painted red for easy identification, Type 305 stainless steel screw, 3/8" hex head screws, Type 304 AISI stainless steel screw housing, Codes and Compliances:., ASTM C-1540; ASTM standard 1460-2012, Comply to the FM 1680-1989 standard (except for markings), CAN/ULC S102.2-10.
- .4 WC-3 – Daycare Toilet – Floor Mounted with Floor Outlet
 - .1 American Standard Baby Devoro 10-1/4" High Elongated Toilet 3128 001. Vitreous china, High Efficiency, Low-consumption (4.8 Lpf/1.28gpf), 10-1/4" rim height, elongated front siphon flush action bowl, speed connect tank/bowl, chrome trip lever, sanitary bar on bowl. Tank model 4019 228 complete with coupling components and tank rim. Meets or exceeds ASME A112.19.2-2008/CSA B45.1-08.
 - .2 American Standard Baby Devoro #5001G055.020 Baby Toilet Seat, Heavy Duty, open front, White Finish Solid polypropylene plastic with EverClean antimicrobial surface, Less cover, Top mount hinges, Post nuts and washers.
 - .3 McGuire #LFH172BV Toilet Supply, Chrome plated finish polished brass, commercial duty 1/4 turn ball valve angle stops, 13 mm (1/2") I.D. Inlet x 127 mm (5") long rigid horizontal integral copper sweat tube nipples, combination V.P. Loose key handles, Escutcheon and flexible copper risers.
 - .4 Provide Floor Flange, (Same material as the connecting pipe drain), with all brass bolts and with rubber gasket.
- .5 L-1 – Wall Hung Lavatory
 - .1 Basin – American Standard 0955001EC.020 0059020EC.020 Basin - MURRO, Wall-hung Lavatory, Vitreous China, EverClean® antimicrobial surface, White finish, Single hole center set, Rear overflow, Faucet ledge with recessed self-draining deck, For concealed arm or wall support, Vitreous China shroud/knee contact guard with EverClean (0059020EC), Soap dispenser, When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud, Overall Dimensions: 545 mm (21-7/16") long, 540 mm (21-1/4") wide, 152 mm (6") high, Bowl Dimensions: 343 mm (13-1/2") long, 394mm (15-1/2") wide, 127 mm (5") deep.
 - .2 Faucet – Sloan EFX-200-CP-0.5GPM-MLM-IR-HLP-FCT Faucet - BASYS®, Counter mounted, Automatic no-touch, Hardwired less plug adapter, Lavatory faucet, Polished chrome finish, Single hole center set, Metal, Flexible supply hoses with 10 mm (3/8") compression connections, 1.9 LPM (0.5 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed spout, 153 mm (6") spout

- reach, 254 mm (10") high, Double infrared sensors with automatic setting feature, Solenoid housed in removable carrier that includes supply strainer, Above deck individual diagnostic indicators for battery life, solenoid condition, and power-up mode, Mixing valve ordered separately, Sloan transformer recommended, Vandal-resistant spray insert, key housed inside faucet body, Integral above deck water supply shut off, Line purge mode.
- .3 Power Kit – Sloan SL-EL-154 Faucet and Flush Valve Power Kit - For flush valve.
- .4 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI
- .5 Fixture Drain – McGuire 155A Fixture Drain - Straight drain, cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17-gauge 32 mm (1-1/4") Ø tailpiece diameter, 17-gauge 152 mm (6") long, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant.
- .6 Supply – McGuire LFBV170 Supply - Lead Free, with Chrome-plated finish, Convertible quarter-turn supply, Lavatory, 13 mm (1/2") copper sweat x 10 mm (3/8") outer Ø brass ball valve connection, one deep bell flange, Convertible loose key handle, extension is 127 mm (5") length, 304 mm (12") copper flexible risers.
- .7 P-Trap – McGuire 8872C P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") distance, with cleanout plug, Steel shallow flange, Neoprene gasket, Slip nuts, 17-gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant.
- .8 Carrier – Watts WCA-411-CA-481 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, Single floor-mounted lavatory carrier with concealed arms, for concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws, Wall mounted steel support plate with plated hardware.
- .6 L-2 –Wall Hung Lavatory – Barrier Free
- .1 Basin – American Standard 0955001EC.020 0059020EC.020 Basin - MURRO, Wall-hung Lavatory, Vitreous China, EverClean® antimicrobial surface, White finish, Single hole center set, Rear overflow, Faucet ledge with recessed self-draining deck, For concealed arm or wall support, Vitreous China shroud/knee contact guard with EverClean (0059020EC), Soap dispenser, When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud, Overall Dimensions: 545 mm (21-7/16") long, 540 mm (21-1/4") wide, 152 mm (6") high, Bowl Dimensions: 343 mm (13-1/2") long, 394mm (15-1/2") wide, 127 mm (5") deep.
- .2 Faucet – Sloan EFX-200-CP-0.5GPM-MLM-IR-HLP-FCT Faucet - BASYS®, Counter mounted, Automatic no-touch, Hardwired less plug adapter, Lavatory faucet, Polished chrome finish, Single hole center set, Metal, Flexible supply hoses with 10 mm (3/8") compression connections, 1.9 LPM (0.5 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed spout, 153 mm (6") spout reach, 254 mm (10") high, Double infrared sensors with automatic setting feature, Solenoid housed in removable carrier that includes supply strainer, Above deck individual diagnostic

indicators for battery life, solenoid condition, and power-up mode, Mixing valve ordered separately, Sloan transformer recommended, Vandal-resistant spray insert, key housed inside faucet body, Integral above deck water supply shut off, Line purge mode.

- .3 Power Kit – Sloan SL-ETF-416 Faucet and Flush Valve Power Kit - For faucet.
 - .4 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI
 - .5 Fixture Drain – McGuire 155A Fixture Drain - Straight drain, cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17-gauge 32 mm (1-1/4") Ø tailpiece diameter, 17-gauge 152 mm (6") long, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant.
 - .6 Supply – McGuire LFBV170 Supply - Lead Free, with Chrome-plated finish, Convertible quarter-turn supply, Lavatory, 13 mm (1/2") copper sweat x 10 mm (3/8") outer Ø brass ball valve connection, one deep bell flange, Convertible loose key handle, extension is 127 mm (5") length, 304 mm (12") copper flexible risers.
 - .7 P-Trap – McGuire 8872C P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") distance, with cleanout plug, Steel shallow flange, Neoprene gasket, Slip nuts, 17-gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant.
 - .8 Carrier – Watts WCA-411-CA-481 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, Single floor-mounted lavatory carrier with concealed arms, for concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws, Wall mounted steel support plate with plated hardware.
- .7 L-3 – Wall Hung Lavatory – Daycare
- .1 Basin – American Standard 0955001EC.020 0059020EC.020 Basin - MURRO, Wall-hung Lavatory, Vitreous China, EverClean® antimicrobial surface, White finish, Single hole center set, Rear overflow, Faucet ledge with recessed self-draining deck, For concealed arm or wall support, Vitreous China shroud/knee contact guard with EverClean (0059020EC), Soap dispenser, When installed with a below deck electronics faucet which has the control box, the accessories will not fit under the shroud and will need to be installed outside the shroud, Overall Dimensions: 545 mm (21-7/16") long, 540 mm (21-1/4") wide, 152 mm (6") high, Bowl Dimensions: 343 mm (13-1/2") long, 394mm (15-1/2") wide, 127 mm (5") deep. **Refer to Architectural for mounting heights.**
 - .2 Faucet – Sloan EFX-200-CP-0.5GPM-MLM-IR-HLP-FCT Faucet - BASYS®, Counter mounted, Automatic no-touch, Hardwired less plug adapter, Lavatory faucet, Polished chrome finish, Single hole center set, Metal, Flexible supply hoses with 10 mm (3/8") compression connections, 1.9 LPM (0.5 GPM) maximum flowrate, Multi-laminar spray outlet, Fixed spout, 153 mm (6") spout reach, 254 mm (10") high, Double infrared sensors with automatic setting feature, Solenoid housed in removable carrier that includes supply strainer, Above deck individual diagnostic indicators for battery life, solenoid condition, and power-up mode, Mixing valve ordered

separately, Sloan transformer recommended, Vandal-resistant spray insert, key housed inside faucet body, Integral above deck water supply shut off, Line purge mode.

- .3 Power Kit – Sloan SL-ETF-416 Faucet and Flush Valve Power Kit - For faucet
 - .4 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, lintegral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI.
 - .5 Fixture Drain – McGuire 155A Fixture Drain - Straight drain, cast brass, Chrome-plated finish, Open grid PO plug, 7/32" (5.5 mm) Ø holes size, 17-gauge 32 mm (1-1/4") Ø tailpiece diameter, 17-gauge 152 mm (6") long, Brass locknut, Heavy rubber basin washer Fiber friction washer, ASME A112.18.2 CSA B125.2, CSA compliant.
 - .6 Supply – McGuire LFBV170 Supply - Lead Free, with Chrome-plated finish, Convertible quarter-turn supply, Lavatory, 13 mm (1/2") copper sweat x 10 mm (3/8") outer Ø brass ball valve connection, one deep bell flange, Convertible loose key handle, extension is 127 mm (5") length, 304 mm (12") copper flexible risers.
 - .7 P-Trap – McGuire 8872C P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") distance, with cleanout plug, Steel shallow flange, Neoprene gasket, Slip nuts, 17-gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant. Provide 0059.020EC Shroud/Knee Contact Guard.
 - .8 Carrier – Watts WCA-411-CA-481 Carrier - WCA-411/WCA-411-WC, Lavatory carrier, Single floor-mounted lavatory carrier with concealed arms, for concealed arm carrier, adjustable arms, epoxy coated cast iron, integral welded feet, upper tie rod, Heavy gauge steel offset uprights, basin locking device, Plated hardware, levelling screws, Wall mounted steel support plate with plated hardware.
- .8 S-1 – Counter Mounted, Drop-In, Commercial Sinks
- .1 Sink – Franke Commercial LBS4010P-1-3 Sink - Single compartment sink, 3 faucet holes, 203 mm (8") center set, Single hole centerset, With faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, standpipe with guard, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: 356 mm (14") long, 508 mm (20") wide, 254 mm (10") deep, Overall Dimension: 478 mm (18-13/16") long, 562 mm (22-1/8") wide, 254 mm (10") high.
 - .2 Faucet – Chicago Faucets 786-GN8FCABCP Faucet - Counter mounted, Manual, Two handles, Sink faucet, Chrome-plated finish, 203 mm (8") center set, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, ECAST® brass construction, -377-XTAB quatern compression cartridge, 5.7 LPM (1.5 GPM) maximum flowrate, -FC 5.7 LPM (1.5 GPM) laminar flow control insert in spout inlet, plain end outlet, Gooseneck spout, 203 mm (8") spout reach, -317-PR

- vandal-resistant 102 mm (4") metal wrist blade handles with red & blue index, Grid drain included, 13 mm (1/2") NPSM supply inlet for 10 mm (3/8") or 13 mm (1/2") flexible riser.
- .3 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI.
- .4 Supply – McGuire LFCK170 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit w/5" sweat extension, Faucet, Sweat to compression connection, 1/2" Sweat w/5" Sweat extension x 3/8" O.D connection, Deep bell wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC.
- .5 P-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, with cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .9 S-2.1 and S-2.2 – Counter Mounted, Drop-In, Commercial Sinks
- .1 Sink – Franke Commercial LBS4010P-1-1 Sink - Single compartment sink, 203 mm (8") center set, Single hole centerset, With faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, standpipe with guard, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: 406 mm (16") long, 457 mm (18") wide, 203 mm (8") deep, Bowl Dimension: 356 mm (14") long, 508 mm (20") wide, 254 mm (10") deep, Overall Dimension: 478 mm (18-13/16") long, 562 mm (22-1/8") wide, 254 mm (10") high.
- S-2.2 – Lower counter mounted. **Refer to Architectural for Millwork heights.**
- .2 Faucet – American Standard 7074300.002 Faucet - COLONY®, Counter mounted, Manual, Single handle, Sink faucet, Polished chrome finish, Single hole center set, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, Metal, Integral check valve, 610 mm (24") flexible colour-coded braided stainless steel supply hoses with 10 mm (3/8") compression connections, Ceramic disc cartridges, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating spray outlet, Pull-down spray with adjustable spray pattern and pause feature, Brass spout, Pull down, 227 mm (8-15/16") spout reach, 375 mm (14-3/4") high, Lever handle.
- .3 Mixing Valve Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI.

- .4 Supply – McGuire LFCK170 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit w/5" sweat extension, Faucet, Sweat to compression connection, 1/2" Sweat w/5" Sweat extension x 3/8" O.D connection, Deep bell wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC.
- .5 P-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .10 S-3 – Counter Mounted, Drop-In, Commercial Double Compartment Sinks
 - .1 Sink – Franke Commercial LBD6408P-1-3 Sink – Double compartment sink, 203 mm (8") centerset, With faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners. Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, standpipe with guard, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: 356 mm (14") long, 406 mm (16") wide, 203 mm (8") deep, Overall Dimension: 794 mm (31-1/4") long, 521 mm (20-1/2") wide, 203 mm (8") high.
 - .2 Sink – Franke Commercial LBD6410P-1-3 Sink – Double compartment sink, 203 mm (8") centerset, With faucet ledge, 18 gauge Type 304 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners. Factory applied rim seal, Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, standpipe with guard, 89 mm (3-1/2") crumb cup strainer, Undercoated to reduce condensation and resonance, ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: 356 mm (14") long, 406 mm (16") wide, 254 mm (10") deep, Overall Dimension: 794 mm (31-1/4") long, 521 mm (20-1/2") wide, 254 mm (10") high.
 - .3 Faucet – American Standard 7074300.075 Faucet - COLONY®, Counter mounted, Manual, Single handle, Sink faucet, Stainless steel finish, 203 mm (8") center set, Installed with included 244 mm (9-5/8") deck plate, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, Metal, Integral check valve, 610 mm (24") flexible colour-coded braided stainless steel supply hoses with 10 mm (3/8") compression connections, Ceramic disc cartridges, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating spray outlet, Pull-down spray with adjustable spray pattern and pause feature, Brass spout, Pull down, 227 mm (8-15/16") spout reach, 375 mm (14-3/4") high, Lever handle.
 - .4 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI.
 - .5 Supply – McGuire LFCK170 Supply - ICV DEFENDER, Lead Free, with Chrome-plated finish, Integral check supply kit w/5" sweat extension, Faucet, Sweat to compression connection, 1/2" Sweat w/5" Sweat extension x 3/8" O.D connection, Deep bell wall flange, Wheel handle, Full turn brass stem, 305 mm (12") chrome-plated risers, Purple EPDM peroxide cured washers, Codes and compliances: NSF/ANSI 61 & 372, UPC.

- .6 P-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, with cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .11 S-4 – Counter Mounted, Drop-In, Commercial Triple Compartment Sink
 - .1 Sink – Franke Commercial LBT6410CB-1-3 - Triple compartment sink, 203 mm (8") centerset, With faucet ledge, 20 gauge Type 302 Stainless steel Polished to #4 satin finish, Factory installed EZ TORQUE™ fasteners, Factory applied rim seal. Center back waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included. Undercoated to reduce condensation and resonance, ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimension: 356 mm (14") long, 406 mm (16") wide, 254 mm (10") deep. Overall Dimension: 1178 mm (46-3/8") long, 522 mm (20-9/16") wide, 254 mm (10") high.
 - .2 Faucet – American Standard 7074300.075 Faucet - COLONY®, Counter mounted, Manual, Single handle, Sink faucet, Stainless steel finish, 203 mm (8") center set, Installed with included 244 mm (9-5/8") deck plate, Lead Free ANSI/NSF 61 and ANSI/NSF 372 compliant, Metal, Integral check valve, 610 mm (24") flexible colour-coded braided stainless steel supply hoses with 10 mm (3/8") compression connections, Ceramic disc cartridges, 5.7 LPM (1.5 GPM) maximum flowrate, Pressure compensating spray outlet, Pull-down spray with adjustable spray pattern and pause feature, Brass spout, Pull down, 227 mm (8-15/16") spout reach, 375 mm (14-3/4") high, Lever handle.
 - .3 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI
 - .4 Supply – McGuire LFCK170SS12 ICV DEFENDER Faucet Supply kit, consisting of (2) stop valves, (2) risers, (2) flanges (standard), Lead Free Brass body, Chrome-plated finish, 138 - 862 kPa (20 - 125 PSI) operating pressure, 4 to 60 °C (40 to 140 °F) operating temperature, Wheel handle (standard), Full turn, Angle stop, Spring actuated integral check valve, C.P. wrought steel deep bell wall flange (standard), C.P. prefabricated 127 mm (5") copper sweat tube extension nipple, 305 mm (12") C.P. lavatory braided stainless riser tube, 13 mm (1/2") Sweat inlet x 10 mm (3/8") O.D. outlet, 82 °C (180 °F) maximum during high-temperature system flush.
Compliances and certifications: AB100 compliant, ASME A112.18.3, ASME A112.18.2-2 (risers), CSA B125.2 compliant (risers), Certified to NSF/ANSI372, Certified to NSF/ANSI61, UPC compliant.
 - .5 P-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, with cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .12 S-5 – Wall-Hung, Handwash Sink
 - .1 Sink – Franke Commercial WSS6713-2 Sink - Single compartment sink, 203 mm (8") center set, Service sink, with overall dimension 508 mm (20") long, 483 mm (19") wide, 635 mm (25") high, constructed from 14 gauge Type 304 Stainless steel, Bowl dimensions are 432 mm (17") long, 406 mm (16") wide, 330 mm (13") deep, Polished to #4 satin finish, With 305 mm (12") high

- backsplash, Radius coved bowl corners, Less overflow, Center waste location, 89 mm (3-1/2") crumb cup strainer, Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant.
- .2 Faucet – Chicago Faucets 897-RCF Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Rough chrome plated finish, 194 - 213 mm (7-5/8" to 8-3/8") adjustable center set, Round wall escutcheons, Brass construction, Adjustable supply arms, 1/4 turn ceramic cartridge, No flow restrictor, Threaded hose end, Spout with pail hook, 146 mm (5-3/4") spout reach, 273 mm (10-3/4") high, Top brace, 60 mm (2-3/8") lever handle with indexed buttons, Atmospheric vacuum breaker is not intended for continuous pressure applications.
- .3 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSIP-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, With cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .13 SS-1 – Scullery Sink
- .1 Sink – Franke Commercial DL2448-1-2 CL-DB Sink - Double compartment sink, 203 mm (8") center set, Scullery sink, with overall dimension 1305 mm (51-3/8") long, 691 mm (27-3/16") wide, 1118 mm (44") high, constructed from Grade 18-10 16 gauge Type 304 Stainless steel, Left bowl is 610 mm (24") long and right bowl is 610 mm (24") long, Left bowl is 610 mm (24") wide and right bowl is 610 mm (24") wide, Left bowl is 356 mm (14") deep and right bowl is 356 mm (14") deep, Finished with rolled rim, Polished to #4 satin finish, With backsplash, Radius coved corners on front and back only, CL-DB drainboard, Less overflow, Stainless steel tubular legs with adjustable feet for leveling, Center waste location, 38 mm (1-1/2") (DN38) brass tailpiece, 89 mm (3-1/2") crumb cup strainer, waste fitting included, Codes and Compliances: ASME A112.19.3 compliant, CSA B45.4 compliant.
- .2 Faucet – Chicago Faucets 510-G613L12XKCAB Faucet - Wall-hung, Manual, Two handles, Pre-rinse fitting, Chrome-plated finish, 203 mm (8") center set, Lead free compliant, ECAST® brass construction, 1/4 turn ceramic cartridge with integrated check valve, 3.8 LPM (1.0 GPM) flowrate @60 PSI pre-rinse spray valve, Spray outlet, Pre-rinse spout, Pull down, 292 mm (11-1/2") spout reach, 1146 mm (45-1/8") high, Pre-rinse spout and valve consisting of 584 mm (23") riser with spring guide, 1118 mm (44") flexible stainless steel hose with insulated handle, pipe strap and hook assembly, Vandal-resistant 60 mm (2-3/8") lever handle with indexed buttons, 13 mm (1/2") NPT female thread inlet.
- .3 Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSIP-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap,

- 292 mm (11-1/2") length, with cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .4 P-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") length, with cleanout plug, Steel box flange, Neoprene gasket, Seamless tubular brass bend, Slip nuts.
- .14 LS-1 – Laundry Scullery Sink
- .1 Sink – Franke Commercial SL2424-5-2-CL-DB, 203 mm (8") centerset, without faucet ledge 16 gauge Type 304 stainless steel, polished to a satin finish, 229 mm (9") high backsplash, Radius coved corners on front and back only, CL-DB drainboard, Stainless steel tubular legs with adjustable feet for leveling, Rear corner waste locations, 38 mm (1-1/2") (DN38) brass tailpiece, Standpipe with guard, 38 mm (1-1/2") duplex waste with rubber stopper ASME A112.19.3 compliant, CSA B45.4 compliant, Bowl Dimensions 610 mm (24") long 610 mm (24") wide, 356 mm (14") deep; Overall Dimensions 691 mm (27-3/16") long, 691 mm (27-3/16") wide 1119 mm (44-1/16") high
- .2 Faucet - Chicago Faucets 510-G613L12XKCAB Wall-hung, Manual, Two handles, Pre-rinse fitting, Chrome-plated finish, 203 mm (8") centerset, Lead free compliant, ECAST® brass construction, 1/4 turn ceramic cartridge with integrated check valve, 3.8 LPM (1.0 GPM) flowrate @60 PSI pre-rinse spray valve, Spray outlet, Pre-rinse spout, Pull down, 292 mm (11-1/2") spout reach, 1146 mm (45-1/8") high. Pre-rinse spout and valve consisting of 584 mm (23") riser with spring guide), 1118 mm (44") flexible stainless steel hose with insulated handle), pipe strap and hook assembly), Vandal-resistant 60 mm (2-3/8") lever handle with indexed buttons), 13 mm (1/2") NPT female thread inlet
- .3 Mixing Valve - Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, lintegral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI.
- .4 P-Trap – McGuire 8912CB P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") distance, With cleanout plug, Steel box flange, Neoprene gasket, Slip nuts, Seamless tubular brass bend, ASME A112.18.2 CSA B125.2, CSA compliant
- .15 LB-1 – Plastic Laundry Box (Fire Rated) (8-3/16" W X 7-1/16" H X 3-5/16" D)
- .1 Laundry Box – PPP MM-500 PLBFR Laundry Box - Plastic, Solenoid operated equipment can create destructive water hammer, by adding the Ice maker box assembly you are protecting your equipment as well as insuring against premature replacement.
- .16 MS-1 – Floor Mounted, Mop Service Sinks
- .1 Sink – Stern Williams SB-900-T-35-T-40-BP Sink - Single compartment sink, Mop service sinks, with overall dimension 610 mm (24") long, 610 mm (24") wide, 305 mm (12") high, constructed from Precast terrazzo, Bowl dimensions are 546 mm (21-1/2") long, 546 mm (21-1/2") wide, 254 mm (10") deep, Pearl grey marble chips and white Portland cement, 76 mm (3") pipe size, cast integrally and provides for a caulked lead connection not less than 25 mm (1") deep to a 76 mm

- (3") pipe, flat stainless steel strainer, Without tiling flange, With stainless steel cap, Hose and wall hook, Mop hanger, Splash catcher.
- .2 Faucet – American Standard 8354112.002 Faucet - Wall-hung, Manual, Two handles, Mop sink faucet, Polished chrome finish, 152 - 254 mm (6" - 10") adjustable center set, Brass construction, Integral check valve, Ceramic disc cartridge, no flow restrictor, 37.8 LPM (10 GPM) @20 PSI, Threaded hose end, Cast brass spout with bucket hook, 248 mm (9-3/4") spout reach, Top brace, Vandal-resistant lever handles, 13 mm (1/2") female inlet.
- .3 Mixing Valve – Lawler TMM-1070-87500 Mixing Valve - The point of use mechanical mixing valve with thermostatic limit stop, MECHANICAL MIXING VALVE, lead free brass body construction, The temperature adjusting dial is located on the cold inlet. Turning the dial clockwise will lower the outlet temperature, turning the dial counterclockwise will raise it. The valve cannot be adjusted above its shut-off temperature of 120F, 1.8 LPM (0.5 GPM) tempered flowrate @ 5 PSI pressure drop, Compression Fitting, 84 mm (3-5/16") high, ASSE 1070 approved ASSE lead free Certified for ASSE 1070 applications, 3/8" MNPT (9.5 mm) inlet, 3/8" MNPT (9.5 mm) outlet, Integral rubber duck-bill backflow checks, High temperature limit stop, 125 PSI max supply pressure, Automatically shuts down flow of water when temperature reaches 120 °F, 5 PSI Minimum Operating pressure, 140 °F max, 118 °F ±3 °F, Protects against scalding and chilling, 8 LPM (2.1 GPM) flowrate @ 45 PSI
- .17 EW-1 – Eye Wash Station Stainless Steel Bowl
- .1 Emergency Equipment – Guardian G1814-G3600LF-T Emergency Equipment - Wall-hung, Eye wash, constructed from Type 304 brushed stainless steel finish, Thermostatic mixing valve blends hot and cold water, 283 mm (11-1/8") Ø bowl size, Corrosion resistant powder coated finish, Two GS-Plus spray heads with flip top dust cover each, 13 mm (1/2") Ø IPS Chrome plated brass stay open ball valve, 13 mm (1/2") Ø NPT female inlet supply inlet, Chrome plated brass tailpiece and trap with 1-1/2" (38 mm) IPS waste connection, 32 mm (1-1/4") Ø NPT female outlet, Codes and Compliances:, ANSI compliant.
- .18 BF-1 – Surface Wall Mounted, Drinking Fountain with Bottle Filler.
- .1 Drinking Fountain– Murdock Mfg A171108F-UG-CSC5-DD-BF12-BCD Drinking Fountain - shall be Wall mounted (On wall), Surface mounted, Drinking fountain with Bottle filler, Hands-free sensor operation or pushbutton operated activation, Requires less than 5 pounds of force to activate (push button), 1 serving station, Indoor application, Low flow flexible bubbler, Gray finish cooler with satin finish bottle filler, Laminar flow provides clean fill with minimal splash, 12 m³/h (52.8 GPM), Bottle Filler included, Bottle filler with sensor operation with bottle counter display, 3.79 LPM (1 GPM) fill rate, Refrigerant R-134a is controlled by accurately calibrated capillary tube., 100 mesh inlet strainer, Concealed support carrier, Drop Down Door (includes WF1 1500-gallon capacity, NSF 42+53, 1 micron lead reduction filter), 335 watts, 4.4 Amps, 120 VAC/9.0VDC Plug-in Transformer, with -BF12 Only, 20-105 psig bubbler water-pressure range, Adjustable thermostat control, Codes and compliances:, ADA compliant when installed without shroud option, Buy American Act, ADA & ICC A117.1, NSF/ANSI 61 & 372 (lead free), UL 399, GreenSpec, CAN/CSA C22.2 No.120, ASME A112.19.3/CSA B45.4.
- .2 Stop Valves – McGuire LFHST01 Stop Valves - Lead Free, Chrome-plated finish, 3/8" I.P.S x 3/8" O.D
- .3 P-Trap – McGuire 8872C P-Trap - Heavy cast brass, Adjustable p-trap, 292 mm (11-1/2") distance, With cleanout plug, Steel shallow flange, Neoprene gasket, Slip nuts, 17-gauge seamless tubular wall bend, ASME A112.18.2 CSA B125.2, CSA compliant
- .4 Carrier – Watts CA-321 Carrier - epoxy coated, Urinal Carrier, Floor Mounted Urinal Carrier with Bearing Plate, Wall Plate, welded feet, Universal steel hangar support plate, bottom bearing plate, Heavy gauge steel offset uprights, integral mounting brackets, Plated hardware.

.19 NFHB-1 – Hose Bibb

- .1 Wall Faucet – Zurn Z1320XL – Recessed wall hydrant, encased, Ecolotrol™, lead-free, non-freeze automatic draining wall hydrant for flush installation. Hydrant features integral backflow preventer with anti-siphon technology, copper casing, all-bronze interior components with 1/2 turn long-life ceramic disc cartridge, combination 19mm (3/4”) female solder and 19mm (3/4”) male pipe thread inlet connection, and 19mm (3/4”) male hose connection. Hydrant furnished with type 304 stainless steel housing with locking hinged cover stamped “WATER” and includes operating key.

2.04 Caulking

- .1 General Electric Series SCS-1200 Silicone Construction Sealant or Dow Corning 780 silicone rubber sealant with primers as recommended by sealant manufacturer. Caulking colour(s) for coloured fixtures other than white, if any, will be selected by the Consultant from sealant manufacturer’s standard colour range.

3 Execution

3.01 Installation of Plumbing Fixtures and Fittings

- .1 Provide required plumbing fixtures and fittings.
- .2 Where new fixtures and fittings are to be connected to existing piping, include for required piping revisions.
- .3 Connect plumbing fixtures and fittings with piping sized in accordance with drawing schedule. Refer to manufacturer’s published connection (rough-in) requirements. Where manufacturer requires piping connection larger than shown below, provide piping accordingly:

Fixture and/or Fitting	Drain Size mm (in)	Vent Size mm (in)	DHW Size mm (in)	DCW Size mm (in)	Temp Water Size mm (in)
Water Closets Flush Valve Type	100 (4)	38 (1-½)	-	25 (1)	-
Urinals	75 (3)	38 (1-½)	-	25 (1)	-
Lavatories	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	-
Lavatories (Electronic Faucet)	32 (1-¼)	32 (1-¼)	12 (½)	12 (½)	12 (½)
Counter Sinks	38 (1-½)	32 (1-¼)	12 (½)	12 (½)	-
Shower Valves and Heads	-	-	12 (½)	12 (½)	12 (½)
Shower Stalls	50 (2)	38 (1-½)	12 (½)	12 (½)	12 (½)
Prefab. Mop Sinks with Drain	75 (3)	38 (1-½)	20 (¾)	20 (¾)	-
Emergency Eye Wash	-	-	-	-	12 (½)
Emergency Shower	-	-	-	-	25 (1)

- .4 Confirm exact location of plumbing fixtures and trim prior to roughing-in. Refer to architectural plan and elevation drawings.

- .5 When installation is complete, check, and test operation of each fixture and fitting. Adjust or repair as required.
- .6 For barrier-free fixtures, comply with mounting height and other requirements of governing Code(s).
- .7 For barrier-free water closets utilizing manual flush controls, controls to be installed so that it is operable from the transfer side of the fixture.
- .8 For barrier-free lavatories with exposed piping ensure a shroud is provided to meet the requirements of governing Code(s).
- .9 Supply templates for counter mounted fixtures and trim and hand to trades who will cut the counter. Ensure openings in counter are properly located.
- .10 Locate control panels for electronic faucets under lavatories and recessed into wall. Coordinate panel installations with electrical trade who will provide 115 V power wiring to panels. Install flexible conduit (supplied with box) and extend cord from faucet through the flexible conduit to control box. Connect hot and cold water piping to mixing valve in each box, and tempered water piping from each mixing valve to faucet. Set mixing valve maximum temperature limit stops to 43°C (110°F) after domestic water systems (hot and cold) are complete. Ensure each programmable controller is properly programmed and water off after deactivation is set for 3 seconds.
- .11 For electronic flush valves, locate transformer in ceiling space above electronic units to be served. Coordinate locations with electrical trade who will provide 120 V line supply to transformers. Provide low voltage wiring from transformers to each electronic flush valve terminal point. Electrical line supply and low voltage wiring is to be concealed and access to transformer must be provided for servicing.
- .12 Protect shower bases from damage during construction and finishing work.
- .13 Confirm exact mixing valve and shower head locations prior to roughing-in.
- .14 Install refrigerated drinking fountains in accordance with manufacturer's instructions. Plug into a wall receptacle provided as part of electrical work. Coordinate receptacle installation with electrical trade on site.
- .15 For emergency showers, install so bottom of shower head is approximately 2 m (82 in) above floor, and approximately 400 mm (16 in) out from the wall. Wall mount mixing valve approximately 1.5 m (5 ft) above floor and adjacent shower head. Set valve temperature limit stop to 35°C (95°F). Ensure valve is open and exposed piping is chrome plated or stainless steel.
- .16 Install eye wash fixtures in accordance with manufacturer's instructions. Ensure exposed piping is painted.
- .17 Wall mount mixing valves for emergency fixtures approximately 1.5 m (5 ft) above floor and secure in place. Check and confirm valve operation and temperature of tempered water supply. Provide cabinets. Identify each cabinet and hand 3 identified cabinet keys to Consultant prior to Substantial Performance of the Work.
- .18 Set mop service basins on floor over drain piping and connect to roughed-in service. Install wall supply trim and any accessories specified.

3.02 Caulking at Plumbing Fixtures and Fittings

- .1 Caulk around plumbing fixtures and fittings where they contact walls, floors, and any other building surface.

- .2 Clean areas/surfaces to be caulked and prime in accordance with sealant manufacturer's instructions. Where damage to a building surface may occur, mask surface to prevent damage and ensure a clean exact edge to the caulking bead.
- .3 Apply caulking using a gun with proper size and shape of nozzle and force sealant into joints to ensure good surface contact and a smooth and even finished bead of sealant.
- .4 If joints have been masked sealant may be tooled in a continuous stroke to obtain complete void filling. Remove masking tape immediately after tooling and before sealant begins to skin.

3.03 Dishwasher Connections

- .1 Provide roughed-in water and drain connections for Owner supplied dishwasher consisting of:
 - .1 15 mm (½") dia. domestic hot water connection with a Dahl "Mini-Ball" valve with hose end and water hammer arrestor;
 - .2 40 mm (1-½") dia. DWV copper drain connection with "P" trap and cleanout plug.

3.04 Clothes Washer Connections

- .1 Provide roughed-in water and drain connections for Owner supplied clothes washer consisting of:
 - .1 15 mm (½") dia. piping connection for both hot and cold water, each terminated in a Dahl "Mini-Ball" Valve with hose end and water hammer arrestor;
 - .2 50 mm (2") dia. standing waste with a height to suit the washer drain and complete with a "P" trap.

End of Section

1 General

1.01 Section Includes

- .1 Materials and installation for piping, valves, and fittings for gas fired equipment.

1.02 References

- .1 CSA B149.1:20, Natural Gas and Propane Installation Code.
- .2 TSSA FS-255-21, Gaseous Fuels Code Adoption Document Amendment: Ontario requirements effective May 1, 2021.
- .3 CSA C282:19, Emergency electrical power supply for buildings.

1.03 Definitions

- .1 PRV – Pressure Reducing Valve.

1.04 Submittals

- .1 Submit shop drawings/product data for all products specified in Part 2 of this section except for pipe, fittings, and unions. Indicate performance criteria, conformance to appropriate reference standards, and limitations.
- .2 For each gas pressure regulating station, submit:
 - .1 a selection sheet for each PRV, indicating connected equipment, heating loads, design allowance, meter model, body size, spring range and orifice size;
 - .2 a selection sheet for each relief valve(s) serving a PRV.

1.05 Closeout Submittals

- .1 Submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00.
- .2 Indicate operating set-points, relief settings and vent arrangements for each regulating station on as-built record drawings.

1.06 Quality Assurance

- .1 All gas system work is to be in accordance with requirements of CSA B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
- .2 All gas system work is to be performed only by licensed gas pipe fitters (holding Gas Technician 1 Certificate) authorized under the TSSA Act.
- .3 Apply for, on TSSA forms, approval of the gas system design by the TSSA prior to work beginning at the site and prior to ordering any equipment. Submit the completed TSSA form and copies of shop drawings/product data sheets as required to the TSSA and obtain an approval certificate. Pay all costs for the TSSA review and approval process. If the TSSA requires revisions to the system and the revisions result in an extra cost, a Notice of Change will be issued by the Consultant for the revision.

2 Products

2.01 Pipe, Fittings, and Joints

- .1 Coated Black Steel - Welded Joints: "Yellow Jacket" Schedule 40 mild black carbon steel, ASTM A53, Grade B, factory coated with yellow plastic, mill or site bevelled, and complete with forged steel butt welding fittings and welded joints. All bare metal surfaces are to be cleaned and corrosion protected with a suitable Denso primer and tape corrosion protection system.
- .2 Polyethylene: Safety yellow coloured polyethylene pipe, fittings, and joints to CSA-B137.4.
- .3 Coated Copper: Type "K" soft temper copper with a factory applied external yellow plastic coating and flare fittings with forged brass nuts to CAN/CSA-B149.1. Nuts are to be stamped with the designation C37700 to indicate that they are forged brass.
- .4 Uncoated Black Steel - Screwed Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, complete with malleable cast iron screwed fittings to ANSI B2.1, and screwed joints.
- .5 Uncoated Black Steel - Welded Joints: Schedule 40 mild black carbon steel, ASTM A53, Grade B, mill or site bevelled, complete with factory made forged steel butt welding fittings and welded joints.
- .6 Copper-Uncoated: Type "G" seamless copper tubing to ASTM B837, hard temper with wrought copper capillary brazed joint type fittings to ASTM B.61, and brazed joints made with "Sil-Fos" or "Sil-Fos 5" brazing alloy, or, soft temper with flared brass fittings of a single 45° flare type, forged or with a machined long nut and copper to copper threaded connectors, and, where required, flared brass copper to NPS adapters.
- .7 Flexible Stainless Steel: Flexible, CSA certified, 860 kPa (125 psi) rated, gas-tight, convoluted stainless steel tubing factory jacketed with a bright yellow PVC coating which is continuously identified. The tubing is to be supplied in coils and is to be complete with factory attached stainless steel end fittings, and adapter unions, protective plates, and steel clamps.
 - .1 Manufacturers:
 - .1 Tru-Flex Metal Hose LLC. "Pro-Flex";
 - .2 Titeflex Corp. "Gastite";
 - .3 Omega Flex Canada "TracPipe".

2.02 Piping Unions

- .1 Screwed Piping: Malleable iron, ground joint, bronze or brass to iron or bronze to bronze seat screwed unions and union elbows with a minimum pressure rating of 1725 kPa (250 psi) steam at 260°C (500°F).
- .2 Flanged Piping: Forged carbon steel slip-on type raised faced welding flange unions to ASTM A105, 150 lb. Class for steel pipe, and slip-on type 150 lb. Class bronze flanges for copper pipe.
- .3 Copper to Steel: Equal to Kamco Products "Copper Stopper".

2.03 Earthquake Activated Automatic Shut-Off Valves

- .1 Equal to KAS International or Nihon Koso Model 315 HPF earthquake activated, flanged, high pressure automatic shut-off valve suitable for both natural gas and propane, ULC listed and in accordance with ANSI Z21.70, Earthquake Actuated Automatic Gas Shutoff Valves.

2.04 Shut-Off Valves

- .1 Ball Type:

- .1 CSA certified, minimum 3100 kPa (450 psi) WOG rated, 1/4 turn, full port non-lubricated brass ball valves, each complete with a Teflon PTFE seat, chrome plated solid ball, removable lever handle, and screwed ends.
- .2 Manufacturers:
 - .1 Neo Valves Inc. #425;
 - .2 Kitz Corp. Code 58;
 - .3 Toyo Valve Co. Fig. 5044A.
- .2 Plug or Ball Type: CSA certified, plain face flanged, Class 125, 1380 kPa (200 psi) rated, 1/4 turn, cast iron lubricated plug valves, each wrench operated and complete with cylindrical plug with lubricant grooves, lubricant screw, and lubricant receptacle, or full port carbon steel ball valves with flanged ends.
 - .1 Manufacturers:
 - .1 Neo Valves Inc. #1AS40114 plug valve;
 - .2 Newman Hattersley #171M plug valve;
 - .3 Kitz Corp. Code No. 150 SCTAM-FS-CGA ball valve.

2.05 Position Indicating Switches for Shut-Off Valves

- .1 CSA approved limit switch, rated EX db IICT6/EX tb IIIC T85°C explosion proof, class 1, zone 1, IP67 enclosure.
- .2 Secure water resistant case with multi-angle top and side visual indicator. Red to indicate fully closed position and yellow to indicate fully open position.
- .3 Two single pole double throw mechanical switches.
- .4 Includes position indicating contacts for connection of supervisory cabling and remote monitoring of valve status.
- .5 NAMUR shaft.
- .6 Ensure the shut off valve and the position indicating switch are compatible with one another.
- .7 Manufacturers:
 - .1 CVS Controls Ltd., CVS 870 series limit switch.
 - .2 Rotork.
 - .3 Topworx.

2.06 Natural Gas Convenience Outlet

- .1 Neo Valves Model 3/375 quick-connect type CSA certified outlet with interlocking safety cam to prevent release of the appliance connector until the valve is off, integral thermal protection to prevent gas flow if the outlet is exposed to temperatures exceeding 90°C (195°F), and a wall enclosure box.
- .2 Manufacturers:
 - .1 Neo Valves Inc.;

- .2 Fairview Fittings & Mfg. Ltd.

2.07 Pressure Regulators

- .1 CSA certified pressure regulators as follows:
 - .1 non-vented type: lever action, dead end lockup type, each complete with a vent limiter, self-aligning valve, die-cast aluminium housing, and synthetic rubber compound diaphragm.
 - .2 vented type: spring-loaded self-operated design, tight closing, selected for the facility gas pressure and piping pressure loss, and connected equipment load at full firing rate plus 20% spare, and complete with:
 - .1 1035 kPa (150 psi) rated cast iron body finished with corrosive resistant epoxy enamel.
 - .2 Aluminum diaphragm and spring case with Nitrile diaphragm, disc, and body o-ring.
 - .3 Throttling type, high flow rate, tight shut-off relief valve selected to protect equipment downstream of the regulator in coordination with regulator capacity.
- .2 Manufacturers:
 - .1 Maxitrol Co.
 - .2 Fisher Controls.
 - .3 Leslie Controls Inc.
 - .4 Lakeside Process Controls.

3 Execution

3.01 Natural Gas Service

- .1 Make all required arrangement with the natural gas supply utility on behalf of the Owner for installation of natural gas service piping with gas pressure regulator and meter assembly.
- .2 Provide an earthquake activated automatic shut-off valve in gas service piping outside the building in accordance with the valve manufacturer's installation instructions. Provide an angle iron framed wire mesh enclosure around the valve and bolted to the wall.
- .3 Provide 2 m (7') high minimum 200 mm (8") diameter Schedule 80 galvanized steel concrete filled bollards at the meter-regulator location in a pattern to protect the meter-regulator. Install the pipe straight and plumb a 1.2 m (4') below grade in a continuous 600 mm (2') diameter reinforced concrete footing. Smoothly crown the top of the concrete above the top of the pipe.
- .4 Maintain minimum 300 mm (12 in) horizontal separation between buried natural gas piping and other services.

3.02 Natural Gas Piping Installation Requirements

- .1 Provide all required natural gas distribution piping and connect gas fired or operated equipment, and provide all required vent piping to atmosphere, including vent piping from pressure regulators. Do all piping work in accordance with requirements of CAN/CSA-B149.1, Natural Gas and Propane Installation Code, as amended by local Gas Codes.
- .2 Piping is to be as follows:

- .1 for underground piping, coated Schedule 40 black steel, coated soft copper, or polyethylene;
- .2 for above ground piping, uncoated Schedule 40 black steel, hard temper or soft copper, or, if permitted, flexible stainless steel.
- .3 Install flexible stainless steel pipe in strict accordance with the pipe manufacturer's printed instructions.
- .4 Slope gas piping in the direction of flow to low points.
- .5 Where natural gas piping is run vertically through internal building risers, provide vent through roof for reach riser.
- .6 Where natural piping serving an emergency generator is run internally to the building, provide a fire rated enclosure around that piping, isolated from all other natural gas piping or other building services.
- .7 Ensure that supports for roof mounted piping are sized (height) to accommodate the roof slope and the required piping slope, and to permit the installation of low point dirt pockets.
- .8 Provide full pipe diameter 150 mm (6") long drip pockets at the bottom of all vertical risers, at all piping low points, and wherever else shown and/or required.
- .9 Identify all natural gas piping above ground with two coats of safety yellow enamel applied over primer and coil type vinyl identification markers with arrows. SMS Ltd. or equal can be used for identification markers.
- .10 For all underground gas piping, provide continuous 75 mm (3") wide yellow PVC warning tape with "CAUTION - GAS LINE BURIED BELOW" wording at 750 mm (30") intervals located above the pipe approximately 250 mm (10") below grade.
- .11 Rough-in all required natural gas piping for kitchen and laundry equipment in accordance with drawing plans and schedules. Obtain accurately dimensioned rough-in drawings for the equipment and confirm exact locations prior to roughing-in. When the equipment has been installed, connect the equipment from the roughed-in Work. Provide shut-off valves in all piping connections to the equipment.
- .12 Include for mounting only of a solenoid valve in the gas piping to kitchen cooking equipment.

3.03 Installation of Shut-Off Valves

- .1 Provide CSA approved ball type or lubricated plug type shut-off valves to isolate equipment, and wherever else shown.
- .2 Ensure that valves are located for easy accessibility and maintenance.
- .3 For all valves installed in an emergency gas supply line including, but not limited to, the regulator station. Provide position indicating contacts to initiate a trouble alarm condition at the generator control panel and/or fire alarm control panel when any valve is closed. Provide in accordance with CSA C282:19 Emergency Electrical Power. Coordinate with electrical trade and generator supplier.

3.04 Installation of Natural Gas Convenience Outlets

- .1 Provide natural gas convenience outlets and wall mount.
- .2 Provide a shut-off valve in connecting piping, confirm exact location prior to roughing-in, and ensure that the outlet is rigidly secured in place.

3.05 Installation of Pressure Regulators

- .1 Provide pressure regulators in gas distribution piping where indicated and/or required.

- .2 For indoor appliances, use lever acting design vent limiter type, sized as shown and mounted in a horizontal upright position in strict accordance with the manufacturer's instructions. Note that these pressure regulators do not require vent piping.
- .3 Use vented type pressure regulators for all other applications.
- .4 Install regulating stations in accordance with requirements of CAN/CSA-B149.1.
- .5 Provide a manual shut-off valve upstream of the pressure regulator and provide overpressure protection devices.
- .6 Provide 6 mm (1/4") diameter test ports upstream and downstream of each regulator assembly.
- .7 Locate outdoor regulating stations vent termination a minimum of 300 mm (12") away from walkways, and 3 m (10') away from equipment air intakes and building openings. Provide all required vent piping and terminate vents in a turn-down elbow fitting with bronze bug screen secured in place.
- .8 Locate indoor regulating stations in locations accessible without the use of ladders or lifts. Combine vents where permitted and increase vent pipe size accordingly. Extend vent piping up through the roof 3 m (10') away from equipment air intakes and building openings and terminated in a turn-down elbow fitting with bronze bug screen secured in place.

End of Section

1 General

1.01 Summary

- .1 System to collect data on Natural Gas supplied as part of the Electricity Metering Package specified per Section 26 27 13.

1.02 Related Requirements

- .1 Section 26 27 13 – Electricity Metering:
 - .1 Refer to this Section for all requirements.

2 Products – Not Used

3 Execution – Not Used

End of Section

1 General

1.01 Section Includes

- .1 Refrigerant piping, joining materials, valves, fittings, and accessories for refrigerant piping.

1.02 References

- .1 CSA B52:18, Mechanical refrigeration code.

1.03 Submittals

- .1 Submit shop drawings/product data sheets for all products specified in Part 2 of this section except for pipe and fittings.
- .2 Submit, in shop drawing form, a schematic piping diagram for each refrigerant piping system indicating pipe sizes, slopes, valves, traps, and piping specialties. Piping schematics must be reviewed, approved, and signed by refrigeration equipment manufacturers prior to being submitted to the Consultant for review.

1.04 Closeout Submittals

- .1 Submit letters from equipment suppliers certifying proper installation and start-up of piping systems and equipment as specified in Part 3 of this section.

1.05 Quality Assurance

- .1 Refrigerant piping systems are to be in accordance with CSA B52, Mechanical Refrigeration Code, and any applicable local Codes and Regulations.
- .2 Refrigerant piping installing contractor is to be certified by Technical Standards and Safety Authority (TSSA). Installing contractor is to install refrigerant piping in accordance with manufacturer's installation instructions and in accordance with local codes. Contractor is responsible for all regulatory approvals, if required. Upon completion of installation, documentation of refrigerant amount, test certificates and verification documentation, etc., is to be provided in a binder, in accordance with requirements of local authorities having jurisdiction.
- .3 Refrigerant piping and direct expansion refrigeration equipment must be installed by or under direct on site supervision of a licensed journeyman refrigeration mechanic.

2 Products

2.01 Pipe, Fittings, and Joints

- .1 Type ACR hard drawn seamless copper refrigerant tubing to ASTM B280, factory degreased, dehydrated and capped or nitrogen filled and capped, complete with factory washed and bagged wrought copper soldering fittings to ASME B16.22, and brazed joints made with high melting point silver brazing alloy conforming to AWS Classification BcuP-5.

2.02 Piping Line Sets

- .1 Equal to Great Lakes Copper Inc. "EZ-Roll" soft annealed copper to ASTM B280, suitable for use with refrigerant involved, factory cleaned and capped, and with sizes and lengths as required.

2.03 General Re: Valves and Piping Specialties

- .1 Refrigerant valves and piping specialties specified below are to factory cleaned, degreased, and supplied to site with capped ends.

2.04 Shut-Off Valves

- .1 Ball Valves
 - .1 ¼ turn, CSA certified forged brass ball valves, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with carbon filled Teflon ball seals, 2 O-ring stem seals, a gasketed seal cap, a flow direction arrow cast into body, a ball position indicator on stem, and extended copper tube connections to permit brazing the valve into line without disassembling valve.
 - .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.
- .2 Diaphragm Valves
 - .1 Forged brass, frost-proof, Type 1 Series, CSA certified packless diaphragm valves, each suitable for a 3445 kPa (500 psi) working pressure and complete with an O-ring to prevent moisture from entering diaphragm chamber, one phosphor bronze and 2 stainless steel diaphragms, and extended copper tube brazing connections.
 - .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.05 Check Valves

- .1 Straight through type for valves 6.4 mm to 16 mm (¼" to 5/8") diameter, globe type for valves 22 mm (7/8") diameter and larger, each complete with extended tubing for brazing connections, and as follows:
 - .1 straight through type check valves complete with a machined brass gasketed body, phosphor bronze spring, and neoprene seat;
 - .2 globe type check valves complete with a cast bronze body, forged brass cap, phosphor bronze spring, Teflon seat disc, and neoprene O-ring seal.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.06 Piping Traps

- .1 Mueller Industries Inc. Style No. WE-554P brazing end copper "P" traps.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;

- .2 Sporlan Valve Co.;
- .3 Superior Refrigeration Products/Sherwood.

2.07 Pressure Vessel Relief Valves

- .1 Factory set pressure relief valves, straight through or angle type as required, each constructed in accordance with requirements of ANSI B9.1 and the ASME Code for Unfired Pressure Vessels, and each complete with a brass body, neoprene seat disc, and lead seal and locking wire.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.08 Refrigerant Liquid Moisture Indicators

- .1 Forged brass, triple sealed, CSA certified liquid moisture indicators, each suitable for a maximum working pressure of 3445 kPa (500 psi) and complete with a liquid indicator which shows "FULL" when system is fully charged with refrigerant and remains blank when there is a restriction or shortage of refrigerant in liquid line, a moisture indicator which changes colour from blue to pink when moisture is present in system, a plastic dust cover, and extended copper tube brazing connections.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.09 Liquid Line Filter-Drier

- .1 Mueller Industries Inc. "Drymaster" CSA certified filter-driers, each suitable for a maximum 3445 kPa (500 psi) working pressure and complete with a combination of desiccants in a fluted briquette for drying, and a fluted briquette type filter.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

2.10 Flexible Piping Connections

- .1 Senior Flexonics Canada "VIBRA-SORBERS" phosphor bronze construction, factory cleaned, dried, and sealed flexible piping connections with copper tube brazing ends.
- .2 Manufacturers:
 - .1 Senior Flexonics Canada;
 - .2 The Metraflex Co.

2.11 Thermostatic Expansion Valves

- .1 Factory tested, balanced port design thermostatic expansion valves, with exact selection to suit the application and refrigerant used, each complete within a replaceable stainless steel diaphragm and welded element construction thermostatic element charged with hydraulic fluid, and removable inlet strainer.
- .2 Manufacturers:
 - .1 Mueller Industries Inc.;
 - .2 Sporlan Valve Co.;
 - .3 Superior Refrigeration Products/Sherwood.

3 Execution

3.01 Installation of Refrigerant Piping, Valves and Specialties

- .1 Provide required refrigerant piping. Piping is to be type ACR copper with wrought copper fittings. Install piping in accordance with requirements of reviewed refrigerant piping schematics referred to in Part 1 of this section.
- .2 Make refrigerant piping joints using a light coat of approved brazing flux applied to both pipe and fitting. Do not use acid flux. During brazing process, ensure pipe and fittings are kept full of nitrogen or carbon dioxide to prevent scale formation inside pipe and fitting.
- .3 Where shown or specified, use soft copper refrigerant piping line sets.
- .4 Provide shut-off valves to isolate each piece of equipment if shut-off valves are not supplied integral with equipment. Provide ball or diaphragm type shut-off valves inside building. Provide diaphragm shut-off valves outside building.
- .5 Provide a refrigerant charging valve for each system if such a valve is not supplied integral with equipment.
- .6 Provide refrigerant piping accessories shown and/or required and install in accordance with manufacturer's recommendations.
- .7 Provide required refrigerant.
- .8 Provide flexible connections at piping connections to roof mounted condensing units. Install in accordance with manufacturer's instructions.
- .9 Provide expansion valves where shown and/or required, each matched to coil and installed in accordance with manufacturer's instructions.

End of Section

1 General

1.01 Section Includes

- .1 HVAC ducts and casings.
- .2 Acoustic duct lining material.
- .3 Special systems ductwork.
- .4 Dampers.
- .5 Louvres.
- .6 Other duct work accessories.

1.02 Submittals

- .1 Submit shop drawings/product data sheets for all products specified in this section except shop fabricated ductwork and fittings.
- .2 Include capacity, throw and terminal velocity, noise criteria, and pressure drops with grille and diffuser shop drawing/product data sheet submission.
- .3 With shop drawing/product data sheet submission, supply evidence that fire rated duct manufacturer is ULC listed to size requirements shows on drawings.
- .4 Submit duct leakage test data prior to ductwork being covered from view.
- .5 Submit manufacturer's colour chart(s) for all items for which a finish colour is to be selected.

1.03 Closeout Submittals

- .1 Submit proper installation certification from fire rated duct manufacturer as specified in Part 3 of this section.
- .2 Submit a site inspection and start-up report from fan filter diffuser manufacturer's representative as specified in Part 3 of this section.

1.04 Maintenance Material Submittals

- .1 Supply and hand to Owner at Substantial Performance of the Work, a minimum of 10 identified (with tags) grille/diffuser volume control damper adjustment keys.

1.05 Coordination

- .1 Supply reviewed copies of ventilator/curb assembly shop drawings or product data sheets to trade who will cut roof openings for ventilators, and ensure openings are properly sized and located.

1.06 Quality Assurance

- .1 Grilles and diffusers are to be tested and performance certified to ANSI/ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

2 Products

2.01 Galvanized Steel Ductwork

- .1 Galvanized steel sheet is to be hot dipped in accordance with requirements of ASTM A653. G60 galvanizing for bare uncovered duct to be finish painted. G90 for all other galvanizing.
- .2 Rectangular
 - .1 Lock forming grade hot dip galvanized steel, ASTM A653, shop fabricated, minimum #26 gauge.
- .3 Round
 - .1 Factory machine fabricated, spiral, mechanically locked flat seam, single wall duct, fittings and couplings.
- .4 Flat Oval
 - .1 Factory machine fabricated, single wall, 4-ply spiral lock seam duct, fittings and couplings.

2.02 Galvanized Steel Round PVC Coated Ductwork

- .1 Factory made G90 galvanized steel, ASTM A653, spiral seam smooth wall round duct and fittings with metal gauges in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible for a 2.5 kPa (0.36 psi) pressure, with a 4 mm thick PVC coating permanently fused to both sides of the duct, fittings and sleeve joint pieces, and type 316 stainless steel sheet metal screws and support hardware.

2.03 Rectangular Aluminum Ductwork

- .1 Alloy 3003 Temper H14 aluminum, ASTM B209, shop or factory fabricated, water-tight, with metal gauges and fabrication in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit the duct working pressure classification, and type 316 stainless steel support hardware.

2.04 Round Aluminum Ductwork

- .1 Alloy 3003 Temper H14 aluminum, ASTM B209, factory fabricated, water-tight, smooth interior, single wall duct, and fittings of spiral lockseam construction with site sealed beaded sleeve (slip type) joints, all in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct working pressure classification, and type 316 stainless steel sheet metal screws and support hardware.

2.05 Rectangular Stainless Steel Ductwork

- .1 300 Series stainless steel, type 304 or type 316 as specified in Part 3 of this Section, ASTM A167 and ASTM A480, with a #4 finish where bare (uncovered) and exposed in finished areas and a #2B finish elsewhere, with, unless otherwise specified, metal gauges in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct location and working pressure classification, and stainless steel support hardware to match duct material.

2.06 Round Stainless Steel Ductwork

- .1 Factory made, spiral, mechanically locked flat seam, single wall duct fabricated from type 316 stainless steel to ASTM A240 with metal gauges in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible for 2.5 kPa (0.36 psi) pressure. Type 316 stainless steel fittings equipped with leak-proof stainless steel couplings secured to connecting duct by means of stainless steel sheet metal screws and duct sealer. Duct system performance is to meet SMACNA's Leakage Class 3 requirements at system design static pressure. Stainless steel finish is to be a #2B mill finish where concealed or exposed in unfinished areas and a #4 finish where exposed in finished areas.

2.07 Round Stainless Steel Lined Ductwork

- .1 Double wall self-sealing duct system constructed from type 316 stainless steel to ASTM A240 and consisting of 24 kg/m³ (1.5 lb/ft³) density, 25 mm (1") thick glass fibre insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102 and wrapped in a thick non-woven polyester fabric, sandwiched between double wall duct and fittings. Spiral, mechanically locked, flat seam outer casing, and perforated inner liner with 3.2 mm (1/8") perforations on 6.4 mm (1/4") staggered centres. Fittings and couplings constructed as for ducts and air-tight to SMACNA Leakage Class 3 requirements. Concealed duct and exposed duct in unfinished areas is to have a #2B mill finish. Exposed duct in finished areas is to have a #4 finish.

2.08 Fiberglass Reinforced Plastic Duct – Rectangular and Round

- .1 Factory fabricated duct and fittings in accordance with ASTM C582, ASTM D3982, ASTM D2996, SMACNA manual entitled "Thermoset FRP Duct Construction Manual", and with resin conforming to 25/50 flame spread/smoke developed rating when tested in accordance with CAN/ULC-S102, pigment coloured as selected from manufacturer's standard colours, with thixotropic resin paste sealed and fibreglass cloth and resin overwrapped bell and spigot joints for round ducts, air-tight gasketed flanged joints with type 316 stainless steel bolts, lock washers and nuts for rectangular ducts, and type 316 stainless steel support hardware.

2.09 Flexible Metallic Ductwork

- .1 Bare
 - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-UN", CAN/ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, and supplied in 3 m (10') lengths.
- .2 Insulated
 - .1 Spirally wound, semi-rigid, self-supporting corrugated aluminum duct with continuous triple lock seams, SMACNA Form "M-I", CAN/ULC-S110 listed and labelled as a Class 1 Air Duct, constructed of dead soft aluminum strip, supplied in 3 m (10') lengths and factory covered with 40 mm (1-1/2") thick, 12 kg/m³ (0.75 lb/ft³) density fibreglass insulation with a vinyl jacket meeting 25/50 flame spread and smoke developed requirements tested in accordance with CAN/ULC-S102.

2.10 Flexible Fabric Ductwork

- .1 Equal to DuctSox Corp. round fabric air duct, 25/50 flame spread/smoke developed rated when tested in accordance with CAN/ULC-S102, white or coloured (to manufacturer's standards), and complete with 3 x 1 tension cable suspension system.

2.11 Flexible Fabric Ductwork

- .1 Bare
 - .1 Equal to Flexmaster Canada Ltd. "Fabriflex" Type 4 ULC listed and labelled Class 1 flexible fabric duct consisting of vinyl coated fibreglass cloth mechanically bonded to a corrosion resistant galvanized steel helix.
- .2 Insulated
 - .1 Equal to Flexmaster Canada Ltd. "Fabriflex" Type 4T ULC listed and labelled Class 1 flexible fabric duct consisting of vinyl coated fibreglass cloth mechanically bonded to a corrosion resistant

galvanized steel helix and factory insulated with 25 mm (1") thick glass fibre insulation with a polyethylene vapour barrier jacket.

2.12 Flexible Connection Material

- .1 Waterproof, indoor-outdoor type flexible connection material meeting requirements of NFPA 90A, consisting of woven glass fibre fabric coated on both sides with synthetic rubber.
- .2 Manufacturers:
 - .1 Duro Dyne Canada Inc. "DUROLON";
 - .2 Dyn Air Inc. "HYPALON".
- .3 Waterproof, flameproof, high temperature flexible connection material meeting requirements of NFPA 90A, consisting of a woven glass fibre fabric coated on both sides with silicone rubber.
- .4 Manufacturers:
 - .1 Duro-Dyne Canada Inc. "THERMAFAB";
 - .2 Dyn Air Inc. "SILICON HI-T".

2.13 Metal Duct System Joint Sealant

- .1 ULC listed and labelled, premium grade, grey colour, water base, non-flammable duct sealer, brush, or gun applied, with a CAN/ULC S102 tested maximum flame spread rating of 5 and smoke developed rating of 0.
- .2 Manufacturers:
 - .1 Johns Manville;
 - .2 Manson Insulation;
 - .3 Knauf Insulation.

2.14 Acoustic Lining

- .1 Minimum 25 mm (1") thick acoustic lining material meeting 25/50 flame spread and smoke developed ratings tested in accordance with CAN/ULC S102, meeting NFPA 90A, ASTM C1071, and ASTM G21 requirements, not supporting microbial growth, flexible for round ducts, board type for rectangular ducts, consisting of a bonded fiberglass mat coated on inside (airside) face with a black fire-resistant coating.
- .2 Manufacturers:
 - .1 Johns Manville;
 - .2 Manson Insulation;
 - .3 Knauf Insulation.

2.15 Kitchen Exhaust Duct Expansion Joint

- .1 Hyspan Precision Products Inc. Series 2500 flanged, carbon steel, rectangular expansion joints sized to suit ductwork.

2.16 Uninsulated Kitchen Grease Exhaust Duct

- .1 Minimum #16 gauge black sheet steel liquid-tight ductwork with welded joints or listed in accordance with CAN/ULC S662.
- .2 Grease-tight access doors in accordance with requirements of NFPA 96, constructed of same material as duct and as large as possible, up to 600 mm (24") in any dimension, located in the sides of the duct for ease of inspection and cleaning at each change in duct direction, at not less than 3 m (10') in straight duct including risers, and not less than 40 mm (1-1/2") from bottom of duct.

2.17 Factory Insulated Round Kitchen Grease Exhaust Duct

- .1 Equal to Selkirk ZeroClear kitchen exhaust duct, 2 hour fire rated to UL 2221, constructed, listed and labelled to UL/ULC 1978, and meeting requirements of NFPA 96. Duct is constructed of a type 304 stainless steel inner liner, 75 mm (3") of high temperature fibre insulation, and a stainless steel outer jacket, and is complete with all required fittings and accessories, including access and cleanout fittings where required.

2.18 Factory Insulated Rectangular/Square Kitchen Grease Exhaust Duct

- .1 Equal to DuraSystems "DuraDuct KEX" kitchen exhaust duct, 2 hour rated kitchen exhaust listed and labelled to CAN/ULC S144, and meeting requirements of NFPA 96. Duct is constructed of minimum #16 gauge black sheet steel inner liner, high temperature fibre insulation and a minimum #24 gauge galvanized steel outer jacket, and complete with required fittings and accessories, including access and cleanout fittings where required. Factory-fabricated grease duct assembly is to not require additional wraps or enclosures to achieve required fire resistance rating.

2.19 Factory Insulated Fire Rated Ductwork

- .1 Equal to DuraSystems Barriers Inc. "DuraDuct HP" or "DuraDuct GNX" duct, 2 hour fire rated, constructed, ULC listed and labelled for fire rated ventilation applications. Duct is constructed of a galvanized steel inner liner, a galvanized steel outer jacket, and all required fittings and accessories, including support hardware.

2.20 In-Slab Exhaust Ductwork

- .1 Equal to ECCO Manufacturing "ECCODUCT" spiral wound, galvanized steel, 300 mm x 45 mm (12" x 1-3/4") rectangular duct supplied in 3 m (10') lengths complete with factory supplied galvanized steel connection couplers, fittings, exterior discharges with back draft dampers, and support brackets. Concrete encased duct and fittings are 3 hour fire rated in accordance with tests conducted by Intertek/Warnock Hersey in accordance with ULC S115 and ASTM E814, are to have an impact loading rating of 200 kg (440 lb) from 1.5 m (5') with no permanent deformations in accordance with CAN3-A23, and are to have a point loading rating with 1 mm (1/32") permanent deformation when tested to CSA S269.1.

2.21 Casing and Plenum Material and Accessories

- .1 Unless otherwise specified, casing and plenum material is to be same as connecting duct material.
- .2 Accessories such as access doors and drain pans are to be constructed of same material as casing and plenum and are to be in accordance with Chapter 6 of SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.22 Acoustic Plenum Panels

- .1 Vibro-Acoustics Ltd. type "AP", 100 mm (4") thick panels with acoustic media meeting NFPA 90A requirements sandwiched between minimum #24 gauge galvanized sheet steel, with airside face perforated, access doors where shown, and with acoustic performance as follows:

Octave Bands, (Hz)	125	250	500	1000	2000	4000
Transmission Loss	21	28	39	50	53	56
Absorption Coefficient	0.7	0.9	0.99	0.99	0.9	0.9

- .2 Acoustic plenum media factory encapsulated in sealed DuPont "Tedlar" polyvinyl fluoride film to ensure no media enters the airstream.
- .3 Manufacturers:
 - .1 Vibro-Acoustics Ltd.;
 - .2 Kinetics Noise Control Inc.;
 - .3 Carrier Corp. – Racan;
 - .4 Haakon Industries;
 - .5 Price Industries Inc;
 - .6 Alumavent.

2.23 Plenum Access Doors

- .1 Factory fabricated, double wall insulated access doors, sized as indicated on drawings, and constructed of same material as connecting ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit operating pressure of the system.

2.24 Round to Rectangular Duct Connections

- .1 Equal to Flexmaster Canada Ltd. galvanized steel, flared, flanged or notched "Spin-On" round duct take-off collars with locking dampers in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.25 Splitter Dampers

- .1 Minimum #20 gauge damper blade constructed of same material as duct, reinforced as required to suit blade size, system velocity, and to prevent "chatter", and complete with operating hardware equal to DynAir Inc. #Q-50 "DYN-A-QUAD S-S" quadrant regulator with RW-50 backup washers to prevent leakage, long square bearing pin, and slide pin.

2.26 Air Turning Vanes

- .1 For square elbows, multiple-radius turning vanes interconnected with bars, adequately reinforced to suit pressure and velocity of system, constructed of same material as duct they are associated with, and in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 For short branch ducts at grille and diffuser connections, air extractor type each equipped with a matching bottom operated 90° opposed blade volume control damper, constructed of same material as duct it is associated with and in accordance with requirements and details in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

2.27 Manual Balancing (Volume) Dampers

- .1 Flanged and drilled, single or parallel blade (depending on damper size) manual balancing dampers, each constructed of same material as connecting ductwork unless otherwise specified, each designed to maintain internal free area of connecting duct, and each complete with:
 - .1 hexagonal or square shaft extension through frame;
 - .2 non-stick, non-corrosive synthetic bearings for rectangular dampers, flange stainless steel bearings for round dampers;
 - .3 blade stops for single blade dampers, designed to prevent blade from moving more than 90°;
 - .4 linkage for multiple blade dampers;
 - .5 locking hand quadrant damper operator with, for insulated ducts 50 mm (2") standoff mounting.
- .2 Rectangular Dampers: Nailor Industries Inc. 1800 Series, maximum size 1.2 m x 1.2 m (4' x 4') for a single damper.
- .3 Round Dampers: Nailor Industries Inc. model 1890, maximum 600 mm (24") diameter, equipped with a minimum 200 mm (8") deep frame, and blade stiffeners where required.
- .4 Multiple Rectangular Damper Section Assembly: Rectangular assembly supplied with the dampers or site constructed, of same material as damper and designed for tight and secure mounting of individual dampers.
- .5 Manufacturers:
 - .1 Nailor Industries Inc.;
 - .2 T.A. Morrison & Co. Inc. "TAMCO";
 - .3 Greenheck Fan Corp.;
 - .4 Ruskin Co.

2.28 Backdraft Dampers

- .1 Nailor Industries Model 1370CB counterbalanced backdraft dampers, vertical or horizontal mounting, 50 mm (2") wide, sized as shown and complete with:
 - .1 extruded 6063-T5 aluminum frame, 2.3 mm (0.090") nominal wall thickness, with mitred corners;
 - .2 extruded 6063-T5 aluminum blades, 1.3 mm (0.050") nominal wall thickness on 92 mm (3-5/8") centres, and with extruded PVC blade seals;
 - .3 corrosion-resistant synthetic bearings;
 - .4 adjustable plated steel counterweights mounted internally in the airstream;
 - .5 concealed blade linkage located out of the airstream.
- .2 Manufacturers:
 - .1 Nailor Industries Inc.;
 - .2 T.A. Morrison & Co. Inc. "TAMCO";

- .3 Greenheck Fan Corp.;
- .4 Ruskin Co.

2.29 Fusible Link Dampers

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

2.30 Combination Fire/Smoke Dampers

- .1 Nailor Industries Series 1221, ULC listed to CAN/ULC S112 and CAN/ULC S112.1, meeting requirements of NFPA 80, 90A, 92, 101 and 105, consisting of type A, B, or C fusible link fire dampers as required and a fail-safe, opposed blade, normally closed, motor operated smoke damper complete with factory installed and tested 120 V electric actuator.
- .2 ULC 1-1/2 hour fire rated and ULC Class I leakage rated for smoke, and equipped with a 74°C (165°F) ULC classified fusible link that will cause damper to close and lock independent of actuator when duct temperature reaches maximum temperature of damper assembly.
- .3 Supply damper with factory installed sleeves of minimum 400 mm (16") length, field verified by contractor dependent on wall thickness. Caulk sleeves to ULC requirements and constructed of 20 gauge for sizes up to 2.1 m (84") wide and 18 gauge for sizes greater than 2.1 m (84") wide.
- .4 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .5 Manufacturers:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 Ruskin Co.;
 - .4 Price Industries (E.H. Price).

2.31 Smoke Dampers

- .1 Multi-blade type, fail-safe, dynamic, galvanized steel (unless otherwise specified) smoke dampers, ULC classified to CAN/ULC S112.1, ULC Class I leakage rated for smoke, meeting requirements of NFPA 90A, 92, 101 and 105, normally closed, low pressure drop design, dynamically tested, each complete with jamb and blade seals, linkage concealed in the frame, a steel sleeve to suit the opening, and an electric actuator to automatically close damper upon receiving an external signal, and to automatically open damper when system is reset.
- .2 Dampers in ductwork other than galvanized steel are to be as specified above but constructed of type 316 stainless steel.
- .3 Manufacturers:
 - .1 Nailor Industries Inc.;
 - .2 Greenheck Fan Corp.;
 - .3 Ruskin Co.;
 - .4 Price Industries (E.H Price).

2.32 Roof Duct Supports

- .1 Equal to PHP Systems Design Model PHP-D adjustable duct support assemblies sized to suit duct size, each assembly complete with injection moulded recycled plastic and carbon black bases and tubular hot dip galvanized steel framing.

2.33 Pressure Relief Doors

- .1 Greenheck model PRAD (positive) or VRAD (negative) pressure relief doors constructed of same material as duct or plenum they are associated with, each complete with a sealing gasket, special latches, cable assembly with spring to limit door opening to maximum 80° and factory set, field adjustable pressure relief magnet assembly.
- .2 Size access doors to match requirements of system so pressure drop through open blow-out door at required flow rate will not exceed rated pressure of duct system.
- .3 Manufacturers:
 - .1 Greenheck Fan Corp.;
 - .2 United Enertech.

2.34 Duct Access Doors

- .1 In accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, with sizes suitable in all respects for purpose for which they are provided, and, unless otherwise specified, constructed of same material as duct they are associated with.

2.35 Ductwork Drain Points

- .1 Equal to Ductmate Canada Ltd. "Moisture Drain", 20 mm (¾") diameter moisture drains with galvanized sheet metal funnel, and chrome plated brass threaded drain, nut, and cap.

2.36 Instrument Test Ports

- .1 Equal to Duro-Dyne of Canada Ltd. #IP1 or #IP2 (to suit insulation thickness where applicable) gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

2.37 Wire Mesh (Birdscreen)

- .1 Heavy-gauge galvanized steel or aluminum mesh, 12 mm x 12 mm (½" x ½") secured in a rigid galvanized steel or aluminum framework, sized as indicated on drawings, and constructed so as to be removable.

2.38 Louvres

- .1 Price Industries Inc. DE439 or DE635, 100 mm (4") or 150 mm (6") deep (to suit wall thickness) factory assembled stationary, drainable, louvres sized as indicated on drawings, each AMCA water penetration and air performance certified, constructed of welded, extruded, alloy 6063-T5 aluminum with drainable blades, mounting and securing hardware to suit the application, and 12 mm (½") mesh aluminum birdscreen in an aluminum frame.
- .2 Acoustical Louvres: Price Industries Inc. Model QA1245 300 mm (12") deep, welded, extruded alloy 3003-H14 aluminum, storm-proof, stationary, drainable acoustical louvers, AMCA water penetration and air performance certified, with high density mineral wool acoustic media secured to blades and protected by perforated aluminum, sound ratings in accordance with ASTM E90 and ASTM E413, and mounting and securing facilities as required.
- .3 Louvres are to be factory finished with a finish equal to PPG Industries "Duramar" fluoropolymer powder coating over primer with colour as selected from manufacturer's standard colour range.
- .4 Manufacturers:
 - .1 Price Industries Inc.;
 - .2 The Airolite Co. LLC;
 - .3 Construction Specialities;
 - .4 Nailor Industries Inc.;
 - .5 Kinetics Noise Control Inc.
 - .6 Greenheck Fan Corp.
 - .7 Ventex.

2.39 Louvre Blank-Off Panels

- .1 Insulated, framed, sandwich construction panels consisting of 40 mm (1-½") thick rigid insulation (meeting NFPA 90A requirements) between minimum #20 gauge galvanized sheet steel with exterior face of panels finished to match finish of exterior wall louvres.

2.40 Brick and Block Vents

- .1 Equal to Price Industries Inc. vents constructed of 6063-T5 alloy extruded aluminum, sized as shown, complete with stainless steel fasteners, aluminum rod vertical supports on minimum 300 mm (12") centres, #2 mesh fixed aluminum screen, and all required accessories to suit the application.

- .2 Vent(s) to be factory finished with a finish equal to a baked "Kynar 500-XL" colour coat and a clear coat over cleaned and primed metal with colour as selected from manufacturer's standard colour range.

2.41 Fire Stop Flaps and Thermal Blanket Material

- .1 Rectangular or round, ULC listed and labelled, blade type galvanized steel fire stop flaps in accordance with CAN/ULC S112, Standard Methods of Fire Test of Fire-Damper Assemblies and CAN/ULC S112.2, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies, each complete with #22 gauge G60 galvanized steel blade(s) and frame, a 74°C (165°F) fusible link, and, for dampers 300 mm (12") and larger, ceramic fibre insulation on both sides of the blades.
- .2 Ceramic fibre material in accordance with 25/50 flame spread/smoke developed ratings when tested to CAN/ULC S102 and of a thickness to suit required fire rating.

2.42 Grilles and Diffusers

- .1 Grilles and diffusers of type, size, capacity, finish, and arrangement as shown on drawings and in accordance with drawing schedule, each equipped with all required mounting and connection accessories to suit mounting location and application.
- .2 Manufacturers:
 - .1 Price Industries Inc.;
 - .2 Anemostat;
 - .3 Krueger Division of Air System Components Inc.;
 - .4 Titus;
 - .5 Nailor Industries Inc.;
 - .6 Tuttle & Bailey.

2.43 Fan Filter Diffusers

- .1 Factory assembled and leakage tested, suspended ceiling mount, modular assemblies, each ULC and CSA or ETL certified and labelled, consisting of a fan-motor and HEPA filter enclosed in a metal plenum, designed for unidirectional vertical flow of filtered air over a cleanroom space. Sound performance of each is not to exceed 50 dBA measured 765 mm (30") from filter face at 0.5 m/s (90 FPM). Units are to be in accordance with the Institute of Environmental Services and Technology Recommended Practices IEST RP CCOO1, HEPA and ULPA Filters, and IEST RP CCOO2, Unidirectional-Flow, Clean-Air Devices. Each unit is to be equipped with:
 - .1 plenum and face frame: airtight low profile design, constructed of type 304 stainless steel with aluminum interior parts including an extruded aluminum filter frame with air by-pass seal, an inlet duct connection collar, sound insulation meeting 25/50 flame spread/smoke developed ratings when tested to CAN/ULC S102, a static pressure port, eyebolts at each corner;
 - .2 fan and motor: removable, consisting of a blower wheel encased in a strategically shaped enclosure a direct connected to a vibration isolated 1/3 HP ECM brushless DC motor with permanent built-in inverter programmed for constant volume airflow and equipped with a 2.4 m (8') length of power cord with plug;
 - .3 filter: HEPA ultra low penetration air (ULPA) filters, 99.9995% efficient on 0.12 µm micron particles, latched into fan plenum and protected by a perforated screen attached with quarter-turn thumb-wheel fasteners, and room side replaceable;

- .4 diffuser face: perforated, laminar flow face constructed of aluminum with quarter-turn fasteners for removal and access to fan-motor and filter;
- .5 mounting gasket: roll type gasket material supplied with units for site installation on T-bar ceiling members;

2.44 Round Low Silhouette Roof Mounted Ventilators

- .1 Spun aluminium, round, gravity roof mounting hoods in accordance with drawing schedule, each complete with:
 - .1 wind band with a rolled bead, and curb cap with one-piece, spun, deep venturi inlet, and pre-punched holes for mounting;
 - .2 galvanized steel bird screen;
 - .3 minimum 300 mm (12") high welded aluminium, insulated roof mounting curb with damper tray;
 - .4 aluminium backdraft damper supplied loose, for site installation in roof curb damper tray;
 - .5 non-corrosive motorized damper supplied loose for site installation in roof curb damper tray, equal to T. A. Morrison TAMCO Series 9000 insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to suit control voltage requirements;
- .2 Manufacturers:
 - .1 Greenheck Fan Corp.;
 - .2 PennBarry;
 - .3 Twin City Fan and Blower.

2.45 Louvred Penthouse Type Ventilators

- .1 Low silhouette, rectangular, roof mounting louvred penthouse type hoods in accordance with drawing schedule, each constructed of aluminium, supplied in knock-down form for site assembly, and each complete with:
 - .1 extruded aluminium, welded storm-proof louver blades with mitred corners and stainless steel securing screws;
 - .2 removable cover for internal access, lined with glass fibre insulation material and equipped with stainless steel fasteners;
 - .3 12 mm x 12 mm (½" x ½") aluminium mesh birdscreen;
 - .4 welded aluminium, minimum 300 mm (12") high insulated roof mounting curb with damper tray and curb seal;
 - .5 aluminium backdraft damper supplied loose, for site installation in roof curb damper tray;
 - .6 non-corrosive motorized damper supplied loose for site installation in roof curb damper tray, equal to T. A. Morrison TAMCO Series 9000 insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to suit site control voltage requirements;
- .2 Manufacturers:
 - .1 Greenheck Fan Corp.;

- .2 Twin City Fan and Blower;
- .3 PennBarry.
- .4 Ventex.

2.46 Hooded Type Ventilators

- .1 Low silhouette, rectangular, roof mounting hooded penthouse type ventilators in accordance with drawing schedule, each constructed of aluminium, supplied in knock-down form for site assembly, and each complete with:
 - .1 full 360° perimeter hood opening;
 - .2 12 mm x 12 mm (½" x ½") aluminium mesh bird screen;
 - .3 welded aluminium, minimum 300 mm (12") high insulated roof mounting curb with damper tray and curb seal;
 - .4 aluminium backdraft damper supplied loose for site installation in roof curb damper tray;
 - .5 non-corrosive motorized damper supplied loose for site installation in roof curb damper tray, equal to T. A. Morrison TAMCO Series 9000 insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to suit site control voltage requirements;
- .2 Manufacturers:
 - .1 Greenheck Fan Corp.;
 - .2 Twin City Fan and Blower;
 - .3 PennBarry.

2.47 Intake Wall Box

- .1 Equal to Reversomatic SWBL-INTAKE wall boxes leakproof seamless construction, extruded aluminum grille, sized as shown, complete with stainless steel fasteners, and all required accessories to suit the application. Contractor to coordinate colour and finish with colour as selected from manufacturer's standard colour range as noted in schedule.

2.48 Exhaust Wall Box

- .1 Equal to Reversomatic SWBL wall boxes leakproof seamless construction, extruded aluminum grille, sized as shown, complete with stainless steel fasteners, neoprene backdraft damper, and all required accessories to suit the application. Contractor to coordinate colour and finish with colour as selected from manufacturer's standard colour range as noted in schedule.

2.49 Lint Trap

- .1 Provide lint trap for in-suite dryer exhaust complete with aluminium screen filter and access door for filter.

3 Execution

3.01 Cleanliness Requirements for Handling and Installation of Ductwork

- .1 Handle and install ductwork in accordance with CSA Z317.2, Special Requirements for Heating, Ventilation, and Air-Conditioning (HVAC) Systems in Healthcare Facilities and SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

- .2 Handle and install ductwork in accordance with SMACNA's Duct Cleanliness for New Construction Guidelines at the Advanced Level.

3.02 Fabrication and Installation of Galvanized Steel Ductwork

- .1 Provide required ductwork, rectangular, round and/or flat oval. Where rectangular ductwork is shown, round or flat oval ductwork of equivalent cross-sectional area is acceptable.
- .2 It is to be understood that all duct dimensions shown on drawings are clear internal dimensions.
- .3 Unless otherwise specified, construct and install ductwork in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit duct pressure class designation of minimum 500 Pa (2" w.c.) positive or negative as applicable, a minimum velocity of 10 m/s (2000 fpm), and so ductwork does not "drum". Flat surfaces of rectangular ductwork are to be cross-broken or beaded per SMACNA standards. Duct system sealing is to meet ANSI/SMACNA Seal Class A requirements.
- .4 Variable air volume ductwork from supply fans to boxes is as above but rectangular duct take-offs are double side straight taper type with a take-off length equal to 0.5 times the branch duct width but minimum 150 mm (6") length, and double taper side is to have an included angle of minimum 60°.
- .5 Confirm routing of all ductwork at site and site measure ductwork prior to fabrication. Duct dimensions may be revised to suit site routing and building element requirements, if dimension revisions are reviewed with and approved by the Consultant. Duct routing and/or dimension revisions to suit conditions at site are not grounds for a claim for an extra cost.
- .6 Refer to structural drawings. Where ductwork is to be run within or through open web steel joists, ductwork shown on mechanical drawings is schematic only and is to be altered as required to suit steel joist configuration, spacing, panel points, and cross-bridging at no additional cost.
- .7 Wherever ductwork is required at locations where sprayed fireproofing is applied to building construction, install ductwork only after fireproofing work is complete and do not compromise fire rating of sprayed fireproofing.
- .8 Install (but do not connect) duct system mounted automatic control components supplied as part of the automatic control work.
- .9 Where indicated, provide duct connections to fan powered heat transfer equipment with integral coils.
- .10 Flange connect ductwork to hot water reheat coils in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Coils will be suspended independent of connecting ductwork as part of the heat transfer work.
- .11 Support horizontal rectangular ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but use trapeze hangers with, unless otherwise specified, galvanized steel channels, and galvanized steel hanger rods for exposed ducts and concealed ducts wider than 500 mm (20"). Support hardware constructed of same material as duct for metal duct, and, unless otherwise specified, type 316 stainless steel for non-metal duct. Supports for "heavy" duct such as cementitious core duct is to be suitable in all respects for the application and approved by the Consultant.
- .12 Support round and flat oval ducts inside building in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, but, unless otherwise specified, for both uninsulated and insulated ducts exposed in finished areas, use bands and secure at top of duct to a hanger rod, all similar to Ductmate Canada Ltd. type "BA". If duct is insulated, size strap to suit diameter of insulated duct. Unless otherwise specified, duct support hardware for metal duct is constructed of same material as duct, and for non-metal duct, type 316 stainless steel.

- .13 Where flanged duct joints are used, do not locate joints in wall or slab openings, or immediately at wall or slab openings. Do not use flanged joints for exposed uninsulated ducts in finished areas.
- .14 Where watertight horizontal ductwork is required, construct ducts without bottom longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer. Slope horizontal duct to hoods, risers, or drain points. Provide drain points. Provide watertight ductwork for:
 - .1 ductwork outside building or otherwise exposed to the elements;
 - .2 dishwasher exhaust;
 - .3 shower exhaust ducts from grilles to duct main or riser;
 - .4 minimum of 3 m (10') upstream and downstream of duct mounted humidifiers or humidifier manifolds;
 - .5 fresh air intakes;
 - .6 wherever else shown.
- .15 Leakage Testing:
 - .1 Ductwork leakage is not to exceed following:
 - .1 ductwork to 2" W.C. Class, 1% of total air quantity handled by respective fans;
 - .2 ductwork exceeding 2" W.C. Class, 2% of total air quantity handled by respective fans.
 - .2 Leakage testing is to be performed by the Testing, Adjusting and Balancing (TAB) agency in accordance with SMACNA HVAC Air Duct Leakage Test Manual and is to be witnessed by the Consultant.
 - .3 Be responsible for following:
 - .1 preparing duct systems for leakage testing prior to installation of external insulation including capping duct runouts and provision of final tap-in for test equipment;
 - .2 schedule testing with TAB agency in advance, be present for all testing and ensure notice is given to the Consultant so they may witness testing;
 - .3 resealing and/or replacement of defective ductwork;
 - .4 bearing all costs associated with retesting ductwork which has failed to pass leakage testing.
- .16 Seal all ductwork in accordance with SMACNA Seal Class "A", except for round duct with self-sealing gasketed fittings and couplings which does not require site applied sealant. Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .17 Apply sealants by brush or gun to cleaned metal surfaces. Where bare ductwork is exposed apply neat uniform lines of sealant. Randomly brushed, sloppy looking sealant applications will be rejected and must be repaired or replaced with a neat application of sealant.
- .18 Clean exterior exposed (uninsulated) ducts and coat with a heavy full coverage of Bakor #410-02 black metal paint.

- .19 Where dissimilar metal ducts are to be connected, isolate ducts by means of flexible duct connection material.
- .20 Round exposed ductwork in Gymnasium is to be 2 metal gauges heavier than standard metal gauge for same size duct, and duct hangers are to be pairs of 9.5 mm ($\frac{3}{8}$ " diameter hanger rods secured to 40 mm (1- $\frac{1}{2}$ ") wide #12 gauge galvanized steel split clamps around full circumference of duct at maximum 1.8 m (72") centres. Provide double nuts and lock washers on each hanger rod above and below each clamp.

3.03 Installation of Aluminum Ductwork

- .1 Provide aluminum ductwork, rectangular or round.
- .2 Wherever bare aluminum ductwork comes in contact with ferrous metal or copper, paint ferrous metal or copper surface with a heavy, 100% covering coat of zinc chromate paint, asphalt paint or otherwise isolate direct contact with the bare aluminum.
- .3 Refer to "Commentary on Aluminum Ducts" in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, do not use drive and S cleats for joining waterproof aluminum ductwork. Use following SMACNA joining methods:
 - .1 T-21 - welded flange;
 - .2 T-22 - companion angle and gasket;
 - .3 T-24A - flanged.
- .4 Keep longitudinal joints at top surface of horizontal runs. Provide proper transverse supports to prevent deflection. Ensure duct is rigid.
- .5 When mastic is used for sealing such as sealing longitudinal joints, apply mastic to both surfaces before they are mated. When dry, apply mastic again for a water-tight seal.

3.04 Installation of Stainless Steel Ductwork

- .1 Provide stainless steel ductwork, round or rectangular.
- .2 Exposed stainless steel kitchen exhaust duct is to be minimum #16 gauge and of welded construction with pickled and passivated welds which are ground to a finish to match duct finish.

3.05 Installation of Fibreglass Reinforced Plastic (FRP) Ductwork

- .1 Provide rectangular fibreglass reinforced plastic ductwork.
- .2 Generally, install duct in accordance with duct manufacturer's instructions and requirements of SMACNA publication entitled "Thermoset FRP Duct Construction Manual".
- .3 Secure duct in place with type 316 stainless steel angles, straps, hanger rods, and accessories. Provide strips of felt or neoprene material between duct and hanging and support hardware.

3.06 Installation of Round PVC Coated Galvanized Steel Ductwork

- .1 Provide round PVC coated galvanized steel ductwork.
- .2 Underground ductwork is to be constructed to SMACNA Positive Pressure Class 10" w.c. with minimum metal gauges as follows:
 - .1 150 mm (6") through 350 mm (14") dia. - #28 gauge;
 - .2 400 mm (15") through 660 mm (26") dia. - #26 gauge;

- .3 685 mm (27") through 915 mm (36") dia. - # 24 gauge;
- .4 940 mm (37") through 1.27 m (50") dia. - #20 gauge.

- .3 Install underground ductwork in accordance with requirements and details for underslab duct in ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.

3.07 Installation of Fabric Ductwork

- .1 Provide fabric ductwork.
- .2 Secure duct from structure by means of tension cable and suspension components supplied with ductwork.
- .3 Install tension cable and suspension components in accordance with duct manufacturer's instructions.
- .4 Provide metal duct connection collars as required.
- .5 Start-up fabric duct system in accordance with manufacturer's instructions.
- .6 Do not penetrate fire barriers with fabric duct.

3.08 Installation of Flexible Ductwork

- .1 For supply air ductwork, provide maximum 1.8 m fully stretched, long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles and diffusers. Do not install flexible ductwork through walls, even if shown on drawings.
- .2 For return air ductwork, provide maximum 1.0 m fully stretched, long lengths of flexible ductwork for connections between galvanized steel duct mains and branches, and necks of ceiling grilles. Do not install flexible ductwork through walls, even if shown on drawings.
- .3 At rectangular galvanized steel duct, accurately cut holes and provide flanged or "Spin-in" round flexible duct connection collars. Seal joints with duct sealer.
- .4 Install flexible ducts as straight as possible and support in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, and secure at each end with nylon or stainless steel gear type clamps, and seal joints. Provide long radius duct bends where they are required.
- .5 Do not penetrate fire barriers with flexible duct.

3.09 Installation of Acoustic Lining

- .1 Provide acoustic lining in ductwork in locations as follows:
 - .1 wherever shown and/or specified on drawings;
 - .2 supply ductwork downstream of air terminal boxes for a distance of 2.4 m (8') measured along duct and outward from box in all directions;
 - .3 all transfer air ducts.
- .2 Install lining in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible, however, for all installations regardless of velocity, at leading and trailing edges of duct liner sections, provide galvanized steel nosing channel in accordance with detail entitled Flexible Duct Liner Installation found in the ANSI/SMACNA manual referred to above.

3.10 Installation of Fire Rated Ductwork

- .1 Provide 2 hour fire rated ductwork.
- .2 Install ductwork in strict accordance with duct manufacturer's instructions using support hardware supplied with duct.
- .3 When installation is complete, arrange, and pay for duct manufacturer to visit site and examine duct installation. Make any revisions requested by manufacturer, and when manufacturer is satisfied with installation, obtain and submit a letter certifying proper installation in accordance with ULC requirements.

3.11 Installation of Sheet Steel Kitchen Grease Exhaust Ductwork

- .1 Provide welded sheet steel kitchen grease exhaust ductwork from exhaust hood(s) to roof mounted exhaust fans, all in accordance with requirements of NFPA 96. Construct ductwork watertight with continuous externally welded seams and joints, cleanouts, duct expansion provisions, riser residue traps, etc.
- .2 Clean and prime coat ground welds in black steel ducts.
- .3 Support ductwork at not greater than 1.5 m (5') intervals and ensure fasteners at hangers do not penetrate duct. Install without forming dips, sags, or traps where grease residue might collect, and locate access door/cleanouts for ease of maintenance.
- .4 Slope horizontal ductwork 25 mm per 300 mm (1" per foot) back to exhaust hood.

3.12 Installation of In-Slab Ductwork

- .1 Provide in-slab concrete encased ductwork, complete with required fittings and accessories.
- .2 Install duct with support brackets supplied with duct and coordinated with location of reinforcing steel, post tensioning cables, and any other structural slab component. Install duct in strict accordance with manufacturer's installation instructions and requirements of the Consultant. Ensure all joints are water-tight.
- .3 Confirm finish of exterior discharge fittings with the Consultant prior to ordering.

3.13 Installation of Casings and Plenums

- .1 Provide required shop or site fabricated casings and plenums. Unless otherwise specified or shown, construct casings and plenums of same material as connecting duct system.
- .2 Construct and install casings and plenums in accordance with Chapter 6 of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible to suit systems' pressure classification. Ensure plenums and casings secured to building structure are gasketed air-tight and equipped with angle reinforcing.
- .3 Provide drain pans with accessible trapped drains for fresh air intake plenums, and wherever else shown.

3.14 Installation of Acoustic Panels

- .1 Provide acoustic panels for plenums. Integrate acoustic plenums with standard casings and plenums. Install acoustic panels in strict accordance with manufacturer's instructions. Seal panels with acoustic caulking where pipes, ducts or conduit penetrate and make air and watertight.
- .2 Provide floor to ceiling high acoustic plenums where shown, each complete with required framing, including framing for access doors and other openings, each structurally designed to resist excessive deflection or bowing, constructed to be air-tight when subjected to a pressure differential of 2.48 kPa (0.36 psi), and designed so any one panel can be removed without dismantling entire plenum.

- .3 Provide acoustic type access doors where shown, and provide acoustic caulking at all locations where acoustic plenums abut building walls or slabs, and at all points where pipe, ducts or conduit penetrate acoustic panels.

3.15 Installation of Casing and Plenum Access Doors

- .1 Provide access doors into all site or shop fabricated casings and plenums requiring access, and wherever shown.
- .2 Construct access doors to open in or out to suit positive and negative pressures of system.
- .3 Provide pitot tube openings in access doors where required for system air quantity balancing purposes.
- .4 Provide suitably sized, engraved, red-white laminated Lamacoid warning nameplates on access doors into casings and plenums where equipment is located, i.e. fans.

3.16 Installation of Round to Rectangular Duct Connections

- .1 Cut round holes in rectangular ducts and provide round to rectangular lock-in fittings with dampers for connection of flexible round ductwork.

3.17 Installation of Splitter Dampers

- .1 Provide splitter dampers in supply ductwork at branch duct connections off supply air mains, and wherever else shown and/or specified on drawings. Install splitter dampers so they cannot vibrate and rattle and so damper operation mechanisms are in an easily accessible and operable location. Ensure operators for dampers in insulated ducts are equipped with stand-off mounting brackets.

3.18 Installation of Turning Vanes

- .1 Provide turning vanes in ductwork elbows where shown on drawings and wherever else required where, due to site installation routing and duct elbow radius, turning vanes are recommended in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Provide volume extractor type turning vanes in short branch supply duct connections off mains to grilles and diffusers where shown and/or specified.

3.19 Installation of Manual Balancing (Volume) Dampers

- .1 Provide manual balancing dampers as required to provide a fully balanced system, including but not limited to in all open end ductwork, in all duct mains, and wherever else shown and/or specified.
- .2 Install dampers so operating mechanism is accessible and positioned for easy operation, and so dampers cannot move or rattle. Ensure operating mechanisms for dampers in insulated ducts are complete with stand-off mounting brackets.
- .3 Where a duct for which a balancing damper is required has dimensions larger than dimensions of maximum size volume damper available, provide multiple dampers bolted together in a properly sized assembly, or bolted to a heavy-gauge black structural steel angle or channel framework which is properly sized. Seal to prevent air by-pass, and provide connecting linkage.
- .4 Confirm exact damper locations with personnel doing air quantity balancing testing work and install dampers to suit. Include for providing 5 additional dampers at no additional cost.

3.20 Installation of Backdraft Dampers

- .1 Provide backdraft dampers.
- .2 Install and secure dampers so they cannot move or rattle.

3.21 Installation of Fusible Link Dampers

- .1 Provide fusible link dampers. Ensure damper rating (1-½ or 3 hr) is suitable for fire barrier it is associated with.
- .2 Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .3 Provide expansion clearance between damper or damper sleeve and opening in which damper is required. Ensure openings are properly sized and located, and all voids between damper sleeve and opening are properly sealed to maintain rating of fire barrier.
- .4 Where size of fire barrier opening requires use of a sectionalized fire damper assembly, provide multiple fusible link dampers (sized to CAN/ULC S112) bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework.

3.22 Installation of Combination Fire/Smoke Dampers

- .1 Provide combination fire/smoke dampers. Install dampers with retaining angles on all 4 sides of each side of damper, and, where required, connect with ductwork, all in accordance with damper manufacturer's instructions and details, and Code requirements.
- .2 Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.

3.23 Installation of Smoke Dampers

- .1 Provide smoke dampers. Install dampers with retaining angles on all 4 sides of sleeve on both sides of damper and connect with ductwork in accordance with damper manufacturer's instructions and details, and Code requirements.
- .2 Coordinate damper installation with electrical work where electrical connections to damper actuators are specified.
- .3 Where size of fire barrier opening requires use of a sectionalized fire damper assembly, provide multiple smoke dampers (sized to CAN/ULC S112) bolted together in a properly sized assembly or bolted to a heavy-gauge black structural steel angle or channel framework.

3.24 Installation of Flexible Connection Material

- .1 Provide a minimum of 100 mm (4") of flexible connection material where ducts, plenums, and/or easings connect to fans, and wherever else shown or specified.
- .2 Rigidly secure a minimum of 75 mm (3") of duct material (minimum #24 gauge) to each edge of flexible fabric and to fan, duct, plenum, etc., in accordance with ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible. Ensure connections to flexible fabric material are arranged and supported so as to not impose any external forces on the fabric.
- .3 Use high temperature flameproof flexible connection material.

3.25 Installation of Roof Mounted Duct Supports

- .1 Supply supports for roof mounted ductwork.
- .2 Hand adjustable structural supports to roofing trade on roof for installation and flashing into roof construction as part of roofing work. Accurately mark exact locations and spacing of structural supports and supervise installation. Provide properly sized hot dip galvanized structural steel angles between

structural supports and secure in place on support studs. Support ductwork on the angles and provide galvanized steel banding to secure ducts to the angles.

- .3 Accurately mark location and spacing of roof support assemblies. At each plastic base location, carefully scrape away loose roof ballast (gravel) and all other debris and dirt. Prime existing membrane with a primer which is compatible with existing roofing components. Set bases in adhesive in accordance with manufacturer's installation instructions. Scrape loose ballast back around and on bases. Install framing, and install ductwork on the cross-members. Secure ductwork to cross-members with galvanized steel banding.

3.26 Installation of Pressure Relief Doors

- .1 Provide pressure release access doors to prevent duct system explosion or implosion as a result of a duct obstruction, i.e. closed fire damper, which prevents normal air flow through the system. Size access doors in accordance with requirements of Part 2 of this section.
- .2 Where pressure release doors are shown in suction ducts or plenums, mount access door assembly so door swings in and latch mechanism is on the inside of duct or plenum. If latch mechanism is not accessible, provide a standard access door at latch side of the pressure release access door for maintenance purposes.
- .3 Adjust each latch mechanism by means of the adjusting pin to suit static pressure of the particular system in accordance with latch mechanism manufacturer's instructions.

3.27 Installation of Duct Access Doors

- .1 Provide access doors in ductwork for access to all components which will or may need maintenance and/or repair, including reheat coils. Install in accordance with requirements of ANSI/SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .2 Identify access doors provided for fusible link damper maintenance with "FLD" stencil painted or marker type red lettering and ensure doors are properly located for damper maintenance.
- .3 When requested, submit a sample of proposed duct access doors for review.
- .4 Where sectionalized fusible link dampers and/or balancing dampers are provided in large ducts, provide a plenum type access door to suit, and adequately reinforce ductwork to suit access door installed.

3.28 Installation of Instruments Test Ports

- .1 Provide instrument test ports in all main ducts at connections to fans, plenums, or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.
- .2 Locate test ports where recommended by personnel performing air quantity testing and balancing work.

3.29 Installation of Wire Mesh (Birdscreen)

- .1 Provide framed, removable wire mesh panels over openings in ducts and/or walls where shown and/or specified on drawings. Rigidly secure in place but ensure panels are removable.
- .2 Provide wire mesh panels for open-end return air ducts in ceiling spaces whether shown on drawings or not.

3.30 Installation of Louvres

- .1 Provide louvres for wall openings.

- .2 Install louvre assemblies and secure in place in accordance with manufacturer's instructions and details.
- .3 Confirm exact louvre sizes and finish prior to ordering.

3.31 Installation of Louvre Blank-Off Panels

- .1 Provide blank-off panels for inactive portions of exterior wall louvres.
- .2 Secure panels in place with non-ferrous hardware so they cannot move or rattle, yet are easily removable.
- .3 Confirm exact finish of panels prior to fabrication.

3.32 Installation of Brick and Block Vents

- .1 Supply brick or block vents for installation in exterior walls.
- .2 Hand assemblies to masonry trade for installation.
- .3 Accurately mark exact locations and coordinate installation.

3.33 Installation of Fire Stop Flaps and Thermal Blankets

- .1 Provide fire stop flaps in duct connection necks of grilles and diffusers installed in ULC fire rated suspended ceiling systems where shown on drawings.
- .2 Provide thermal blanket material to completely cover grille and/or diffuser pans above suspended ULC fire rated ceilings. Cut, install, and secure in place in accordance with manufacturer's instructions and ULC requirements.

3.34 Installation of Grilles and Diffusers

- .1 Provide grilles and diffusers. Wherever possible, grilles and diffusers are to be product of same manufacturer.
- .2 Unless otherwise specified connect grilles and diffusers in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible.
- .3 Exactly locate grilles and diffusers to conform to final architectural reflected ceiling plans and detailed wall elevations, and to conform to final lighting arrangement, ceiling layout, ornamental and other wall treatment.
- .4 Equip supply diffusers having a basic 4-way or all round air pattern for operation in 1-, 2-, or 3-way pattern where indicated on drawings.
- .5 Attach troffer type diffusers associated with typical ceiling mounted fluorescent lighting fixtures to the fixtures on floor prior to fixture installation in ceiling. When fixtures are installed, connect diffuser boots with flexible ductwork.
- .6 Provide sheet metal plenums, constructed of same material as connecting duct, for linear grilles and/or diffusers where shown. Construct and install plenums in accordance with requirements of SMACNA HVAC Duct Construction Standards Metal and Flexible. Where individual sections of linear grilles or diffusers are not equipped with a volume control device, equip duct connection collar(s) with volume control device(s).
- .7 Where linear type diffusers/grilles are installed in suspended T-bar ceilings, clip diffusers/grilles in place using clip supplied by diffuser/grille manufacturer.
- .8 Confirm grille and diffuser finishes prior to ordering.

3.35 Installation of Fan Filter Diffusers

- .1 Provide fan filter diffusers.
- .2 Exactly locate fan filter diffusers to conform to final architectural reflected ceiling plans, and to conform to final lighting arrangement and locations of ceiling equipment.
- .3 Install in strict accordance with manufacturer's instructions, including gasket tape on T-bar ceiling members at unit locations. Plug each unit into an adjacent ceiling receptacle.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration.

3.36 Supply of Door Grilles

- .1 Supply door grilles as shown and scheduled.
- .2 Hand grilles to appropriate trade at site for installation.

3.37 Installation of Roof Mounted Gravity Ventilators

- .1 Provide roof mounted gravity ventilators.
- .2 Supply a roof mounting curb with each ventilator and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of the roofing work. Site assemble gravity ventilators as required, and secure in place on curbs.
- .3 Install dampers in curb damper tray and secure in place.

3.38 Installation of Intake and Exhaust Wall Boxes

- .1 Supply brick or block vents for installation in exterior walls.
- .2 Hand assemblies to masonry trade for installation.
- .3 Accurately mark exact locations and coordinate installation.

3.39 Duct System Protection, Cleaning and Start-Up

- .1 Temporarily cover all open ends of ducts during construction.
- .2 Remove all dirt and foreign matter from entire duct systems and clean duct system terminals and interior of air handling units prior to operating fans.
- .3 Prior to starting any supply air handling system provide 50 mm (2") thick glass fibre construction filters at fan equipment in place of permanent filters.
- .4 Provide cheesecloth over duct system inlets and outlets and run system for 24 hours, after which remove cheesecloth and construction filters, and install new permanent filters.
- .5 Include all labour for a complete site walk-through with testing and balancing personnel following route of all duct systems to be tested, adjusted, and balanced for the purpose of confirming proper position and

attitude of dampers, location of pitot tube openings, and any other work affecting testing and balancing procedures. Perform corrective work required as a result of this walk-through.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for fans and accessories. Include following:
 - .1 certified fan performance curves at specified operating point with flow, static pressure and HP clearly plotted;
 - .2 certified sound power data that conforms to specified levels;
 - .3 product data sheets for all accessories;
 - .4 product data sheets for fan motors.

1.02 Closeout Submittals

- .1 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O&M Manual project closeout data.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Supply reviewed copies of fan/curb assembly shop drawings or product data to trade who will cut roof openings for fans, and ensure openings are properly located.
- .4 Supply reviewed copies of fan assembly shop drawings or product data to trade who will form/prepare wall openings for fans, and ensure openings are properly located.
- .5 Submit a signed copy of destratification fan manufacturer's 5 year extended parts and labour warranty.
- .6 Submit a signed copy of ceiling mounted fan manufacturer's extended 3 year warranty.
- .7 Training attendance records.

1.03 Quality Assurance

- .1 Fan manufacturers, as applicable, are to be current members of the Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
 - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
 - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
 - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans.

2 Products

2.01 Centrifugal Fans

- .1 Centrifugal fans in accordance with drawing schedule, each capable of operating over the complete pressure class limits as specified in AMCA Standard 99-16.

- .2 Continuously welded heavy-gauge steel housing, braced and reinforced as required to prevent vibration or pulsation, equipped with a discharge flange, spun, aerodynamically designed inlet cones or venturies with wire grid guards, drain plug, and epoxy enamel coated both inside and outside to a 3 mm dry film thickness.
- .3 Continuously welded, stable, non-overloading wheel with die-formed steel blades and, unless otherwise required, a cast iron hub, statically and dynamically balanced prior to assembly, then balanced as an assembly and braced and secured to base prior to shipment.
- .4 AISI C1040 or C1050 hot rolled steel fan shaft, accurately turned, ground, polished, and ring gauged for accuracy, and sized for a first critical speed of at least 1.25 times the maximum rated speed for fan, and heavy-duty, grease lubricated, ball or roller, self-aligning pillow block type bearings selected for an AFBMA L-10 minimum average bearing life in excess of 200,000 hours, and equipped with extended copper lubrication lines terminated in lubrication fittings immediately inside fan section access door.
- .5 NEMA Premium TEFC motor, adjustable V-belt drive selected for 40% service factor based on motor nameplate data, and OSHA guard, all in accordance with requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .6 Fan and motor support base is to be rigid, welded structural steel, vibration isolated base with steel cross members, factory cleaned, deburred, and finished with epoxy enamel, and complete with a slide type motor base and stable, colour coded spring mounts with sound pads selected to suit static deflection and maximum equipment load and to operate at not greater than 2/3 solid load, and shipping restraints.
- .7 Unless otherwise specified, finish is to consist of rust inhibiting primer applied to cleaned and deburred metal surfaces prior to assembly, then a second coat of primer after assembly and an air dried epoxy enamel finished coat both inside and outside to a 3 mm dry film thickness.
- .8 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 CML Northern Blower;
 - .5 PennBarry.

2.02 Explosion-Proof Centrifugal Fans

- .1 Explosion-proof centrifugal fans in accordance with drawing schedule, each capable of operating over complete pressure class limits as specified in AMCA Standard 99-2408 and rated Spark A in accordance with AMCA Standard 99-0401, Classification for Spark Resistant Construction.
- .2 Housing constructed as per ASTM Standard 99-0401 to suit "Spark" classification, with a wheel direct connected to an explosion-proof TEFC motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, statically and dynamically balanced prior to assembly, then balanced as an assembly and secured to base prior to shipment.
- .3 Rigid, welded structural steel, vibration isolated fan support base with steel cross members, factory cleaned, deburred, and finished with epoxy enamel, and complete with stable, colour coded spring mounts with sound pads selected to suit static deflection and maximum equipment load and to operate at not greater than 2/3 solid load, and shipping restraints.
- .4 Manufacturers:

- .1 Twin City Fan and Blower;
- .2 Loren Cook Co.;
- .3 Greenheck Fan Corp.;
- .4 CML Northern Blower;
- .5 PennBarry.

2.03 Utility Fans

- .1 Centrifugal, single width and inlet, factory run tested utility fans in accordance with drawing schedule, and capable of operating over complete pressure class limits as specified in AMCA Standard 2408.
- .2 Rotatable, continuously welded heavy-gauge steel housing, braced and reinforced as required to prevent vibration or pulsation, equipped with a spun, aerodynamically designed inlet cone, and an attached welded steel bearing and motor support platform.
- .3 Riveted aluminum or welded steel wheel, statically and dynamically balanced.
- .4 For belt driven fans only, AISI C1040 or C1045 hot rolled steel shaft, accurately turned, ground, polished, and ring gauged for accuracy, and sized for a first critical speed of at least 1.43 times maximum rated speed for fan, equipped with heavy-duty, grease lubricated, ball, pillow block type bearings, selected for a minimum average AFBMA L-50 bearing life of 200,00 hours at the maximum fan RPM, and secured to bearing support platform, and an adjustable V-belt drive with OSHA guard (weather cover) in accordance with requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .5 NEMA Premium TEFC motor conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .6 Unless otherwise specified, the finish is to consist of rust inhibiting primer applied to cleaned and deburred metal surfaces prior to assembly, then a second coat of primer after assembly and an air dried epoxy enamel finished coat both inside and outside to a 3 mm dry film thickness.
- .7 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 CML Northern Blower;
 - .5 PennBarry.

2.04 Centrifugal Inline Fans

- .1 Centrifugal, ULC listed, factory run tested rectangular inline fans in accordance with drawing schedule.
- .2 Heavy-gauge galvanized steel housing with removable side panels to permit removal of power assembly without disturbing duct connections, universal mounting brackets and hardware including spring vibration isolators to accommodate horizontal or vertical mounting as required, a flanged inlet panel with inlet venturi, a flanged outlet panel, both with duct connection collars, and galvanized steel wire grid fan inlet/outlet guard(s).
- .3 Non-overloading aluminium wheel with backward inclined blades with matching inlet venturi, statically and dynamically balanced as an assembly.

- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and heavy-duty, self-aligning pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours and equipped with lubrication line and fitting, and an adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .5 TEFC motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted out of the airstream, complete with a cover, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 For fans as scheduled, factory supplied accessories as follows:
 - .1 for fans as scheduled, housing insulation (lining), consisting of neoprene spray coated glass fibre semi-rigid insulation meeting NFPA 90A requirements and 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, permanently secured in place with no exposed edges;
 - .2 for fans as scheduled, a galvanized steel filter box with frame suitable for 25 mm (2") thick disposable panel type filters;
- .7 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 JencoFan;
 - .5 Carnes Company Inc.

2.05 Plenum Fans

- .1 Centrifugal airfoil design plenum fans in accordance with drawing schedule, designed without a scroll type housing, and capable of operating over complete pressure class limits as specified in AMCA Standard 99-2408.
- .2 Heavy-gauge reinforced steel inlet plate with perimeter square formed lip, spun steel inlet cone bolted to inlet plate for smooth airflow into venturi shaped inlet cone of the fan wheel, and a welded structural steel framework forming a mounting base and bearing support platform welded to the inlet plate.
- .3 Non-overloading wheel with 9 backward inclined, die-formed, airfoil design steel blades continuously welded to a spun inlet cone, back plate, and cast iron hub, statically and dynamically balanced as an assembly, and designed for critical speeds of at least 1.25 times maximum class speed.
- .4 For belt driven fans, AISI C1040 or C1050 hot rolled steel shaft, accurately turned, ground, polished and ring gauged for accuracy, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and heavy-duty, grease lubricated, ball or roller self-aligning pillow block type bearings selected for an AFBMA L-10 minimum average life in excess of 200,000 hours and equipped with extended copper tube lubrication lines terminated in accessible lubrication fittings, and an adjustable V-belt drive selected for 40% service factor based on motor nameplate data and conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical.
- .5 NEMA Premium TEFC motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical.

- .6 Rigid, welded structural steel, vibration isolated fan and motor support base with steel cross members, factory cleaned, deburred, and finished with epoxy enamel, and complete with slide type motor base, and stable, colour coded spring mounts with neoprene sound pads selected to suit static deflection and to operate at not greater than 2/3 solid load, and equipped with shipping restraints.
- .7 Rigid, open mesh galvanized steel screen enclosure with fan wheel access facilities, and a removable galvanized steel mesh inlet screen.
- .8 Unless otherwise specified, factory finish is to consist of rust inhibiting primer applied to cleaned and deburred surfaces prior to assembly, then a second coat of primer after assembly and an air dried epoxy enamel finish applied to all inside and outside surfaces to a 3 mm dry film thickness.
- .9 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 CML Northern Blower;
 - .5 PennBarry.

2.06 Roof Mounted Exhaust Fans

- .1 Centrifugal, ULC listed, factory run tested roof mounted exhaust fans in accordance with drawing schedule.
- .2 Spun aluminium housing with deep venturi inlet, aluminium curb cap with continuously welded corners, pre-punched mounting holes, galvanized steel or aluminium bird screen, and EMT conduit chase to the motor compartment.
- .3 Centrifugal, non-overloading aluminum wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.
- .4 For belt-drive fans only, hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 500,000 hours at maximum catalogue operating speed and equipped with a lubrication fitting, and a heavy-gauge galvanized steel adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .5 Motors are to conform to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, mounted on vibration isolation in a compartment outside of the airstream, and factory pre-wired to a NEMA 4 disconnect switch.
- .6 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation, continuously welded seams, and damper tray.
- .7 For fans as scheduled, factory supplied accessories as follows:
 - .1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;
 - .2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;

- .3 continuous non-corrosive piano type curb hinge to permit access to fan, damper and connecting duct, complete with retaining chain and a security hasp to prevent removal of unit from curb cap and prevent building entry through connecting ductwork;
- .4 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section 20 05 00 – Common Work Results for Mechanical;
- .8 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 JencoFan;
 - .5 Carnes Company Inc.

2.07 Sidewall Propeller Fans

- .1 Axial flow type, ULC listed, factory run tested propeller fans in accordance with drawing schedule.
- .2 Heavy-gauge galvanized steel drive component frame bolted or welded to formed galvanized steel fan panel equipped with formed flanged edges, pre-punched mounting holes, and a deep formed inlet venturi.
- .3 Fabricated steel blades unless otherwise specified, welded to a heavy-gauge steel hub, and dynamically balanced.
- .4 For belt-drive fans only, AISI 1045 cold rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and grease lubricated or permanently lubricated, sealed, ball type pillow block bearings selected for an AFBMA L-50 minimum average life in excess of 200,000 hours at maximum fan RPM, with a variable pitch adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .5 Motor in accordance with requirements specified in Section 20 05 00 – Common Work Results for Mechanical.
- .6 Unless otherwise specified, all bare steel surfaces are to be cleaned, primed, and factory finished with epoxy equipment enamel.
- .7 Factory supplied accessories as follows:
 - .1 #16 gauge G90 galvanized steel wall box with removable screen guard, equipped with mounting flanges with pre-punched holes;
 - .2 back draft damper with galvanized steel frame, aluminum blades with felt edge seals, stainless steel shaft, and OSHA damper guard;
 - .3 galvanized steel weather hood with removable galvanized steel wire mesh bird screen, with mounting flanges equipped with pre-punched mounting holes;
 - .4 OSHA motor side guard with galvanized steel side panels and removable galvanized steel wire mesh screen;
- .8 Manufacturers:
 - .1 Twin City Fan and Blower;

- .2 Loren Cook Co.;
- .3 Greenheck Fan Corp.;
- .4 JencoFan;
- .5 Carnes Company Inc.;
- .6 PennBarry.

2.08 Corrosion Resistant Centrifugal Fans

- .1 Centrifugal FRP fans in accordance with drawing schedule, with drive arrangement and configuration as indicated on drawings, and capable of operating over complete pressure class limits as specified in AMCA Standard 99-2408.
- .2 Aerodynamically designed housing with high efficiency inlet, manufactured from resins, UV inhibited, reinforced with fiberglass, and with bolts holding housing to support plate encapsulated in FRP, and no uncoated metal in contact with corrosive air stream. Each assembly is to be complete with graphite impregnated interior casing, lifting lugs, type 304 stainless steel fasteners, a FRP ridge inside casing to divert condensation from dripping over hub and shaft, a flanged inlet and outlet, and an impeller inspection and service access door.
- .3 Backward curved FRP wheel electronically statically and dynamically balanced after assembly, with an integral metal back plate encapsulated in resin and with hub extended to outside housing, a removable FRP cap to cover impeller end of shaft, and a vacuum hub seal to prevent contaminated air from escaping from fan housing.
- .4 For belt driven fans, type 316 stainless steel shaft, accurately turned, ground, polished, and ring gauged for accuracy, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and complete with guard, and heavy-duty, sealed, grease lubricated, ball or roller, self-aligning pillow block type bearings selected for an AFBMA L-10 minimum average bearing life in excess of 200,000 hours, and equipped with extended copper lubrication lines terminated in lubrication fittings at exterior of fan assembly, and an adjustable V-belt drive selected for 50% service factor based on motor nameplate data, with FRP OSHA in accordance with requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .5 NEMA Premium TEFC motor conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .6 Rigid, welded structural steel unitary fan and motor support base, factory cleaned and finished with 4 to 6 mm thick baked powder epoxy enamel.
- .7 Manufacturers:
 - .1 M. K. Plastics Corp.;
 - .2 New York Blower Co.;
 - .3 Pasticair Inc.

2.09 Vaneaxial Fans

- .1 Vaneaxial, ULC listed, factory run tested fans in accordance with drawing schedule.
- .2 Heavy-gauge welded ASTM A-569 hot rolled steel housing with inlet and outlet flanges, and, on the discharge side of fan wheel, aerodynamically designed stationary straightening guide vanes welded to both inner cylinder and fan housing interior.

- .3 Propeller type wheel, solid, one-piece casting of A356-T6 aluminium with 7 airfoil shape blades and an integral centre hub, machined to proper diameter, secured to fan/motor shaft by means of a taper-lock bushing, and statically and dynamically balanced as an assembly.
- .4 For belt-drive fans only, AISI 1040 or 1045 hot rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.43 times maximum rated speed for fan, and heavy-duty, self-aligning, grease lubricated pillow block type bearings selected for an AFBMA L-50 minimum average life in excess of 200,000 hours at maximum fan RPM and equipped with extended lubrication lines terminated at housing exterior in lubrication fittings, and an adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical. Drive assembly is to extend through a 2-piece aerodynamically shaped belt fairing welded continuously to both inner cylinder housing fan shaft and bearings, and fan housing.
- .5 TEFC foot mounted motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical.
- .6 Steel surfaces of entire fan assembly, excluding fan shaft, are to be thoroughly degreased, deburred, coated with rust-preventive primer, and finished with equipment enamel. Coat fan shaft with a petroleum-based rust protectant.
- .7 For fans as scheduled, factory supplied accessories as follows:
 - .1 vibration isolators;
 - .2 torosoidal shaped inlet bell, flanged, drilled and bolted to fan's flanged inlet;
 - .3 galvanized steel wire grid fan inlet/outlet guard(s);
 - .4 inlet/outlet cones, flanged at both ends and drilled to match fan flanges;
 - .5 steel support legs welded to fan flanges;
 - .6 formed steel angle support clips welded to fan housing;
- .8 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 CML Northern Blower;
 - .5 PennBarry;
 - .6 JencoFan;
 - .7 Carnes Company Inc.

2.10 Ceiling Mounted Destratification Fans

- .1 Northwest Envirofan "Gold Line" white, down-blowing, extra heavy-duty industrial grade, CSA certified direct drive ceiling mount destratification fans in accordance with drawing schedule, each complete with:
 - .1 curved aluminum fan blades secured to a steel hub;
 - .2 permanent magnet, brushless, non-ventilated, heat sink design motor rated for continuous operation at maximum speed in a 55°C (130°F) ambient temperature and capable of modulating

- fan speed from 0 to 100% without the use of a gearbox or other mechanical means of control, and a factory programmed controller housed in an enclosure independent of motor to minimize starting and braking torques, with a simple diagnostic program and a LED to identify and relay faults in system;
- .3 250 mm (10") long down rod, a 330 mm (13") long galvanized steel safety chain, and all other required mounting and securing hardware;
- .4 400 mm (16") long power cord with 3-prong plug, factory pre-wired to motor;
- .5 "Protecto-Guard" welded wire fan guard sized to suit fan blade size;
- .6 120 volt variable speed (Off-High-Low) solid-state infinite speed fan controller with stainless steel faceplate designed to mount to a 100 mm (4") outlet box and to control fan groupings as indicated on drawings;
- .2 Manufacturers:
 - .1 Northwest Envirofan;
 - .2 Big Ass Fan Co.;
 - .3 Marley Engineered Products "Leading Edge".

2.11 Ceiling Mounted Fans

- .1 ULC listed and labelled ceiling mounted centrifugal, AMCA rated and certified (capacity and sound to AMCA Standards 211 and 311), exhaust fans in accordance with drawing schedule, complete with:
 - .1 minimum #20 gauge galvanized steel housing equipped with duct connection collar(s), integral spring loaded aluminum backdraft damper, 12 mm (½") thick acoustic insulation meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, multi-position mounting brackets, and an integral CSA certified electrical receptacle in an outlet box for plug-in connection of fan motor;
 - .2 low RPM, resiliently mounted, direct connected fan wheel and motor assembly with a forward curved, statically and dynamically balanced galvanized steel or calcium carbonate filled polypropylene centrifugal wheel direct connected to a 1-phase motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical, and equipped with a length of power cord and plug;
 - .3 for fans as indicated and/or scheduled, a white calcium carbonate exhaust grille;
 - .4 factory supplied accessories in accordance with drawing schedule, as follows:
 - .1 rectangular to round duct transitions;
 - .2 roof cap with backdraft damper and birdscreen;
 - .3 wall cap with backdraft damper and birdscreen.
- .2 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;

- .4 CML Northern Blower;
- .5 PennBarry.

2.12 Roof Mounted Filtered Supply Fans

- .1 Low profile louvre penthouse type, weatherproof, packaged, centrifugal, factory run tested, roof mounted filtered supply fans as per the drawing schedule.
- .2 Hood is to be all aluminium welded structural framing and aluminium alloy blade extrusions with mitred corners, removable top cap pitched for water run-off, side access panel, expanded aluminium mesh bird screen, formed filter channels, 25 mm (1") thick glass fibre insulation meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and an aluminium curb cap.
- .3 Galvanized steel fan housing of lock seam construction, braced to minimize pulsation and/or vibration and complete with spun, aerodynamically designed inlet cones or venturies, duct adaptor designed to fit over roof curb and permit duct connection before fan is set in place, and a fan inlet screen.
- .4 Centrifugal, non-overloading aluminum wheel with backward inclined blades continuously welded to rim and back plate, and statically and dynamically balanced as an assembly.
- .5 Disposable, 50 mm (2") thick glass fibre media filters, ULC Class 2, 20% – 35% efficient, minimum MERV 6 as per ASHRAE 52.2, enclosed in permanent galvanized steel frames with metal retainers on both sides.
- .6 ANSI 1040 or 1045 cold rolled steel shaft, accurately turned, ground, and polished, and sized for a first critical speed of at least 1.25 times maximum rated speed for fan, and one-piece grease lubricated pillow block type bearings selected for an AFBMA minimum average life in excess of 200,000 hours at maximum catalogue operating speed and equipped with zinc rich paint coated steel bearing supports and a lubrication fitting.
- .7 Motor mounted on a slide type base and factory pre-wired to a NEMA 4 disconnect switch on unit casing, and adjustable V-belt drive with guard conforming to requirements of Section 20 05 00 – Common Work Results for Mechanical.
- .8 Prefabricated, minimum 300 mm (12") high heavy-duty aluminum roof mounting curb with factory installed wood nailer, 40 mm (1-½") thick insulation meeting 25/50 flame spread/smoke developed ratings when tested in accordance with CAN/ULC S102, and continuously welded seams.
- .9 Non-corrosive motorized damper supplied loose for site installation in connecting ductwork, equal to T. A. Morrison TAMCO Series 9000 insulated damper with linkage, end switch, and a Belimo or equal motor with voltage to match fan motor.
- .10 Manufacturers:
 - .1 Twin City Fan and Blower;
 - .2 Loren Cook Co.;
 - .3 Greenheck Fan Corp.;
 - .4 CML Northern Blower;
 - .5 PennBarry;
 - .6 JencoFan;
 - .7 Carnes Company Inc.

3 Execution

3.01 Installation of Centrifugal Fans

- .1 Provide centrifugal fans.
- .2 Secure each base mounted fan in place, level and plumb, on vibration isolation on a concrete housekeeping pad.
- .3 Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers, properly sized galvanized steel hanger rods and galvanized structural steel angle or channel trapeze supports.
- .4 Install explosion-proof units in accordance with classification requirements.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.02 Installation of Utility Fans

- .1 Provide utility fans.
- .2 Secure each fan in place, level, and plumb, on vibration isolation on a concrete housekeeping pad or base as indicated.
- .3 Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers, properly sized galvanized steel hanger rods, and galvanized structural steel angle or channel trapeze supports.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.03 Installation of Centrifugal Inline Fans

- .1 Provide inline centrifugal fans.
- .2 Secure each fan in place from structure with vibration isolation, independent of connecting ductwork and in accordance with fan manufacturer's instructions.
- .3 Ensure duct connections are made using flexible connection material.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.04 Installation of Plenum Fans

- .1 Provide plenum fans in air handling system plenums.
- .2 Secure fans in place, level, and plumb, on vibration isolation.
- .3 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .4 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.05 Installation of Roof Mounted Exhaust Fans

- .1 Provide roof mounted exhaust fans.
- .2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.
- .3 Install dampers in curb damper tray and secure in place.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.06 Installation of Sidewall Propeller Fans

- .1 Provide sidewall propeller fans. Coordinate location(s) and size(s) of wall opening(s) with trade preparing the opening(s).
- .2 Rigidly secure each fan and accessories in place to structure in accordance with fan manufacturer's instructions.
- .3 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .4 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.07 Installation of FRP Centrifugal Fans

- .1 Provide FRP centrifugal fans.

- .2 Secure each base mounted fan in place, level, and plumb, on corrosion resistant vibration isolation on a concrete housekeeping pad.
- .3 Secure suspended units in place from structure, level and plumb, by means of corrosion resistant vibration isolation spring hangers, properly sized type 316 stainless steel hanger rods and a structural type 316 stainless steel angle, or channel support structure.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.08 Installation of Vaneaxial Fans

- .1 Provide vaneaxial fans.
- .2 Secure each fan in place to or from structure with vibration isolation as indicated, independent of connecting ductwork.
- .3 Ensure duct connections are made using flexible connection material.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, Refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.09 Installation of Ceiling Destratification Fans

- .1 Provide ceiling destratification fans.
- .2 Secure each fan in place at the ceiling from structure in accordance with manufacturer's instructions and drawing details. Confirm exact locations prior to roughing-in. Install safety chains and fan blade guards.
- .3 Plug each fan motor into an adjacent receptacle.
- .4 Supply a fan speed controller for fans as indicated and hand to electrical trade at site for wall mounting and connection to fan motor controllers. Confirm exact speed controller locations prior to installation, and include for identification of each speed controller.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

3.10 Installation of Ceiling Fans

- .1 Provide ceiling exhaust fans.

- .2 Secure each ceiling mounted fan housing in place in ceiling space, flush with suspended ceiling.
- .3 Secure suspended units in place from structure, level, and plumb, by means of vibration isolation spring hangers and galvanized steel hanger rods.
- .4 Plug fan motors into housing receptacles.
- .5 Supply exterior wall/roof discharge caps as indicated.
- .6 Hand roof caps to roof trade for installation and flashing into roof construction as part of roofing work.
- .7 Install wall caps and secure in place. Caulk perimeter of each wall cap in accordance with caulking requirements specified in Division 07.
- .8 Connect fan housings and discharges with ductwork.
- .9 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.11 Installation of Roof Mounted Filtered Supply Fans

- .1 Provide roof mounted filtered supply fans.
- .2 Supply a roof mounting curb with each fan and hand curbs to roofing trade on roof for mounting and flashing into roof construction as part of roofing work. Secure fans in place on curbs.
- .3 Secure duct adaptors in place on curbs on foam tape or other suitable gasket material, and install motorized dampers (supplied loose) in connecting ductwork. Coordinate connection of power from fan starter to damper motor with electrical trade who will make the connection.
- .4 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .5 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.12 Closeout Activities

- .1 Include for a 4 hour on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for the exhaust fan and accessories. Include following:
 - .1 certified fan performance curves;
 - .2 product data for all accessories;
 - .3 product data for fan motors.

1.02 Closeout Submittals

- .1 Submit with delivery of each unit a copy of the factory inspection report, and include a copy of each report with O&M manual project closeout data.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Supply reviewed copies of appropriate fan assembly shop drawings or product data to trade who will cut roof opening or provide wall opening for fan, and ensure openings are properly located.
- .4 Training attendance records.

1.03 Quality Assurance

- .1 Kitchen exhaust fan manufacturers are to be current members of Air Movement and Control Association International Inc. (AMCA), and fans are to be rated (capacity and sound performance) and certified in accordance with requirements of following standards:
 - .1 ANSI/AMCA Standard 210, Laboratory Method of Testing Fans for Certified Aerodynamic Performance Rating;
 - .2 AMCA Standard 211, Product Rating Manual for Fan Air Performance;
 - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans;
 - .4 AMCA Standard 311, Product Rating Manual for Fan Sound Performance;
 - .5 AMCA Standard 99-2408, Operating Limits for Centrifugal Fans;
 - .6 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations;
 - .7 ULC-S645, Power Ventilators for Commercial and Institutional Kitchen Exhaust Systems.

2 Products

2.01 Manufacturers

- .1 Spring Air Systems Inc;
- .2 Reversomatic;
- .3 Twin City Fan and Blower;
- .4 Loren Cook Co.;

- .5 Greenheck Fan Corp.;
- .6 JencoFan;
- .7 Carnes Company Inc.

2.02 Kitchen Exhaust Fans

- .1 Centrifugal, ULC listed and labelled, factory run tested up-blast type kitchen exhaust fans in accordance with drawing schedule.
- .2 The commercial kitchen exhaust fan shall be a Spring Air Model No. XF-B236 with capacity of 5385 CFM at 2.61 W.C. total static pressure. The 5 HP shall be Nema design B with class B insulation rated for continuous duty. The Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (Power Ventilator for Restaurant Exhaust Appliances). Fan shall bear the AMCA certified ratings seal for sound and air performance.
- .3 Fan shall be a spun aluminum, roof mounted, belt driven, upblast centrifugal exhaust ventilator. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. The spun aluminum structural components shall be constructed of minimum 16 gauge marine alloy aluminum, bolted to a rigid aluminum support structure. The aluminum base shall have a one piece inlet spinning and continuously welded curb cap corners for maximum leak protection. The windband shall have a rolled bead for added strength. Centrifugal, non-overloading aluminium wheel with backward inclined blades matched to inlet venturi, statically and dynamically balanced as an assembly.
- .4 A two piece top cap shall have stainless steel quick release latches to provide access into the motor compartment without the use of tools. An external wiring compartment with integral conduit chase shall be provided into the motor compartment to facilitate wiring connections. The motor, bearings and drives shall be mounted on a minimum 14 gauge steel power assembly. These components shall be enclosed in a weather-tight compartment, separated from the exhaust airstream.
- .5 A one inch thick, three pound density foil backed heat shield shall be utilized to protect the motor and drive components from excessive heat. Lifting lugs shall be provided to help prevent damage from improper lifting. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.
- .6 Wheel shall be centrifugal backward inclined, constructed of 100 percent aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
- .7 Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.
- .8 Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150 percent of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.
- .9 Optional insulated perimeter roof curb.
- .10 For fans as scheduled, factory supplied accessories as follows:
 - .1 gravity backdraft damper with #20 gauge galvanized steel frame and #26 gauge aluminum blades with felt edge blade seals;
 - .2 non-corrosive motorized damper with linkage, end switch, and motor with voltage to match fan motor;

- .3 2-speed switch and 2-speed double winding 1-phase motor in accordance with Section 20 05 00 – Common Work Results for Mechanical;

3 Execution

3.01 Installation of Kitchen Exhaust Fans

- .1 Provide kitchen hood exhaust fans.
- .2 Supply a roof mounting curb with each fan and hand curb to roofing trade on roof for mounting and flashing into roof construction as part of the roofing work. Secure fan curb cap in place on curb. Test hinge operation and make any required adjustments.
- .3 Secure wall mounted fans in place over wall openings and caulk perimeter water-tight.
- .4 Install damper in curb damper tray and secure in place.
- .5 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .6 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Include for supervising fan operation during hood performance testing.

3.02 Closeout Activities

- .1 Include for two, 4 hour on-site operation demonstration and training sessions for two groups of six people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for each hood and accessories. Include following:
 - .1 certified power and control wiring schematics;
 - .2 product data for all accessories;
 - .3 drawings indicating methods of assembly and installation details.

1.02 Closeout Submittals

- .1 Submit with delivery of each hood a copy of the factory inspection report, and include a copy of the report with O&M Manual project closeout data.
- .2 Submit site inspection and start-up reports from manufacturer's representative as specified in Part 3 of this section.
- .3 Submit documentation from a third party testing laboratory to certify hood to be supplied has been tested and is listed as being in accordance with requirements of NSF/ANSI No. 2.
- .4 Training attendance records.

1.03 Maintenance Material Submittals

- .1 Hand to Owner, at Substantial Performance of the Work, an identified filter removal tool.

1.04 Quality Assurance

- .1 Kitchen cooking equipment exhaust hood is to be constructed and certified in accordance with requirements of governing Provincial/Municipal Regulations, and following standards:
 - .1 UL 300, Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment;
 - .2 UL 710, Exhaust Hoods for Commercial Cooking Equipment;
 - .3 UL 1046, Grease Filters for Exhaust Ducts;
 - .4 NSF/ANSI No. 2, Food Equipment, including listing and approval by a third part testing laboratory;
 - .5 NFPA 17/17A, Standard for Dry/Wet Chemical Fire Extinguishing Systems;
 - .6 NFPA 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
- .2 Each hood is to be installed by personnel experienced in installation of food service equipment, using licensed journeyman plumbers and electricians to connect electrical and plumbing services to hood.
- .3 Hood manufacturer/supplier is to have an exhaust hood parts and 24/7 service facility within 100 km of site.
- .4 Manufacturers must meet all requirements of this section and drawing details/requirements.

2 Products

2.01 Kitchen Cooking Commercial Ventilation Unit

- .1 The commercial kitchen supply unit shall be a SPRING AIR SYSTEMS Inc. model no. SFT15-IGDXOH-2, TruFlow Enabled, outdoor design, horizontal arrangement, motorized inlet damper with end switch, assembled, wired and tested prior to shipment with a supply capacity of 2032 l/s at 0.38 kPa external static pressure with 5 HP motor 208V/3/60. The unit is designed with a heating output of 360,000 btu/hr.
- .2 The supply unit shall be factory certified by Canadian Standards Association, installed in accordance with local building codes and local authorities having jurisdiction.
- .3 The supply unit has a forward curved DWDI, AMCA rated with ball bearings, belt driven, and statically and dynamically balanced forward curved supply fan, belts, ODP motor, motor-starter and overloads. The unit has modular, perimeter supports and panels of 18 gauge, galvanized construction suitably reinforced to ensure rigidity. The access doors are lift off or hinged when the cabinet is pressurized. The Inlet cowl and birdscreen has 2-inch MERV7 filters. The unit insulated with 1" fiberboard insulation. When DX or Chilled water coil included the cooling section has 1" foil face insulation.
- .4 Indirect gas fired, power vent burner, with stainless steel exchanger and burner complete with intermittent-duty pilot ignition gas controls for use with natural gas, non-lockup type. Controls to include modulator/regulator valve, combination main/pilot/manual valve spark ignition controller, overheat control and low voltage transformer.
- .5 Modulating Burner Control:
 - .1 Electronic modulation control with maxitrol duct sensing system with local set point adjustment located in burner control panel. Ductstat installed in heater discharge by mechanical contractor.
- .6 The SFT shall have a DX cooling section after the burner section and before the optional turndown section. The DX controls are provide in conjunction with the Spring Air Systems RPD-P panel. Remote wiring is per the project drawings. The cooling section shall include DX coil, stainless steel DX coil rack, stainless steel drain panel before and after the DX coil and a NPT drain. For two stage systems the DX coil is complete with two scrambled circuits. The cooling section will be insulated with foil face insulation on roof, walls and floor after DX cooling rack. The cooling section is a integral part of the complete SFA or SFT mounted a single perimeter curb.
- .7 Single Stage Cooling. The condenser/compressor package is a integral part of the complete SFA or SFT mounted a single perimeter curb. The condenser/compressor is build in accordance to ARI standard 210/240, with UL/ULC label, with capacity of 5 tons, complete with a single/two stage roomstat shipped loose for field, ambientstat, a scroll compressor assembly, an air cooled condenser coil, propeller type condenser fan, and control box with discharge condenser air upward. Unit shall be matched to DX evaporative coil with scrambled circuit. The hermetic compressor units shall be leak tested to 200 psig and pressure tested to 428 psig. The air-cooled condensing units will provide a EER of 11.5 which meets ASHRAE 90.1 efficiency levels.
- .8 The factory assembled, single piece air-cooled condenser unit shall contain all factory wiring, piping, controls, compressor(s) and holding charge. Evaporative cooling coil to be 1/2" OD copper tube with 0.018" wall thickness, aluminum fins, type "L" copper and copper adapter header material with 18 Ga. galvanized steel casing material.
- .9 The condenser fans shall be direct driven, propeller type, discharging vertically upward. The condenser coil shall be constructed of aluminum fins mechanically bonded to internally grooved seamless copper tubes.
- .10 The compressor(s) shall be mounted on vibration isolators, complete with compressor lockout on auto-reset safety unit reset, including high discharge pressure cutout and loss-of-charge cutout, overload

protection, equipped with crankcase heaters, and include either suction cutoff unloading or electrical solenoid unloading. Refrigeration circuit components shall include liquid line service valve, liquid line main and branch solenoid valves, suction line service valve, a full charge of compressor oil and holding charge of refrigerant. The complete package will be charged on site during commissioning.

.11 TruFlow Enabled Makeup Air Unit:

- .1 The SFT unit shall be complete with a Variable Frequency Drive (VFD). Supply volume control from 100% to 50% of design fresh air. The VFD is provided a signal from the Truflow control enclosure to automatically adjust the supply volume. As the TruFlow Enabled exhaust fan volume changes to suit the cooking appliance operation the SFT supply unit matches the exhaust air requirements to provide between 50 and 100% fresh air to the space.

2.02 Kitchen Demand Ventilation Controller

- .1 The commercial kitchen demand ventilation controller shall be a Spring Air Systems TruFlow-ZoneFlow model RPD-P11-AW-SW-LS-TFZ1-4-SC-BS. The TruFlow-ZoneFlow shall provide a 24 hour/day demand ventilation for the commercial kitchen system. The touchscreen panel shall be CSA certified and supplied in an 18GA stainless steel enclosure with No. 4 finish for hood, surface wall, or wall mounting. The TruFlow NEMA4x Touchscreen operates in conjunction with the Zoneflow HUB panel with integral PLC to provide daily reduction of the commercial kitchen exhaust and supply, and real-time temperature based control of energy target goal management. TruFlow has optional BACnet interfaced to the building automation systems (BAS). The Touchscreen controller shall be complete with Dashboard, System Control, Alarm Status, and Reports and Setup & Diagnostic screens.
- .2 The Dashboard screen shall graph energy usage throughout the day measuring energy consumption against user set goals. The Dashboard screen also displays exhaust volume, outdoor temperature, hood lights, and % of goal reduction that is achieved each minute of the day.
- .3 The System Control screen displays all components of the kitchen ventilation system: Hood lights, fan on/off, summer/winter switch, and overrides. The TruFlow-ZoneFlow is capable of providing two independent kitchens with a maximum of two exhaust variable speed drives and two supply variable speed drives. The TruFlow-ZoneFlow provides a 4-20 milliamp output for each makeup air connected. The Alarm Status Screen indicates and logs all alarm events which include; high temperature operation, electrical faults, J-couple faults, and supply drive communication error/failure and exhaust/supply drive communication error/failure.
- .4 The The Report screen provides finger tip selection of reports for Year to Date cost of gas, Year to Date cost of electricity, Daily cost of Utilities, % time exceeding goal and % time in override.
- .5 The System Setup screen is accessible by the administrator with a secure password to customize the screen to the user, enter reduction goal, operating times, utility costs and provide system diagnostics.
- .6 The TruFlow-Zoneflow panel operates two or more Spring Air Systems UL/ULC listed commercial kitchen exhaust hoods. Each hood has a Modulating Zoneflow damper (shipped loose for bolted field installation) and a exhaust duct J-Couple. The J-Couple modulates the Zoneflow damper and sends a signal to the TruFlow-Zoneflow HUB panel to modulate the exhaust VFD to match the total exhaust volume to the cooking operation under each individual hood. In addition the TruFlow-Zoneflow HUB panel modulates the supply VFD and sends a 4-20milliamp or 2-10VDC modulating signal. The kitchen demand ventilation system modulates from 30 to 100%. Pressing the touchscreen override button modulates the VFD's and Zoneflow dampers to high volume position.
- .7 The HUB panel is connected to an outdoor temperature transducer supplied by Spring Air to data log the actual real time energy savings during the winter and summer.
- .8 Input Line Reactors:

- .1 All variable frequency drives (VFD) shall be supplied with a input line reactors (ILR). The VFD's and ILR's will be shipped separately in NEMA1 enclosures to be installed and wiring by the electrical division. IRL's are designed to improve the reliability of VFD, DC drives. The kitchen will remain operating and the Truflow touchscreen shall alert kitchen operators and building management of a drive failure. In addition they shall provide limited input line current harmonic mitigation and aid in long lead protection for inverter fed motors. The 3% impedance IRL's shall provide IGBT protection.
- .9 Remote Wiring Connections:
 - .1 The Touchscreen panel is hood mounted or wall mounted
 - .2 The HUB panel is wall mounted.
 - .3 The Truflow/Zoneflow controls up to two Truflow Enabled exhaust fans and up to 12 hoods per fan.
- .10 Wiring to panel:
 - .1 Power supply to the RPD-P11-AW-SW-LS-TFZ1-4-SC-BS 15 amps 120V/1/60
 - .2 Interlock from Building Automation System (BAS), CAT5 cable.
- .11 Wiring Drives:
 - .1 High voltage power supply from breaker panel to input side of each drive
 - .2 High voltage power wiring from output side of each drive to fan mounted motor disconnect switch.
- .12 Wiring from panel:
 - .1 Interlock each VFD with CAT5 connection in series.
 - .2 CAT5 cable to Outdoor temperature transducer located in a fresh air stream.
 - .3 CAT5 cable to each Zoneflow damper connected to each hood.
- .13 Options:
 - .1 TruFlow RPD-P11-AW-SW-LS-TFZ1-4-SC-BS located on the hood
 - .2 Variable speed drive enclosure mounted on the hood
 - .3 Variable speed drive for supply fan.
- .14 Remote Wiring:
 - .1 Power supply to the HUB panel at 15 amps 120V/1/60
 - .2 Power supply 208V/3/60 from breaker panel to variable speed exhaust fan drive(s)
 - .3 Power supply 208V/3/60 from breaker panel to variable speed supply fan drive(s) if equipped with VFD
 - .4 Power supply from the variable speed supply fan drive to the supply fan disconnect switch if equipped with VFD

- .5 Power from the variable speed exhaust fan drive(s) to the exhaust fan disconnect switch
- .6 Interlock to shunt trip 120V/1/60 2 amps maximum
- .7 Interlock to fire suppression system 120V/1/60 2 amps maximum
- .8 Interlock two (2) J-cables from HUB panel to each duct collar. J-cable wire supplied by Spring Air.
- .9 Interlock two (2) wires 4-20 milliamp signal to supply fan variable speed drive when SC Truflow panel.
- .10 Interlock two (2) wires 4-20 milliamp signal to HVAC unit as required.
- .15 Input Line Reactors:
 - .1 All variable frequency drives (VFD) will be supplied with a input line reactor (ILR). The VFD's and ILR's will be shipped separately in NEMA1 enclosures to be installed and wiring by the electrical division.
 - .2 IRL's are designed to improve the reliability of adjustable frequency drives, DC drives. In addition they provide limited input line current harmonic mitigation and aid in long lead protection for inverter fed motors. The 3% impedance IRL's provide IGBT protection.

2.03 Kitchen Cooking Equipment Exhaust Hood

- .1 CSA certified and labelled, completely enclosed, water-tight Type I grease and smoke extractor exhaust hood with manufacturer, model number, size, and configuration as indicated on drawings, constructed of minimum #20 gauge type 304 stainless steel with a #4 brushed satin finish on all exposed surfaces. Hood designed to permit thorough cleaning of entire hood and to automatically start exhaust fan, and constructed using continuous welded standing seam method with all exposed external welds ground and polished to the specified hood finish. Hood is to be complete with:
 - .1 hot-dipped galvanized steel framework;
 - .2 grease extractor type, high efficiency cartridge style baffle filters of adequate number and size to ensure optimum performance, arranged to be easily accessible and removable for cleaning (with a filter removal tool supplied loose) so all exhaust air will pass through filters, installed at an angle not less than 45° from horizontal with housing terminating in a pitched, full length grease trough which is to drain into a removable minimum 3.78 L (1 gal) capacity container;
 - .3 vapour-proof, recessed LED lighting fixtures with energy efficient ballasts and T-8 WWRS lamps for a minimum of 540 lux (50 fc) illumination at cooking surface, pre-wired in accordance with Code requirements to a junction box located at top of the hood;
 - .4 self-closing, accessible, stainless steel ULC listed and labelled fire damper with fusible link(s) in the duct connection collar, and a pressurized wet chemical fire detection and suppression system with hood fusible link(s), suppression chemical cylinder assembly with wall mounting bracket, a manual pull station, and a surface wall mounting control panel with #4 finish stainless steel hinged enclosure and all required controls and contacts for interconnection to exhaust fan and source of heat supply to cooking equipment, fire alarm system, and, if applicable, building automation system;
 - .5 factory pre-piped and pre-wired nozzle type detergent and water spray system terminated for site water connections, with chrome plated brass or #4 finish control panel with piano hinge door and following:
 - .1 door mounted manual start-stop push button, selector switches with LED's for run and wash, and a pressure gauge;

- .2 24 hour, 7 day program timer for cleaning cycle;
- .3 detergent container and a detergent pump;
- .4 shut-off valves, domestic hot and cold water strainers and solenoid valves, a domestic cold water pressure reducing valve and solenoid valve, and a relay timer.
- .6 demand exhaust fan control achieved through various hood mounted sensors such as exhaust air temperature sensors, optic sensor, carbon dioxide sensor, etc., factory connected to a junction box for site connection to a variable frequency drive for exhaust fan motor, with, if required, contacts for monitoring hood exhaust control by building automation system;

2.04 Kitchen Dishwasher Exhaust Hood

- .1 CSA and NSF certified and labelled, completely enclosed, water-tight Type II exhaust hood with manufacturer, model number, size, and configuration as indicated on drawings, constructed of minimum #20 gauge type 304 stainless steel with a #4 brushed satin finish on all exposed surfaces. Hood constructed using continuous welded standing seam method with all exposed external welds ground and polished to the specified hood finish, and complete with:
 - .1 hot-dipped galvanized steel framework;
 - .2 #18 gauge stainless steel, full length, removable condensate baffle pitched to drain into a full perimeter condensate collecting gutter with 15 mm (1/2") diameter stainless steel drain connection fitting;
 - .3 vapour-proof incandescent lighting fixture with lamp for a minimum of 540 lux (50 fc) illumination under hood, pre-wired in accordance with Code requirements to a junction box located at top of the hood;

3 Execution

3.01 Installation of Kitchen Exhaust Hood for Cooking Equipment

- .1 Provide an exhaust hood over kitchen cooking equipment.
- .2 Install hood level and plumb with access clearances required for operation, maintenance, and cleaning, and in accordance with manufacturer's instructions. Coordinate installation with building structural support facilities.
- .3 Install components supplied loose with hood. Perform required fire suppression system and domestic water and drain piping in accordance with requirements of Contract Documents.
- .4 Perform required control wiring in conduit in accordance with certified control wiring schematics and requirements of the electrical work wiring requirements. Carefully coordinate all control wiring such that following sequences occur:
 - .1 with control panel selector switch turned to "RUN", exhaust and make-up air fans are energized;
 - .2 with control panel selector switch turned to "WASH", exhaust and make-up air fans are de-energized, wash cycle begins after a 60 second delay, and ends after a pre-set time (3 minutes);
 - .3 when a fire condition occurs with fans not operating, exhaust fan continues to operate, make-up air fan is de-energized, wash down cycle is disabled, and dry contacts of the fire relay re-close;

- .4 when a fire condition occurs with fans operating, exhaust fan automatically starts, make-up air fan remains de-energized, wash down cycle stops or is disabled, and dry contacts of the fire relay re-close.

3.02 Installation of Kitchen Dishwasher Exhaust Hood

- .1 Provide an exhaust hood over kitchen dishwasher.
- .2 Install hood level and plumb with access clearances required for operation, maintenance, and cleaning, and in accordance with manufacturer's instructions. Coordinate installation with building structural support facilities.

3.03 Hood Certification, Testing, Start-Up, and Training

- .1 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Hood manufacturer/supplier is to visit site at 25%, 50%, and 100% installation intervals and after each visit, is to issue an installation certification report.
- .2 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical. Prior to start-up, under supervision of hood manufacturer's technical representative and with all required jurisdictional authorities present, perform a complete test to demonstrate proper operation of all hood functions and sequences.

3.04 Closeout Activities

- .1 Include for two, 6 hour on-site operation demonstration and training sessions for two groups of six people. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

End of Section

1 General

1.01 Section Includes

- .1 Listed gas vents and vent connectors for natural gas fired appliances.

1.02 References

- .1 CSA B149.1:20, Natural gas and propane installation code.
- .2 CAN/ULC-S604:2016, Standard for factory-built type A chimneys.
- .3 CAN/ULC 605:2022, Standard for Gas Vents.
- .4 CAN/ULC 609:2022, Standard for low temperature vents type L and PL.
- .5 ULC-S636-08, Standard for type BH gas venting systems.

1.03 Submittals

- .1 Submit product data sheets for flue gas vents/air intakes and accessories.

1.04 Coordination

- .1 Supply a reviewed shop drawing to appropriate trade to indicate vent size and flashing materials supplied, and accurately locate building openings.

2 Products

2.01 Condensing Appliance Type BH Flue Gas Vents (and Combustion Air Intakes)

- .1 Equal to Ipex "System 636" PVC (for vent gas to 65°C (130°F)) or CPVC (for vent gas to 90°C (195°F)) solvent weld vent pipe and fittings, in accordance with CSA B149.1, certified as type BH vents to ULC-S636, Standard for Type BH Gas Venting Systems, suitable for negative or positive venting and complete with an orange warning label to verify compliance with ULC-S636, and a moulded cap with screen for vertical termination, or low profile wall termination kit, as applicable.

2.02 Double Wall Type "A" Vent

- .1 Sectional, prefabricated, double wall, type 316 stainless steel, insulated Type "A" all fuel vent, ULC listed and labelled to CAN/ULC-S604, maximum 540°C (1000°F) rated, with prefabricated mated fittings, couplings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

2.03 Double Wall Type "B" Vent

- .1 Sectional, prefabricated, double wall Type "B" gas vent, ULC listed and labelled to CAN/ULC 605, maximum 243°C (460°F) rated, with an aluminium alloy inner wall, G90 galvanized steel outer wall, annular air space, prefabricated mated fittings, couplings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

2.04 Double Wall Stainless Steel Vent for Condensing Equipment

- .1 Positive pressure double wall stainless steel flue gas vent with a type 304 outer casing, an AL29-4C inner flue, and a 25 mm (1") annular air space, ULC-S636 listed and labelled, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

2.05 Double Wall Type "L" Vent

- .1 Type "L" Neutral or negative pressure Type "L" double wall stainless steel flue gas vent, listed and labelled to CAN/ULC 609, with a type 304 stainless steel outer casing, type 304 stainless steel inner flue, and a 12 mm (½") annular air space, maximum 300°C (570°F) rated, complete with prefabricated mated fittings and accessories including a flashing accessory, storm collar counter-flashing piece, and a termination cap.

2.06 Barometric Dampers

- .1 Equal to Field Controls UL/ULC listed and CSA certified Type M+MG2, field adjustable, single or double acting barometric damper to suit burner fuel, each complete with a gate which rests on a long, thin, stainless steel knife edge which in turn is supported by self-aligning and self-cleaning bearings, sized to suit the application, approved by equipment manufacturer, and complete with a field thermal switch accessory for dual fuel oil/gas fired burners.

3 Execution

3.01 Installation of Type BH Flue Gas Vents (and Combustion Air Intakes)

- .1 Provide type BH flue gas vents and combustion air intakes for condensing appliances.
- .2 Support spacing is to be in accordance with flue gas vent manufacturer's instructions. Installation is to be in accordance with gas fired appliance manufacturer's instructions and requirements of CSA B149.1.
- .3 Route piping using shortest route possible to termination point while avoiding interference with other work. Slope vent piping for positive drainage.
- .4 Equip termination of vent with a turn-down elbow with open end covered with bronze insect screen. Terminate exhaust vent a minimum of 3 m (10') away from fresh air intakes and operable windows.
- .5 Confirm flue gas vent diameter prior to ordering.

3.02 Installation of Flue Gas Vents

- .1 Provide ULC listed and labelled flue gas vents for equipment. Confirm flue gas vent diameters prior to ordering.
- .2 Secure horizontal sections in place by means of support hardware supplied with vents and conforming to flue diameter, and hanger rods attached to structure. Support spacing is to be in accordance with vent manufacturer's instructions.
- .3 Support vertical flue sections inside building at roof level and wherever else required by means of purpose made vertical support accessories supplied by manufacturer.
- .4 Hand flashing collars to roofing trade at site on roof for installation and flashing into roof construction. Install counter-flashing pieces over collars.
- .5 Equip termination of each chimney with a rain cap. Confirm height requirement for chimney above roof prior to installation, and ensure proper distance from fresh air intakes is maintained.
- .6 Provide braided stainless steel aircraft cable guy wires attached to roof anchors and to stainless steel strap anchors on the vents as required and/or shown.
- .7 Anchor and restrain vents in accordance with requirements of Section 20 05 48.16 – Seismic Controls for Mechanical Systems.

- .8 Provide required accessories, including insulated thimbles at building wall penetrations, barometric damper(s), cleanout(s), fire stops, and expansion joints where shown and/or required.
- .9 Locate and install barometric dampers in accordance with manufacturer's instructions and field adjust to suit operating conditions.

End of Section

1 General

1.01 Submittals

- .1 Submit shop drawings/product data sheets for all make-up air units. Include following:
 - .1 certified fan performance curves;
 - .2 certified sound power data;
 - .3 hardware for section-to-section site connections;
 - .4 dimensioned layouts, including dimensioned curb layouts as applicable;
 - .5 product data for fan motors.

1.02 Closeout Submittals

- .1 Submit with delivery of each furnace a copy of the factory inspection and fire test report as specified in Part 2 of this section, and include a copy of each report with O&M Manual project close-out data.
- .2 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Training attendance records.

1.03 Maintenance Material Submittals

- .1 Submit spare air filters as specified in Part 2 of this section.

1.04 Quality Assurance

- .1 Make-up air units and installation are to be in accordance with requirements of following:
 - .1 all applicable Provincial Codes and Standards;
 - .2 CAN/CSA B149, Natural Gas and Propane Installation Codes;
 - .3 CSA or cETL listed and labelled electrical components.
- .2 Make-up air unit installation tradesmen are to be journeyman and licensed gas fitters.

2 Products

2.01 Manufacturers

- .1 Spring Air Systems Inc;
- .2 En Mar Systems Ltd.;
- .3 Greenheck Fan Corp.;
- .4 Trane Canada Corp.;
- .5 Mestek Inc. Sterling;
- .6 Engineered Air;
- .7 Thomas & Betts Reznor.

2.02 Gas Fired Make-Up Air Units

- .1 Down discharge, air-tight, weather-proof make-up air units, approved for operation in ambient temperatures of -50°C (-60°F), in accordance with drawing schedule and details, factory inspected and fire tested with an inspection and fire test report prepared and submitted, and following additional performance features:
 - .1 units are to be suitable for operation at any supply gas pressure between 1.7 kPa and 3.5 kPa (0.25 psi and 0.51 psi);
 - .2 unless otherwise specified, sound emitted through casings or intakes of roof mounted units at maximum air flow rate is not to exceed 78.4 dBA at 1 m (4'), and for interior spaces, sound emitted through supply and return air openings is not to exceed 82 dBA at 1.5 m (5').
- .2 Sectional, double wall insulated casing and section construction with dimensions and arrangements as shown and detailed on drawings and as follows:
 - .1 rigid, full perimeter structural channel iron base frame with reinforcing channels cleaned and coated with rust resistant primer, lifting lugs and identified lifting points;
 - .2 minimum #16 gauge G90 galvanized sheet steel exterior casing panels, #22 gauge G60 galvanized steel liner panels over all interior insulation including underside of floor, with overlapped roof panels, all joints neatly caulked with water resistant sealant, and rain shields over all access doors;
 - .3 50 mm (2") thick, minimum 48 kg/m³ (3 lb/ft³) density semi-rigid glass fibre acoustic insulation meeting 25/50 flame spread/smoke developed ratings when tested to CAN/ULC-S102, secured in place by means of adhesive and pins;
 - .4 double wall insulated access doors constructed as for casing panels, of sufficient size and number to permit physical entry into sections from both sides of unit for servicing of filters, fans and motors, burners, and other equipment requiring maintenance and service, and each complete with:
 - .1 full perimeter captive gasketing;
 - .2 full length galvanized steel hinges;
 - .3 2 lever lock roller handles operable from both inside and outside casing;
 - .4 for sections such as fan sections requiring full access, double doors of sufficient size with a removable mullion.
 - .5 galvanized steel intake hood complete with storm louvre, aluminium mesh birdscreen, motorized inlet damper, "V" bank filter framing, and 50 mm (2") thick, UL Class 1, 25% to 30% efficient MERV 7 disposable glass fibre filters with an extra set of filters in identified packaging for each unit;
 - .6 clean and prime casing, both inside and outside, and finish with epoxy enamel applied to all panel surfaces, including exterior undersides.
- .3 Fully modulating direct fired type burners capable of 30:1 turndown ratio and located in a burner section with a heat treated glass observation port for full viewing of flame, and a control panel/gas manifold vestibule with access door and weather-proof electric heater with thermostat, a 120 volt marine light with guard and lighted switch, and a duplex 15 ampere GFI receptacle factory wired to a separate 120 volt, 1-phase circuit with disconnect switch. Burner efficiency is to limit products of combustion to maximum 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide, and equip burner with:

- .1 adjustable profile plates, stainless steel combustion baffles, non-clogging gas ports, and spark-ignition intermittent pilot with 100% flame safety shut-down;
- .2 pre-piped gas manifold with main gas pressure regulator, manual shut-off and test firing valves, main and auxiliary gas automatic shut-off valve, a modulating control system, pilot pressure regulator and automatic shut-off valve, pilot needle valve, and multiple test ports.
- .4 Burner control, located in burner control/manifold vestibule, factory pre-wired, and consisting of:
 - .1 blower motor starter with ambient compensated overloads, and auxiliary contacts;
 - .2 primary 120 volt control transformer;
 - .3 6000 volt ignition transformer;
 - .4 control circuit breaker and service switch;
 - .5 automatic reset temperature high limit;
 - .6 solid-state flame safeguard relay with LED status and flame rod;
 - .7 discharge temperature control sensor with RTS;
 - .8 all hardware required for site connection of the remote control panel.
- .5 AMCA rated and certified double width and inlet centrifugal fan with forward curved blades, secured to a heavy-duty machined and polished steel shaft with an operating speed not to exceed 75% of its first critical speed, and statically and dynamically balanced. Fan motor, V-belt drive, and OSHA guard in accordance with requirements specified in Section 20 05 00 – Common Work Results for Mechanical.
- .6 Surface wall mounting (to a recessed or surface mounting outlet box) supervisory control panel with 2 switches, 5 indicating lights including "Clogged Filter", a temperature selector, and a LED discharge temperature readout.
- .7 Roof mounting curb factory supplied loose and ready for site assembly and insulation, 405 mm (16") high, complete with wood nailer and site assembly hardware.
- .8 Factory secured seismic restraint connection hardware.

3 Execution

3.01 Installation of Make-Up Air Unit

- .1 Provide a gas fired make-up air unit on roof.
- .2 Unless otherwise specified or required, provide required rigging and hoisting/moving equipment required to move units to required location. Perform rigging/hoisting/moving in accordance with unit manufacturer's directions and details.
- .3 Supply a curb for each unit, assemble curb, and hand curb to roofing trade on roof for installation and flashing into roof construction. Provide continuous gasketing around perimeter of curb between curb and unit mounting frame. Insulate curb with rigid weather-proof board type insulation in accordance with curb manufacturer's details.
- .4 Install components shipped loose with units. Install a discharge air temperature sensor in supply ductwork approximately 2 m (6-½') downstream of unit and in accordance with manufacturer's recommendations.

- .5 Brace and secure unit in accordance with requirements specified in Section 20 05 48.16 - Seismic Controls for Mechanical Systems.
- .6 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .7 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.02 Closeout Activities

- .1 Include for a 1/2 day on-site operation demonstration and training session. Training is to be a full review of all components including but not limited to a full operation and maintenance demonstration, with abnormal events.

End of Section

1 General

1.01 Summary

- .1 These specifications describe requirements for a Computer Room Air Conditioning (CRAC) system. The system shall be designed to control temperature and humidity conditions in rooms containing electronic equipment.

1.02 Submittals

- .1 Submit shop drawings/product data sheets for units. Include certified fan performance curves, estimated sound power levels to be expected across individual octave bands in dB, certified power, and control wiring diagrams which differentiate between factory and site wiring, and product data for fan motors and drives.
- .2 Prepare and submit schematic layout of refrigerant piping showing piping components required for satisfactory operation and maintenance of systems, including but not limited to pipe sizes, charging valve, isolating valves, sight glasses, strainers, driers, traps and other ancillary devices. Review schematic diagram with and obtain approval from air conditioning equipment supplier prior to submittal to the Consultant.
- .3 Submit sample sheet indicating finish colours available for air conditioning units, and review colour selection with the Consultant during shop drawing submission prior to ordering.
- .4 Submit AHRI-1360 certificate with shop drawings.

1.03 Closeout Submittals

- .1 Submit with delivery of each unit a copy of factory inspection and test report, and include copy of each report with O&M Manual project closeout data.
- .2 Submit site inspection and start-up report from manufacturer's representative as specified in Part 3 of this section.
- .3 Submit signed copy of unit manufacturer's extended warranty, in name of Owner, for standard one year parts and labour warranty.
- .4 Training attendance records.

1.04 Maintenance Material Submittals

- .1 Submit spare air filters as specified in Part 2 of this section.

2 Products

2.01 Floor Mounted Air Conditioning Units

- .1 Liebert PDX or Liebert PCW chilled water units with features as follows:
 - .1 CSA approved and in compliance with CSA C22.2 No. 236/UL 1995 for Heating and Cooling Equipment;
 - .2 The system shall be AHRI Certified, for performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.
 - .3 designed for service from the front and right side of unit;

- .4 designed for draw through air arrangement to ensure even air distribution to entire face area of coil – Upflow (Front or Rear Return - requires 600 mm (24") high floor stand with built in filter box complete with ductable rear opening) or Downflow (Front, Right and or Left Side Discharge);
 - .5 exterior panels to be 20 gauge steel and powder-coated with black colour paint to protect against corrosion and insulated with 12.7 to 25.4 mm (1/2" to 1"), 0.68 kg (1-1/2 lb) insulation;
 - .6 matching steel air discharge plenum with grilles, 450 mm (18") high, finished as for main unit (upflow models);
 - .7 equipped with one plug electronically commutated (EC) fan within unit; integral direct driven fan with backward-curved blades and electronically commutated DC motors; fan speed variable and automatically regulated by unit controller through all modes of operation; fans have dedicated motor, fault monitoring circuitry, and speed controller, which provides a level of redundancy; impeller made of aluminum and dynamically balanced.
 - .8 50 mm (2") thick disposable UL Class 2 MERV 8 glass fibre media filters with a spare filter change supplied with each unit;
 - .9 single refrigeration circuit includes liquid line filter drier, refrigerant sight glass with moisture indicator, expansion valve, pressure safety switches and liquid line solenoid valve. Indoor evaporator refrigerant piping to be filled with a nitrogen holding charge and spun shut; field relief of Schrader valve indicates a leak-free system.
- .2 Compressor features as follows:
- .1 R-454B scroll-type compressor with variable capacity operation from 20-100%; hot gas bypass not acceptable; compressor solenoid valve unloads compressor to provide variable capacity operation; compressor includes suction gas-cooled motor, EPDM vibration isolators, internal thermal overloads, automatic reset high pressure switch with lockout after three failure occurrences, rotalock service valves, low pressure transducer, and crankcase heater; compressor is removable and serviceable from front of unit; crankcase heater and discharge check valve provided for additional system protection from refrigerant migration during Off cycles;
 - .2 Compressor sound jacket reduces level of sound emitted from compressor; consists of 9.5 mm (3/8") closed cell polymeric 72–136 kg/m³ (4.5-8.5 lb/ft³) density jacket that encloses compressor.
- .3 Cooling coil constructed of copper tubes and hydrophilic coated aluminum fins. Hydrophilic coating significantly improves speed of condensate drainage from fins and provide superior water carryover resistance. Stainless steel condensate drain pan removes moisture from cooling coil.
- .4 Dual-float condensate pumps with minimum capacity of 18.9 L/min (5 GPM) at 12.2 m (40 ft.) head. Pump complete with integral primary and secondary float switches, pump, motor assembly and reservoir. Secondary float sends signal to local alarm and shut down unit upon high water condition. Condensate pump is factory-installed on upflow units and field-installed on downflow units.
- .5 Humidifier to be of the infrared type, consisting of high intensity quartz lamps mounted above and out of the water supply. Evaporator pan to be stainless steel and arranged to be serviceable without disconnecting water supply lines, drain lines or electrical connections. Complete humidifier section to be pre-piped ready for final connection. Infrared humidification system uses a bypass air to prevent over humidification of controlled space. Auto-flush system automatically flush deposits from humidifier pan. System to be field adjustable to change cycle time to suit local water conditions. Humidifier have a capacity of 3.5 kg/h (7.7 lb/h).
- .6 Reheat to be a low-watt density 304 stainless steel finned-tubular electric reheat which includes ULC/CSA-recognized safety switches to protect the system from overheating.

- .7 Controller:
 - .1 Liebert iCOM to be factory-set to allow precise monitoring and control of IT equipment it is placed near. This control includes predictive methods to control air flow and cooling capacity based on supply and remote sensors. Proportional and tunable PID to be also be user-selectable options. Internal unit component control includes following:
 - .1 prevents compressor short-cycling and needless compressor wear;
 - .2 auto restart feature shall automatically restart system after a power failure. Time delay to be programmable;
 - .3 on initial startup or restart after power failure, each operational load to be sequenced with a minimum of one second delay to minimize total inrush current;
 - .4 calculates the moisture content in room and prevent unnecessary humidification and dehumidification cycles by responding to changes in dew point temperature;
 - .5 compatible with remote monitoring and control devices. Options to be available for BMS interface via Modbus, HTTP, BACnet and SNMP;
 - .6 microprocessor-based with a 320x240 dot matrix graphic front monitor display and control keys for user inputs mounted in an ergonomic, aesthetic housing. Display and housing to be viewable while the front panel is open or closed;
 - .2 Controls to be menu driven with displays featuring:
 - .1 Organized into three main sections: User Menus, Service Menus and Advanced Menus with a secure login for each section.
 - .2 System displays User menus for active alarms, event log, graphic data, unit view/status overview (including monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup and service contacts.
 - .3 Password to be required to make system changes within Service menus.
 - .4 Service menus includes set points, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards and diagnostics/service mode.
 - .5 Password to be required to access Advanced menus, which include factory settings and password menus.
 - .3 User Menu includes following:
 - .1 Unit memory holds 200 most recent alarms with time and date stamp for each alarm.
 - .2 Unit memory holds 400 most recent events with ID number, time and date stamp for each event.
 - .3 Two selectable graphic records to be available from following: return air temperature, return air humidity, dew point, supply air temperature.
 - .4 Simple or Graphical Unit View summary displays includes temperature and humidity values, active functions (and percent of operation) and any alarms of host unit.

- .5 Total Run Hours: Menu displays cumulative component operating hours for major components including compressors, Econ-O-Coil (FC), fan motor, humidifier and reheat.
- .6 Allows setup and display of optional custom sensors.
- .7 Menu allows display of local service contact name and phone number.
- .8 System View - Status Overview: System view displays summary of operation for total number of operating units within Unit-to-Unit (U2U) configuration.
- .9 Spare Parts List: list of critical spare parts, their quantity and part numbers.
- .10 Unit Diary: free field area within unit memory where unit history may be stored for reference.
- .4 Service Menus as follows. Setpoints within following ranges:
 - .1 Temperature Setpoint: 41-104°F (5-40°C)*.
 - .1 (* The microprocessor may be set within these ranges; however, the unit may not be able to control to extreme combinations of temperature and humidity.)
 - .2 Temperature Proportional Band: +1-50°F (-17 to 10°C).
 - .3 Fan Temperature Setpoint: 41-104°F (5-40°C)*.
 - .1 (* The microprocessor may be set within these ranges; however, the unit may not be able to control to extreme combinations of temperature and humidity.)
 - .4 Humidity Setpoint: 20-80% RH*.
 - .5 Humidity Sensitivity: 1-30% RH.
 - .6 High Temperature Alarm: 35-90°F (2-32°C).
 - .7 Low Temperature Alarm: 35-90°F (2-32°C).
 - .8 High Humidity Alarm: 15-85% RH.
 - .9 Low Humidity Alarm: 15-85% RH.
- .5 Menu allows planned rotation or emergency rotation of operating and standby units.
- .6 Menu allows customer settings for alarm notification (audible/local/remote). The following alarms are available:
 - .1 High Temperature;
 - .2 Low Temperature;
 - .3 High Humidity;
 - .4 Low Humidity;
 - .5 Compressor Overload - Optional;
 - .6 Main Fan Overload - Optional;
 - .7 Humidifier Problem;

- .8 High Head Pressure;
- .9 Change Filter;
- .10 Fan Failure;
- .11 Low Suction Pressure;
- .12 Unit Off.
- .7 Audible alarm annunciates any alarm that is enabled by operator.
- .8 Programmable common alarm provided to interface user-selected alarms with remote alarm device.
- .9 Alarms communicated to monitoring system with following information:
 - .1 date and time of occurrence;
 - .2 unit number;
 - .3 present temperature and humidity.
- .10 Menu allows unit sensors to be calibrated with external sensors.
- .11 Maintenance/Wellness Settings: allow reporting of potential component problems before they occur.
- .12 Options Setup: operation settings for installed components.
- .13 System/Network Setup: Unit-to-Unit (U2U) communication and setup for Teamwork Modes of operation (up to 32 units).
- .14 Teamwork Modes of Operation: Saves energy by preventing operation of units in opposite modes multiple units.
- .15 Controller provides self-diagnostics to aid in troubleshooting. Microcontroller board to be diagnosed and reported as pass/not pass. Control inputs to be indicated as On or Off at the front display. Control outputs to be able to be turned On or Off from front display without using jumpers or a service terminal. LED on a circuit board will indicate each control output.
- .8 Miscellaneous:
 - .1 Locking type disconnect switch, factory wired, mounted in electrical panel and mechanically interlocked with front panel door. Electrical panel provides at least 65,000 A SCCR, unless otherwise noted.
 - .2 Steel adjustable floor stand, sized to unit and depth of raised floor, and adjustable to ± 40 mm (1- $\frac{1}{2}$ ").
 - .3 Factory installed high temp sensor to sense return air temperature and to shut-down unit upon sensing high temperature.
 - .4 "Liqui-tect" leak detection sensor complete with corrosion resistant probes mounted in height adjustable painted enclosure and equipped with dry contact 24 volt common alarm relays and a 24 volt secondary transformer.
 - .5 Liebert IntelliSlot Unity Card (IS-UNITY-DP) provides ground fault isolated RS-485 Modbus, BACnet IP and Modbus IP network connectivity to Building Management Systems for unit

monitoring and management. Also, it provides ground fault isolated 10/100 baseT Ethernet connectivity for unit monitoring and management. Supported management interfaces include: SNMP for Network Management Systems, HTTP for Web page viewing, SMTP for e-mail and SMS for mobile messaging. Card supports IP and 485 protocols simultaneously.

- .9 Condensing Unit:
 - .1 Factory assembled, weatherproof, package type air cooled condensing unit in accordance with drawing schedule, complete with:
 - .1 microchannel coils constructed of aluminum microchannel tubes, fins and manifolds; tubes to be flat and contain multiple, parallel flow microchannels and span between aluminum headers;
 - .2 full-depth louvered aluminum fins fills spaces between the tubes; tubes, fins and aluminum headers oven brazed to form a complete refrigerant-to-air heat exchanger coil;
 - .3 copper stub pipes electric resistance welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements;
 - .4 coil assemblies to be factory leak-tested at a minimum of 2068 kPa (300 psig);
 - .5 hot gas and liquid lines to be copper and be brazed using nitrogen gas flow to stub pipes with spun-closed ends for piping connections;
 - .6 complete coil/piping assembly filled and sealed with an inert gas holding charge for shipment;
 - .7 condenser designed for use in 35°C (95°F) ambient temperature with low ambient of -34.4°C (-30°F);
 - .8 locking-type disconnect switch factory-mounted and wired to electrical panel; switch to be accessible from outside of unit with door closed, and prevent access to high-voltage electrical components until switched to Off position; locking disconnect to be lockable in support of lockout/tagout safety programs; electrical panel to provide at least 65,000 A SCCR (Short Circuit Current Rating), unless otherwise knitted.
 - .10 Suitable anchoring connection hardware, factory installed on both indoor and outdoor units to suit specific application requirements. Provide seismic restraints to comply with applicable local governing authority and code requirements. Refer to Section 20 05 48.16 – Seismic Controls for Mechanical Systems.
 - .11 Manufacturers:
 - .1 Liebert Corp.;
 - .2 STULZ Air Technology Systems, Inc.
 - .3 Daikin Industries.

2.02 Ceiling Mounted Air Conditioning Units

- .1 Liebert Corp. "Mini-Mate2", CSA certified factory assembled, ceiling mounted air conditioning unit with matching remote mounted condensing unit in accordance with drawing schedule.
- .2 The system shall be AHRI Certified, for performance assurance for heating, ventilation, air conditioning and commercial refrigeration equipment, using AHRI Standard 1360.

- .3 Cabinet and chassis constructed of heavy gauge galvanized steel with minimum 25 mm (1") thick, 24 kg/m³ (1-½ lb/ft³) density glass fibre insulation and factory attached mounting brackets. Cabinet components are to be serviceable from one side only.
- .4 For ducted applications steel return air filter box: Steel plenum, 600 mm x 1.2 m (2' x 4'), equipped 4-way air distribution with grilles and complete with a pleated type MERV 8 glass fibre filter, and a spare filter change.
- .5 Centrifugal double width, double inlet, statically and dynamically balanced fan with a heavy-duty steel shaft and self-aligning, lifetime lubricated ball bearings, and a 2-speed motor conforming to requirements specified in Section 20 05 00 – Common Work Results for Mechanical. Dehumidification is to utilize lower fan speed.
- .6 Copper tube, aluminium fin, factory tested and piped evaporator coil with externally equalized expansion valve, filter-drier, and an insulated galvanized steel drain pan.
- .7 Factory mounted and piped condensate drainage pump, sized to suit the application, complete with sump and automatic control with dual float, common alarm, and unit shut-down.
- .8 Electric steam generating type humidifier controlled by microprocessor control system and complete with a disposable canister, a spare canister, required water supply and drain valves, steam distributor, and electronic controls. Need to change canister is to be enunciated on microprocessor wall box control panel, which is to be equipped with LED's to indicate cylinder full, over-current detection, fill system fault, and end of cylinder life conditions.
- .9 Rigid, fin-tubular design, 2-stage, low watt density stainless steel element reheat coil with CSA certified overheat protection, and ample capacity to maintain room dry bulb conditions during a system call for dehumidification.
- .10 Microprocessor-based control system in wall mounting control enclosure equipped with temperature and humidity sensors and 2, 11 mm high, 7 segment LED numerical displays to permit observation of room temperature and humidity and each settable function.
 - .1 Control Parameters:
 - .1 temperature set-point: 18°C to 29°C (64°F to 84°F);
 - .2 temperature sensitivity: 1°C to 3°C (1.8°F to 5.4°F);
 - .3 humidity set-point: 20% to 80% R.H.;
 - .4 humidity sensitivity: 1% to 10% R.H.;
 - .5 monitoring of normal operating modes (heating, cooling, humidification, dehumidification) and operating status indicated by coloured LED's on display panel.
 - .2 Control system is to monitor unit operation and activate an audible and visual alarm in the event of following factory preset but field changeable (with 3-digit password) alarm conditions:
 - .1 high temperature and low temperature;
 - .2 high humidity and low humidity, as well as humidifier problem;
 - .3 high water alarm (to lock-out unit operation);
 - .4 compressor overload, high head pressure, compressor short cycle;
 - .5 loss of power;

- .6 custom alarms (up to 2) chosen by Consultant.
- .3 Each alarm is to be separately enabled or disabled, selected to activate common alarm (except for high head pressure). Audible alarm is to annunciate any alarm that is enabled by operator. Programmable common alarm is to be provided to interface user selected alarms with a remote alarm device. Alarms are to be communicated to site monitoring system with date and time of occurrence, unit number, and preset temperature and humidity.
- .4 Control system is to prevent compressor short-cycling by means of a 3 minute timer from compressor stop to next start.
- .5 Auto restart control with programmable time delay to automatically restart system after a power failure.
- .6 Temperature/humidity sensors may be calibrated from front monitor panel.
- .7 Common alarm relay is to be provided to interface alarms with building automation system, and same relay may be used as a remote on/off control contact through building automation system instead of common alarm function.
- .8 Control is to be programmable on a daily basis or on a 5 day/2 day program schedule, and is to be capable of accepting 2 programs per day.
- .11 Locking type disconnect switch, factory wired, mounted in electrical panel and mechanically interlocked with front panel door.
- .12 Factory installed high temperature sensor to sense return air temperature and to shut-down unit upon sensing high temperature.
- .13 Factory assembled, weatherproof, package type air cooled condensing unit in accordance with drawing schedule, complete with:
 - .1 high efficiency scroll type compressor with hot gas by-pass, pressure safety switches, filter drier, refrigerant sight glass, crankcase heater, and a liquid line solenoid valve for refrigerant pump-down control;
 - .2 low profile, direct drive air cooled condenser designed for use in a 35°C (95°F) ambient temperature, complete with aluminium propeller fan, PVC coated fan guard, copper tube-aluminum fin condenser coil, and a pre-wired power and control panel with unfused disconnect switch;
 - .3 "Lee-Temp" head pressure control to permit condensing unit start-up and positive head pressure control with ambient temperatures as low as -34.4°C (-30°F), complete with insulated refrigerant receiver with electric heater ready for field connection to condensing unit, pressure relief valve for each refrigerant circuit, head pressure 3-way control valve, and rotaloc valve for isolating refrigerant charge.
- .14 Suitable anchoring connection hardware, factory installed on both indoor and outdoor units to suit specific application requirements. Provide seismic restraints to comply with applicable local governing authority and code requirements. Refer to Section 20 05 48.16 – Seismic Controls for Mechanical Systems.
- .15 Manufacturers:
 - .1 Liebert Corp.;
 - .2 Data Aire Inc.;
 - .3 STULZ Air Technology Systems, Inc.

3 Execution

3.01 Installation

- .1 Provide split system Computer Room air conditioning units. Install units level and plumb.
- .2 As required, anchor both indoor and outdoor units in accordance with requirements specified in Section 20 05 48.16 – Seismic Controls for Mechanical Systems. Provide flexible connections in all piping connections to units.
- .3 Coordinate exterior roof top work with General Trades Contractor and roofing work.
- .4 Coordinate connection of water and drain piping to each evaporator unit with plumbing trade. Ensure drainage piping is trapped.
- .5 Install components shipped loose with units. Install in accordance with manufacturer's recommendations. Calibrate control components requiring field calibration.
- .6 Carefully coordinate installation of each unit with all other trades making connections to unit, in particular, electrical power and building automation system control connections.
- .7 Perform required wiring to interconnect evaporator units and condensing units, and any other control wiring, all in accordance with unit manufacturer's wiring schematics and instructions and electrical wiring requirements of electrical work.
- .8 For equipment/system manufacturer certification requirements and for equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.02 Closeout Activities

- .1 Include for full 8 hour day of on-site operation demonstration and training session. Training is to be full review of components including but not limited to full operation and maintenance demonstration, with control parameters and abnormal events.

End of Section

1 General

1.01 Related Requirements

- .1 Section 23 23 00 – Refrigerant Piping.

1.02 Submittals

- .1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.

1.03 Closeout Submittals

- .1 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this section.
- .2 Prepare and submit a schematic layout of refrigerant piping showing all piping components required for satisfactory operation and maintenance of the system(s), including but not limited to pipe sizes, charging valve, isolating valves, sight glasses, strainers, driers, traps, etc. Schematic diagram must be reviewed with and approved by air conditioning equipment supplier prior to submittal to the Consultant.

1.04 Quality Assurance

- .1 Split system air conditioning equipment and installation of equipment are to be in accordance with requirements of following:
 - .1 All applicable Provincial Codes and Standards.
 - .2 ANSI/AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .2 Split system air conditioning system installation tradesmen are to be journeyman refrigeration mechanics.

2 Products

2.01 Split System Air Conditioning Equipment

- .1 Factory assembled and tested, package type equipment consisting of an indoor evaporator unit and an exterior condensing unit in accordance with drawing schedule, CSA or ETL listed and labelled, AHRI rated and certified and with a minimum system efficiency of 13 SEER.
- .2 Wall mounting evaporator assembly consisting of a white moulded high-strength plastic cabinet with front access panel, a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction and which closes when fan operation is stopped, motorized vertical vanes controlled remotely, and a mounting plate supplied loose. Evaporator complete with:
 - .1 double inlet, forward curve fan(s) direct driven by a single 4-speed motor;
 - .2 removable and washable return air filter;
 - .3 factory pressure tested multi-angled coil of non-ferrous construction with aluminium fins, copper tubes with silver alloy solder joints, and an insulated condensate drain pan sloped to a drain connection for positive drainage.
- .3 Factory run tested, weatherproof condensing unit equipped with a control board to interface with indoor unit and perform all necessary operation functions. Pre-charge unit with R-454b refrigerant for a minimum of 21 m (70') of refrigerant tubing. Unit is to be capable of operation at -18°C (0°F) without additional low ambient controls, and capable of a height difference between condensing unit and evaporator of 30 m (100'). Each condensing unit complete with:

- .1 galvanized steel plate cabinet with an electrostatically applied thermally fused polyester powder finish, and an ABS plastic fan grille;
 - .2 draw-through direct driven balanced fan with horizontal air discharge, mounted in front of coil, arranged to pull air across coil, and equipped with a raised fan guard;
 - .3 "L" shaped coil with copper tubes and aluminium fins, factory pressure tested, complete with an integral metal guard and refrigerant flow controlled by a linear expansion valve metering orifice controlled by a microprocessor controlled step motor;
 - .4 vibration isolated DC rotary compressor driven by an inverter circuit to dynamically control compressor speed to match room load, complete with an accumulator, high pressure safety switch, and circuitry to permit a minimal amount of current to be applied to motor to maintain enough heat during off cycle to prevent liquid from accumulating.
- .4 System controls consisting of a microprocessor in each indoor and outdoor unit, and an indoor wall mounted controller site connected to indoor evaporator unit. System is to be capable of automatic restart after power interruption, and have self-diagnostics ability and indication of total compressor run time, and following:
- .1 Indoor unit microprocessor is capable of monitoring return air temperature and evaporator coil temperature, receiving and processing commands from wall mounted controller, providing emergency operation, and controlling outdoor unit through its microprocessor and interface board;
 - .2 controller is complete with an integral temperature sensor, able to perform input and output functions necessary to operate system, and equipped with following:
 - .1 large DOT liquid crystal display to indicate diagnostic codes for both indoor and outdoor units, compressor run time, a weekly timer with up to 8 pattern settings per day, set temperature, room temperature, refrigerant piping temperatures, compressor operating conditions, and linear expansion valve opening pulses, sub-cooling and discharge super heat;
 - .2 On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louvre Swing button, a Ventilation button, a Test Run button, and a Check Mode button.

2.02 Manufacturers

- .1 Daikin Industries Ltd.;
- .2 Mitsubishi Electric Sales Canada Inc.;
- .3 LG Electronics Canada Inc.;
- .4 Samsung HVAC LLC.

3 Execution

3.01 Installation

- .1 Provide split system air conditioning equipment consisting of an exterior condensing unit and an indoor evaporator.

- .2 Secure condensing unit in place, level and plumb, on vibration isolation pads on a concrete housekeeping pad.
- .3 Secure condensing unit in place, level and plumb, on vibration isolation pads on pressure treated wooden sleepers as indicated.
- .4 Mount indoor evaporator unit. Confirm exact location prior to roughing-in.
- .5 Connect condensing unit and indoor evaporator with refrigerant piping in accordance with piping shop drawing schematic. Refer to Section 23 23 00 – Refrigerant Piping. Provide any required additional refrigerant.
- .6 Install loose control components and perform required control wiring (except building automation system connections) between condensing unit and evaporator in conduit in accordance with manufacturer's control wiring schematic and wiring standards of electrical work.

3.02 System Startup

- .1 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .2 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.03 Closeout Activities

- .1 Include for 4 hours of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

End of Section

1 General

1.01 Abbreviations and Definitions

.1 Abbreviations used in this Specification are as follows:

- .1 BAS building automation system;
- .2 DDC direct digital controls;
- .3 LAN local area network;
- .4 PC personal computer.

1.02 Submittals

.1 Submit shop drawings/product data sheets for BAS components. As a minimum, submit the following:

- .1 BAS network architecture, including modes and interconnections;
- .2 systems schematics, sequences, and flow diagrams;
- .3 points schedule for each point in BAS, including point type, object name, expanded ID, display units, controller type, and address;
- .4 samples of graphic display screen types and associated menus;
- .5 detailed Bill of Materials for each system or application, identifying quantities, part numbers, descriptions, and optional features;
- .6 control damper schedule including a separate line for each damper and a column for each of damper attributes including code number, fail position, damper type, damper operator, duct size, damper size, mounting and actuator type;
- .7 control valve schedules including a separate line for each valve and a column for valves as for control dampers;
- .8 room schedule including a separate line for each HVAC terminal unit indicating type, location and address;
- .9 details of BAS interfaces and connections to other systems;
- .10 product data sheets or marked catalogue pages including part number, photograph and description for BAS hardware and software.

1.03 Closeout Submittals

- .1 Submit a site inspection and start-up report from manufacturer's representative as specified in Part 3 of this Section.
- .2 Record "as-built" drawings are to include:
 - .1 schematic outline of BAS for quick reference of overall system scope;
 - .2 adequate record of work as installed, including locations and routing of system wiring.
- .3 O&M Manual is to include:
 - .1 hardware specification manual which gives a functional description of hardware components;

- .2 operator's manual which outlines concise instructions for operation of system and an explanation and recovery route for system alarms;
- .3 engineering manual which outlines and defines system set-up, definition and application;
- .4 data manual which indicates applications data programmed into system;
- .5 system software documentation.

1.04 Description of the Building Automation System

- .1 Building automation system is to consist of a modular, BACnet protocol, open architecture system incorporating direct digital control and monitoring of equipment and systems and consisting of all hardware and software required for complete, functional DDC control system. BAS is to be accessible through standard personal computers within building through a wireless application protocol device, or remotely through Internet by means of a standard web browser.
- .2 BAS is to be field expandable, with a distributed architectural design to eliminate dependence upon any single device for alarm reporting and control execution. Failure of any single component or network connection is not to interrupt execution of control strategies at other operational devices. BAS is to maintain all settings and overrides through a system re-boot, and is to incorporate, as a minimum, following integrated features, functions, and services:
 - .1 graphic user interface for accessing and viewing BAS information, commanding points, changing setpoints, responding to alarms, programming time-of-day schedules;
 - .2 operator information, alarm management, and control features;
 - .3 enterprise-level information and control access;
 - .4 information management including monitoring, transmission, archiving, retrieval, and reporting functions;
 - .5 diagnostic monitoring and reporting of BAS functions;
 - .6 off-site monitoring and management access;
 - .7 energy management;
 - .8 standard applications for terminal HVAC systems.
- .3 BAS is to include, but not be limited to, following:
 - .1 personal computer based server for networking and integrating all hardware components into a single BAS;
 - .2 personal computer based operator work station with colour monitor for colour graphic displays, and a colour printer;
 - .3 portable operator's terminal;
 - .4 network of standalone network automation engine(s);
 - .5 network of field equipment controllers;
 - .6 input/output modules;
 - .7 local display devices;

- .8 distributed user interfaces;
- .9 network processing, data storage and communication equipment;
- .10 all other components required for a complete and operating BAS.

1.05 Quality Assurance

- .1 BAS hardware and software is to be installed by experienced personnel employed and trained by manufacturer/supplier of field equipment controllers. System wiring is to be installed by journeyman electricians or under direct on-site supervision of journeyman electricians.

2 Products

2.01 General Re: Building Automation System

- .1 Control system components (field devices) other than those specified in this Section are generally specified in Section 25 05 01 – Automatic Control Systems. Components factory installed with equipment or supplied with equipment are specified in mechanical work Sections with equipment.
- .2 BAS specified in this Section is an expandable DDC building automation system in accordance with drawing control diagrams and sequences, and points lists.
- .3 Manufacturers:
 - .1 Johnson Controls Inc.;
 - .2 Siemens Building Technologies Inc.;
 - .3 Honeywell International Inc.;
 - .4 Trane Controls;
 - .5 Distech Controls;
 - .6 Delta Controls;
 - .7 Schneider Electric;
 - .8 Alerton.

2.02 BAS Architecture

- .1 BAS is to be based industry standard Ethernet TCP/IP communications protocol. Where used, LAN controller cards are to be standard "off-the-shelf" products available through normal PC vendor channels. BAS is to be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication. BAS is to be compatible with other enterprise-wide networks, and where indicated, BAS is to be connected to the enterprise network and share resources with it by way of standard networking devices and practices.
- .2 Network automation engines are to provide supervisory control over control network and are to support BACnet Standard MS/TP bus communication protocol (ASHRAE SSPC-135, Clause 9). Control networks are to provide either a "peer-to-peer", master-slave, or supervised token passing communications and are to operate at a minimum communication speed of 9600 baud. DDC controllers are to reside on control network.
- .3 BAS is to include appropriate hardware and software to allow BACnet bi-directional data communications between BAS and building equipment/system control panels. BAS is to receive, react to, and return

information from connected equipment and systems. Data required by application is to be mapped into automation engine's data base and is to be transparent to operator. Point inputs and outputs from building equipment/system control panels is to have real-time interoperability with BAS software features such as control software, energy management, custom process programming, alarm management, historical data and trend analysis, totalization, and local area network communications.

2.03 Dedicated Web Based User Interface

- .1 User interface is to be web based and is to operate on a personal computer for command entry, information management, network alarm management, and database management functions. Real-time control functions including scheduling, history collection, and alarming are to be resident in appropriate components of BAS network to facilitate greater fault tolerance, availability, and reliability.
- .2 Architecture of personal computer is to be implemented to conform to industry standards such that it can accommodate applications provided with BAS and mechanical systems and equipment, including but not limited to Microsoft Office Applications. Specifically, it must conform to following interface standards:
 - .1 Microsoft Edge (or other standard browser) for user interface functions;
 - .2 Microsoft Office Professional for creations, modification and maintenance of reports, and sequencing other necessary building management functions;
 - .3 Microsoft Outlook or other email program for supplemental alarm functionality and communication of system events, and reports;
 - .4 required network operating system for exchange of data and network functions such as printing of reports, trends, and specific system summaries.
- .3 Personal computer server or operator workstation is to be configured at minimum as follows:
 - .1 memory: 8 GB;
 - .2 processor: Intel;
 - .3 hard drive: 500 GB free hard drive;
 - .4 graphics card: 1 GB DDR3;
 - .5 ports: 1 HMDI, 2 serial, one parallel, and 2 USB-C ports;
 - .6 keyboard: 101 keyboard and 2-button mouse;
 - .7 monitors: 584 mm (23 in) LCD monitor with 1920 x 1080 resolution;
 - .8 LAN communications: 10/100/1000 network card.
- .4 Operating System Software: Windows 7 Professional 64-bit Microsoft SQL 2008 Server and SQL 2008 Server Express are automatically installed by EBI. Where user interface is not provided via browser, PC is to be equipped with a complete workstation software package including any software or hardware keys, and package is to include original installation discs and licenses for all software, device drivers, peripherals, and software registration cards which are to be handed to Owner.
- .5 Printer is to be at minimum equal to Hewlet Packard "DeskJet" colour printer with a speed of 600 DPI black and 300 DPI colour, and 64 kB input print buffer.

2.04 Distributed Web Based User Interface

- .1 Features and functions of dedicated web-based user interface described above are to be available on any computer connected directly or via a wide area or virtual private network to BAS network, which conforms to the following specifications:
 - .1 software is to run on Microsoft Edge (or other standard browser);
 - .2 minimum hardware requirements are:
 - .1 2 GB RAM;
 - .2 2.0 GHz clock speed Pentium 4 microprocessor;
 - .3 120 GB hard drive;
 - .4 keyboard with 83 keys minimum;
 - .5 SVGA 1024 x 768 resolution display with 64 k colours and 16 bit colour depth;
 - .6 mouse or other pointing feature.

2.05 Remote Access Via Smart Phone and/or Tablet Devices

- .1 Available with an operator interface designed for use on various modern smart phone devices with network connectivity with the follow features:
 - .1 Mobile user interface operating over standard TCP network connection, performing well down to standard mobile 3G speeds, and optimized to ensure very high performance across different network topologies.
 - .2 Solution written with HTML5 web standards and browser agnostic, not deploying or using ActiveX controls, nor requiring installation of Java Runtime engine.
 - .3 Mobile solution incorporating full scope of responsibilities of BAS operators for remote mobile users, allowing them to view or control points within their assigned facility locations.
 - .4 Without alternation, mobile user interface operable within any standard internet browser from a normal personal computer.
- .2 Along with optimized smart phone user interface, a dedicated tablet access user interface, optionally providing full operator workstation functionality, on a tablet style device. Tablet interface is to support standard operator workstation features including full operator scope of responsibility, and operable using commercial off-the-shelf technology.

2.06 User Interface Application Components

- .1 Integrated browser based client application is to be used as user operator interface program. System is to employ an event-driven rather than a device polling methodology to dynamically capture and present new data to user. Additional features are as follows:
 - .1 inputs, outputs, set-points, and other parameters as defined in Part 3 of this Section, shown on drawings, or required as part of system software are to be displayed for operator viewing and modification from operator interface software;
 - .2 user interface software is to provide help menus and instructions for each operation and/or application;

- .3 system is to support customization of user interface configuration and a home page for each operator;
- .4 system is to support user preferences in alarm, trend, display, and applications screen presentations;
- .5 controller software operating parameters are to be displayed for operator to view/modify from user interface, and these parameters are to include set-points, alarm limits, time delays, PID tuning constants, run times, point statistics, schedules, etc.;
- .6 operator interface is to incorporate comprehensive support for functions including but not limited to following:
 - .1 user access for selective information retrieval and control command execution;
 - .2 monitoring and reporting;
 - .3 alarm, non-normal, and return to normal condition annunciation;
 - .4 selective operator override and other control actions;
 - .5 information archiving, manipulation, formatting, display and reporting;
 - .6 BAS internal performance supervision and diagnostics;
 - .7 on-line access to help menus;
 - .8 on-line access to current BAS as-built records and documentation;
 - .9 means for controlling, re-programming, and re-configuration of the BAS operation and for the manipulation of the BAS database information in compliance with applicable Codes and Regulations for individual BAS applications.
- .7 system is to support a list of application programs configured by users that are called up by the Tools Menu, hyperlinks within graphic displays, and key sequences;
- .8 operation of control system is to be independent of user interface, which is to be used for operator communication only.
- .2 System is to have a minimum of 5 levels of nesting, and the capability of displaying multiple navigation trees to aid operator in navigating throughout all systems and points connected, adding custom trees, defining any logical grouping of points, and arranging them on a tree in any order, and nesting groups within other groups. Navigation trees are to be "dockable" to other displays such as graphics, meaning trees will appear as part of display but can be detached and then minimized to Windows task bar or closed altogether, however, a simple keystroke will reattach navigation to primary display of user interface.
- .3 Alarms are to be routed directly from network automation engines to PC's and servers, and it is to be possible for specific alarms from specific points to be routed to specific PC's and servers. BAS is to annunciate diagnostic alarms indicating system failures and non-normal operating conditions, annunciate application alarms as required by points lists and sequences, and as a minimum, permit 4 categories of alarm sounds customizable through user defined wav files. Alarm management segment of user interface is to provide, as a minimum, following alarm functions:
 - .1 log, date, and time of alarm occurrence;
 - .2 generate a "pop-up" window or populate a dedicate section of screen with audible alarm to inform a user that an alarm has been received;

- .3 permit a user with the appropriate security level to acknowledge, temporarily silence, or discard an alarm;
 - .4 provide an audit trail on PC hard drive for alarms by recording user acknowledgement, deletion or disabling of an alarm, name of the user, alarm, action taken, and time/date of alarm;
 - .5 facilitate ability to direct alarms to an email address or alphanumeric pager, in addition to pop-up window described above;
 - .6 any attribute of any object in system may be designated to report an alarm.
- .4 Reports and summaries are to be generated and directed to user interface displays with subsequent assignment to printers or discs. Summaries and reports are to be accessible via standard user interface functions, and selection of a single menu item, tool bar item, or tool bar button is to print any displayed report or summary. System is to permit creation of custom reports and queries via a standard web services XML (Extensible Mark-up Language) interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports. As a minimum, BAS is to provide following reports and summaries:
- .1 all points in BAS;
 - .2 all points in each BAS application;
 - .3 all points in a specific controller;
 - .4 all points in a user-defined group of points;
 - .5 all points currently in alarm;
 - .6 all points locked out;
 - .7 all BAS schedules;
 - .8 all user defined and adjustable variables, schedules, interlocks, etc.
- .5 Graphical display for time-of-day scheduling and override scheduling of building operations is to be provided, with weekly schedules for each group of equipment with a specific time use schedule, and it is to be possible to define one or more exception schedules for each schedule including reference to calendars, with monthly calendars provided to permit simplified scheduling of holidays and special days for a minimum of 5 years in advance, user selected with the pointing device or keyboard. Changes to schedules made from user interface are to directly modify network automation engine schedule database. Selection of a single menu item or tool bar button is to print any displayed schedule. As a minimum, following functions are to be provided:
- .1 weekly schedules;
 - .2 exception schedules;
 - .3 monthly calendars;
 - .4 global schedules.
- .6 BAS is to be complete with multiple-level password access protection to permit user/manager to user interface control and display, database manipulation capabilities deemed appropriate for each user, based on an assigned password. Password access protection features are to include:
- .1 each user is to have a user name (24 characters minimum), a password (12 characters minimum), and access levels;

- .2 each user may change his or her password at any time;
- .3 when editing or entering passwords, system is not to echo actual characters for display on monitor;
- .4 minimum of 500 unique password is to be supported;
- .5 operators are to be able to perform only those commands available for their respective passwords, and display of menu selections is to be limited to only those items defined for access level assigned to password of each user;
- .6 BAS is to automatically generate a report of log-on/log-off and system activity for each user, and any action that results in a change in operation or configuration of control system is to be recorded, including acknowledgement and deletion of alarms;
- .7 minimum of 5 levels of access is to be supported individually or in any combination of following:
 - .1 Level 1 – view data;
 - .2 Level 2 – command;
 - .3 Level 3 – operator overrides;
 - .4 Level 4 – database modification;
 - .5 Level 5 – database configuration;
 - .6 Level 6 – all privileges including password add/modify.
- .7 User interface is to be equipped with screen management capabilities that allows user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network of user defined navigation trees.
- .8 Graphics application program is to be an integral part of user interface and is to include a create/edit function and a runtime function, and system architecture is to support a number of graphic documents (graphic definition files) limited only by memory and computing resources to be generated and executed. Graphics are to be capable of displaying and providing animation based on real-time data that is acquired, derived, or entered. Additional features include following:
 - .1 maximum of 16 graphic applications are to be able to be executed at any one time on a user interface or workstation with 4 visible to user, and each graphic application is to capable of following functions:
 - .1 all graphics are to be fully scalable;
 - .2 graphics are to support a maintained aspect ratio;
 - .3 multiple fonts are to be supported;
 - .4 unique background is to be assigned on a per graphic basis;
 - .5 colour of animations and values on displays is to indicate status of object attribute.
 - .2 it is to be possible to change values (set-points) and states in system controlled equipment by using drop-down windows accessible via pointing device;
 - .3 graphic editing tool is to be provided to permit creation and editing of graphic files, and graphic editor is to be capable of performing/defining animations, defining runtime binding, and:

- .1 in general, facilitate creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required;
 - .2 be capable of adding additional content to any graphic by importing backgrounds in the SVG, BMP, or JPG file formats.
 - .4 many graphic displays representing part of building and various building components are exact duplicates, with exception that various variables are bound to different field values, consequently, it is to be possible to bind value of a graphic display to aliases, as opposed to physical field tags.
- .9 Trend and change of value data is to be stored within the automation engines or server and uploaded to a dedicated trend database or exported in a selectable data format via a data export utility. Uploads to a dedicated database are to occur based on one of user-defined interval, manual command, or when trend buffers are full. Exports are to be as requested by user or on a time scheduled basis. System is to be equipped with a configurable data storage sub-system for collection of historical data which can be stored in either Microsoft Access or SQL database format. Each automation engine is to store, trend, and point history data for analog and digital inputs and outputs as follows:
- .1 any point, physical or calculated, may be designated for trending, and methods of collection are to be defined time interval or a change of value;
 - .2 each automation engine or server is to be capable of storing multiple samples for each physical point and software variable based on available memory, including an individual sample time/date stamp, and points may be assigned to multiple history trends with different collection parameters.
- .10 Trend viewing utility with access to data points and capability of defining trend study displays to include multiple trends is to be provided, and is to include:
- .1 capability of retrieving any historical database point for use in displays and reports by specifying point name and associated trend name;
 - .2 displays which are able to be single or stacked graphs with on-line selectable display characteristics such as ranging, colour, and plot style;
 - .3 display magnitude (zoom capability) and units selectable by operator at any time without reconfiguration of processing or collection of data;
 - .4 display magnitude is to be automatically scaled to show full graphic resolution of data being displayed;
 - .5 trend studies are to be capable of calculating and displaying calculated variables including highest value, lowest value, and time based;
 - .6 display is to support user's ability to change colours, sample sizes, and types of markers.
- .11 BAS is to be equipped with a database manager that separates database monitoring and management functions by supporting 2 separate windows. Database secure access is to be accomplished using standard SQL authentication including ability to access data for use outside of BAS application. Additional features are as follows:
- .1 database management function is to include summarized information on trend, alarm, event, and audit for backup, purge, and restore database management functions;
 - .2 database manager is to support 4 tabs as follows:
 - .1 statistics, which is to display database server information and trend, alarm (event), and audit information on BAS database;

- .2 maintenance, which is to be an easy method of purging records from BAS server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting database, and allowing for retention of a selected number of day's data;
- .3 backup, which is to provide means to create a database backup file and select a storage location;
- .4 restore, which is to provide a restricted means of restoring a database by requiring user to log into an Expert Mode in order to view Restore screen.
- .3 status bar is to appear at bottom of BAS database manager tabs and is to indicate information on current display activity with icons as follows:
 - .1 Ready;
 - .2 Purging Record From Database;
 - .3 Action Failed;
 - .4 Refreshing Statistics;
 - .5 Restoring Database;
 - .6 Shrinking A Database;
 - .7 Backing-Up A Database;
 - .8 Resetting Internet Information Services;
 - .9 Shutting Down BAS Deice Manager;
 - .10 Action Successful.
- .4 database manager monitoring functions are to be accessed through Monitoring Settings window and are to continuously read database information once user has logged in;
- .5 system is to advise user via task bar icons and email messages when a database value has exceeded a warning or alarm limit;
- .6 Monitoring Settings window is to have following sections:
 - .1 General: allow user to set and review scan intervals and start times;
 - .2 Email: allow user to create and review email and telephone text messages to be delivered when a warning or alarm is generated;
 - .3 Warning: allow user to define warning limit parameters, set reminder frequency, and link email message;
 - .4 Alarm: allow user to define alarm limit parameters, set reminder frequency, and link email message;
 - .5 Database Login: protect system from unauthorized database manipulation by creating a read access and write access for each trend, alarm (event), and audit databases as well as an Expert Mode required to restore a database.
- .7 Monitoring Settings taskbars to display following informational icons:

- .1 Normal: indicates by colour and size that databases are within their limits;
- .2 Warning: indicates by colour and size that one or more databases have exceeded their warning limit;
- .3 Alarm: which indicates by colour and size that one or more databases have exceeded their alarm limit.
- .8 BAS is to indicate via taskbar icons and email messages when a database value has exceeded a warning or alarm limit;
- .12 BAS is to be equipped with a demand limiting and load rolling program for purpose of limiting peak energy usage and reducing overall energy consumption. Program is to support both Sliding Window and Fixed Window methods of predicting demand. Additional features are as follows:
 - .1 system is to support 3 levels of sensitivity in Sliding Window demand calculations for fine tuning the system, as follows:
 - .1 Low Setting: sheds loads later and over shortest period of time and maximizes period of time equipment is on;
 - .2 Medium Setting: sheds loads earlier over a period of time greater than Low Setting, and increases time equipment is on and decreases probability of exceeding "Tariff Target";
 - .3 High Setting: sheds loads earlier and over a longer period of time than Medium Setting to minimize probability of exceeding "Tariff Target".
 - .2 system is to have both a Shed Mode and a Monitor Only Mode of operation, as follows:
 - .1 when Shed Mode is engaged, system is to actively control demand;
 - .2 when Monitor Mode is engaged, system is to simulate shedding action but will not take any action.
 - .3 Demand Limiting Program is to monitor energy consumption rate and compare it to a user defined "Tariff Target", and maintain consumption below target by selectively shedding loads based on a user defined strategy;
 - .4 Demand Limiting Program is to be capable of supporting a minimum of 10 separate load priorities, with each load user assigned, and a minimum of 12 separate "Tariff Targets" defining maximum allowed average power usage during current interval;
 - .5 system is to support a maximum shed time for each load as determined by user, and system is to restore load before maximum shed time has expired;
 - .6 system is to support a minimum shed time for each load as determined by user, and system is not to restore load before minimum shed time has expired;
 - .7 system is to support a minimum release time for each load as determined by user, and system is not to shed load until it has been off for minimum release time;
 - .8 system is to support three user defined options if meter does not function properly, as follows:
 - .1 shedding – currently shed loads will be released as their maximum shed time expires;
 - .2 maintain current shed rate – system will use demand limiting shed rate that was present when meter began to function improperly;

- .3 use unreliable meter shed rate – system is to control to a user defined unreliable shed rate target.
- .9 Load Rolling Program is to sum the loads currently shed and compare sum to a user defined load rolling target, and system is to maintain consumption below target by selectively shedding loads based on a user defined load priority;
- .10 Load Rolling Program is to be capable of supporting a minimum of 10 separate load priorities with each load user defined to a load priority;
- .11 Load Rolling Program is to be capable of supporting a minimum of 12 separate "Tariff Targets" defining amount of energy by which demand must be reduced;
- .12 system is to equip user with a Load Tab that displays all demand limiting and load rolling parameters for any selected load;
- .13 system is to be complete with a Load Summary that displays all loads associated with demand limiting and load rolling program, and status icons for each load are to indicate:
 - .1 Load Is Offline;
 - .2 Load Is Disabled;
 - .3 Load Is Shed;
 - .4 Load Is Locked;
 - .5 Load Is In Comfort Override.
- .14 Load Summary is to include a load summary runtime view listing following load conditions:
 - .1 Load Priority;
 - .2 Shed Strategy;
 - .3 Load Rating;
 - .4 Present Value;
 - .5 Ineligible Status;
 - .6 Active Timer;
 - .7 Time Remaining;
 - .8 Last Shed time.

2.07 Network Automation Engines

- .1 Network automation engines are to be ULC listed and labelled, BACnet Testing Labs (BTL) certified and labelled, fully user programmable supervisory controllers to monitor a network of a minimum of 100 distributed application-specific controllers for a global strategy and direction and to communicate on a peer-to-peer basis with other network automation engines.
- .2 Each network automation engine is to have ability to deliver a web based user interface as specified above, and computers connected physically or virtually to automation network are to have access to web-based user interface. Additional characteristics/requirements are as follows:
 - .1 web-based user interface software is to be imbedded in each network automation engine;

- .2 each network automation engine is to support a minimum of 4 concurrent users;
- .3 user is to be capable of accessing all system data through one network automation engine;
- .4 remote users connected to network through an internet service provider or by telephone dial-up are also to have total system access through one network automation engine;
- .5 each network automation engine is to be capable of generating web-based user interface graphics, and this capability is to be imbedded in network automation engine;
- .6 user interface is to support following functions using a standard version of Microsoft Edge:
 - .1 configuration;
 - .2 commissioning;
 - .3 data archiving;
 - .4 monitoring;
 - .5 commanding;
 - .6 system diagnostics.
- .7 each network automation engine is to permit temporary use of portable devices without interrupting normal operation of permanently connected modems.
- .3 Each network automation engine is to be a multi-tasking, multi-user, microprocessor-based real time digital control processor sized to meet requirements of system with a minimum word size of 32 bits, and standard operating systems.
- .4 Each network automation engine is to have sufficient memory to support its own operating system, databases, and control programs to provide supervisory control for control level devices.
- .5 Each network automation engine is to include an integrated, hardware based real time clock.
- .6 Each network automation engine is to be equipped with LED indicators to identify following conditions:
 - .1 Power, On/Off;
 - .2 Ethernet Traffic, Ethernet Traffic/No Ethernet Traffic;
 - .3 Ethernet Connection Speed, 10 Mbps/100 Mbps;
 - .4 FC Bus A, Normal Communications/No Field Communications;
 - .5 FC Bus B, Normal Communications/No Field Communications;
 - .6 Peer Communication, Data Traffic Between Network Automation Engines;
 - .7 Run, NAE Running/NAE in Start-up/NAE Shutting Down/Software Not Running;
 - .8 Battery Fault, Battery Defective/Data Protection Battery Not Installed;
 - .9 24 VAC, 24 VAC Present/Loss of 24 VAC;
 - .10 Fault, General Fault;
 - .11 Modem RX, NAE Modem Receiving Data;

- .12 Modem TX, NAE Modem Transmitting Data.
- .7 Each network automation engine is to be equipped with ports for operation of operator input/output devices such as industry standard computers, modems, and portable operator's terminals. Ports are to be as follows:
 - .1 2 USB ports;
 - .2 2 RS-232 serial data communication ports;
 - .3 2 RS-485 ports;
 - .4 one Ethernet port.
- .8 Each network automation engine is to continually perform self-diagnostics, communications diagnostics, and diagnostics of all pane components, and transmit both local and remote annunciation of any detected component failure, low battery condition, and repeated failures to establish communication.
- .9 In event of loss of normal power each network automation engine is to continue to operate for a user adjustable period of up to 10 minutes after which there is to be an orderly shut-down of all programs to prevent loss of database or operating system software, and:
 - .1 during a loss of normal power, control sequences are to go to normal system shutdown conditions, and critical configuration data is to be saved into Flash memory;
 - .2 upon restoration of normal power and after a minimum off-time delay, controller is to automatically resume full operation through a normal soft-start sequence without manual intervention.

2.08 Field Equipment Controllers

- .1 Each field equipment controller is to be a fully user programmable BACnet Testing Labs (BTL) certified and labelled digital controller that communicates via BACnet MS/TP protocol. Each controller is to be housed in a plenum rated plastic housing with removable base to permit pre-wiring of analog and binary input/output field points without controller in place.
- .2 Each controller is to employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences, and is to be factory programmed with a continuous adaptive tuning algorithm that sense changes in physical environment and continually adjusts loop tuning parameters appropriately.
- .3 Each field equipment controller is to:
 - .1 include troubleshooting LED's to identify following conditions:
 - .1 Power On;
 - .2 Power Off;
 - .3 Download or Start-Up In Progress-Not Ready For Normal Operation;
 - .4 No Faults;
 - .5 Device Fault;
 - .6 Field Controller Bus-Normal Data Transmission;
 - .7 Field Controller Bus-No Data Transmission;

- .8 Field Controller Bus-No Communication;
- .9 Sensor Actuator Bus-Normal Data Transmission;
- .10 Sensor Actuator Bus-No Data Transmission;
- .11 Sensor Actuator Bus-No Communication.
- .2 support universal inputs, configured to monitor any of following:
 - .1 analog input, voltage mode;
 - .2 analog output, current mode;
 - .3 analog input, resistive mode;
 - .4 binary input, dry contact maintained mode;
 - .5 binary input, pulse counter mode.
- .3 support binary inputs configured to monitor either of following:
 - .1 dry contact maintained mode;
 - .2 pulse counter mode.
- .4 support analog outputs configured to output either of following:
 - .1 analog output, voltage mode;
 - .2 analog output, current mode.
- .5 support binary outputs, 24 VAC Triac;
- .6 support configurable outputs capable of following:
 - .1 analog output, voltage mode;
 - .2 binary output mode.
- .7 have ability to reside on a master-slave/token-passing field controller bus supporting BACnet standard protocol as follows:
 - .1 support communications, including input/output communications between field controllers and network automation engines;
 - .2 support a minimum of one hundred input/output modules and field equipment controllers in any combination;
 - .3 operate at a maximum distance of 4560 m (15,000 ft) between field controller and furthest connected device.
- .8 have ability to monitor and control a network of sensors and actuators over a master-slave/token-passing sensor-actuator bus supporting BACnet standard protocol as follows:
 - .1 bus is to support a minimum of ten devices per trunk;
 - .2 bus is to operate at a maximum distance of 365 m (1200 ft) between field controller and furthest connected device.

- .9 capability of executing complex control sequences involving direct wired input/output points as well as input and output devices communicating over field controller bus or sensor-actuator bus;
- .10 support, but not limited to, following:
 - .1 hot water, chilled water/central plant applications;
 - .2 custom air handling units for special applications;
 - .3 terminal units;
 - .4 special programs as required for systems control.
- .11 support a password protected local controller LCD back-lit display with 6 key keypad as an integral part of field controller or as a remote device communicating over sensor-actuator bus to permit user to view monitored points without logging into system, and to view and change set-points, modes of operation, and parameters.

2.09 Input/Output Modules

- .1 Input/output modules to facilitate additional inputs and outputs for use in field equipment controllers are to be similar to field equipment controllers but less display and with a minimum of 4 and a maximum of 17 points.

2.10 System Configuration Tools

- .1 System configuration tool is a software package supplied with BAS to enable a computer platform to be used as a stand-alone engineering configuration tool for a network automation engine and to permit programming of field equipment controllers. Configuration tool is to provide an archive database for configuration and application data and is to have same look and feel at user interface regardless of whether configuration is being done online or offline. Additional features and characteristics are as follows:
 - .1 tool is to include:
 - .1 basic system navigation tree for connected networks;
 - .2 integration of system enabled devices;
 - .3 customized user navigation tree;
 - .4 point naming operator parameter setting;
 - .5 graphic diagram configuration;
 - .6 alarm and event message routing;
 - .7 graphical logic connector tool for custom programming;
 - .8 downloading, uploading, and archiving databases.
 - .2 tool is to have capability to automatically discover field devices on connected buses and networks;
 - .3 tool is to be capable of configuring from a library of standard applications, simulating to verify applications, and commissioning field equipment controllers and field devices;

- .4 tool is to be complete with a Bluetooth Wireless Technology wireless access point to enable a wireless enabled portable computer to make a temporary Ethernet connection to automation network.
- .2 Bluetooth Wireless Technology converter is to provide temporary wireless connection between sensor-actuator bus or field-controller bus and a wireless enabled portable computer. Converter is to be powered through a connection to either sensor-actuator bus or the field-controller bus and is to support downloading and troubleshooting field equipment controllers and field devices from portable computer over wireless connection. Converter is to be complete with LED indicators for following conditions:
 - .1 Power: On/Off;
 - .2 Fault: Fault/No Fault;
 - .3 SA/FC Bus: Bus Activity/No Bus Activity;
 - .4 Bluetooth: Bluetooth Communication Established/Bluetooth Communication Not Established.

2.11 Wiring Materials

- .1 System wiring, conduit, boxes, and similar materials are to be in accordance with requirements specified in Division 26 – Electrical.

3 Execution

3.01 General Re: Installation of the BAS

- .1 Provide a complete building automation system in accordance with requirements of this Section of the Specification, Section 25 05 01 – Automatic Control Systems, drawings, and the input/output points list(s).
- .2 Unless otherwise specified, perform BAS work in accordance with system manufacturer's instructions.

3.02 Installation of Direct Digital Control System Components

- .1 Provide required direct digital control hardware, software, accessories, and wiring for a complete BAS. Refer to drawing control diagrams and sequences, points list(s), and Section 25 05 01 – Automatic Control Systems.
- .2 Provide operator workstation, including required power and data connections, in a location as directed by the Owner or as indicated on drawings.
- .3 DDC work is to be performed by skilled technicians, properly trained and are qualified for this work.
- .4 Materials and equipment used are to be standard components, regularly manufactured for this and/or other systems, and not custom designed especially for this project. Systems and components are to have been thoroughly tested and proven in actual use.
- .5 System is to be modular, permitting expansion by adding hardware and software without changes in communication or processing equipment.
- .6 Provide new communications bus as required complete with required ancillaries. Connect and extend existing communications bus.
- .7 Provide 1 supervisory controller (SC) per cabinet fan (air handler). Provide necessary field equipment controllers (FEC).

- .8 Provide necessary quantity of SC to accomplish requirements of this specification, and to minimize number of mechanical systems that would be inoperative in event of a FEC failure. A maximum of 2 major mechanical systems are to be controlled by 1 FEC.
- .9 Surface wall mount SC and FEC control units in Mechanical Rooms ensuring they are not mounted on vibrating surfaces, and connect to 15 A/1-pole circuit breakers dedicated for control system applications, in branch panel circuit boards in adjacent spaces. Power wiring from control units to circuit breakers is to be the responsibility of the controls contractor. Wiring is to be in conduit and conduit and wiring are to be in accordance with standards and requirements of Division 26 – Electrical. Refer to electrical drawings for locations of branch circuit panelboards with dedicated circuits for controls system applications.
- .10 Indicate via number, and systems controlled by SC and FEC. Indicate via a lamacoid label mounted inside panel the identification number of electrical panel supplying power to SC and FEC.
- .11 Submit schedule(s) of input/output points to the Consultant for review. Directly connect each SC and FEC to point devices in accordance with control diagrams and schedule of miscellaneous control points as shown on drawings. Sensor wires for each analogue input are to be 18 AWG twisted-shielded cable. Other types of wire required are to be as recommended by system supplier.
- .12 Provide required sensors, remote devices, etc., and required interface accessories. Mount duct and/or plenum sensors half-way across duct or plenum.
- .13 Differential pressure sensor used to provide space pressurization control through regulation of return air quantities must be mounted with snubbers on indoor pressure leg to prevent sudden fluctuations caused by door openings, etc. Mount outdoor air ports in locations that minimize effects of abnormal surface flow conditions and wind gusts.
- .14 Supply and turn over to the Consultant prior to application for a Certificate of Substantial Performance of the Work, reports to be used in assisting Owner in defining and debugging DDC programs. These reports are to consist, as a minimum, of following:
 - .1 process control language (PCL) logs;
 - .2 control loop logs;
 - .3 PCL master point.
- .15 Submit Point Data Input forms to Consultant that Owner will fill out with DDC system supplier's assistance. Input this point data into the system.
- .16 Contacts will be supplied as part of mechanical work or electrical work for alarm and status points for systems and equipment other than building environmental systems and equipment. Connect to DDC system in accordance with point schedule.

3.03 Implementation of Energy Management Programs

- .1 Implement energy management programs indicated for building equipment and systems.
- .2 Ensure energy management program adjustable parameters are accessible to and adjustable by building operations personnel at operator's workstation.
- .3 Configure energy management programs so they may be enabled/disabled on an individual basis for each system to which they apply.

3.04 Control Wiring

- .1 Perform required control wiring work for control systems except:

- .1 power wiring connections to equipment and panels, except as noted below;
 - .2 control wiring associated with mechanical plant equipment and systems whose control is not part of work specified in this Section;
 - .3 starter interlock wiring.
- .2 Except as specified below, install wiring in conduit. Unless otherwise specified, final 600 mm (2 ft) connections to sensors and transmitters, and wherever conduit extends across flexible duct connections is to be liquid-tight flexible conduit.
- .3 Control wiring in ceiling spaces and wall cavities may be plenum rated cable installed without conduit but neatly harnessed, secured, and identified.
- .4 Wiring work is to be in accordance with BAS manufacturer's certified wiring schematics and instructions, and wiring standards specified in electrical work Division of this Specification.

3.05 Identification and Labelling of Equipment and Circuits

- .1 Refer to Section 20 05 00 – Common Work Results for Mechanical.
- .2 Identify BAS equipment as follows:
 - .1 enclosures: engraved laminated nameplates with lettering such as BAS Panel CP2, or BAS Relays, or BAS E/P Transformers, with all wording listed and approved prior to manufacture of nameplates;
 - .2 panel points: a weather-proof input/output layout sheet for each controller with the name of each point connected to controller, and associated wire labelling information;
 - .3 wiring: numbered sleeves or plastic rings at both ends of conductor, with numbering corresponding to conductor identification on shop drawings and "as-built" record drawings;
 - .4 interface components: a weather-proof layout sheet clearly illustrating/identifying purpose of each component within enclosure such that an operator or service technician can quickly identify exact use of each relay, transducer, contactor, etc., with each sheet fastened securely to back of enclosure door.

3.06 System Startup

- .1 For equipment/system manufacturer certification requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.
- .2 For equipment/system start-up requirements, refer to Section 20 05 00 – Common Work Results for Mechanical.

3.07 Closeout Activities

- .1 Include for demonstration and training sessions for each of 2 groups of Owner's operating and maintenance personnel as follows:
 - .1 3 full, 8 hour day orientation sessions at system manufacturer's office to educate personnel on BAS architecture, hardware, and software, with an overview of BAS operation and capabilities including but not limited to operational programmes, equipment functions (both individually and as part of a total integrated system), BAS commands, advisories, alarms, and appropriate operator intervention required in responding to BAS operation;

- .2 2 full, 8 hour day sessions at site using BAS for a "hands-on" demonstration of BAS functions and features with instruction regarding chronological flow of information from field devices, contacts and sensors to operator's workstation, an overview of communications network describing interplay between initiating devices, field hardware panels, systems communications, and their importance within operating BAS, and alarm indications and appropriate responses;
 - .3 2 full, 8 hour day seasonal (summer-winter) site sessions to perform additional instruction regarding seasonal changes and how they affect BAS.
- .2 Include for 2 follow-up site training and troubleshooting visits, one 6 months after Substantial Completion and other at end of warranty period, both when arranged by Owner and for a full day to provide additional system training as required.

End of Section

October 31, 2025

1 General

1.01 Section Includes

.1 Building Automation System integration requirements related to electrical systems.

1.02 Related Requirements

.1 Division 26 – Electrical.

2 Products

2.01 Points Specified but Not Described in Sequences

.1 Any remaining points not detailed in this section are to be monitored and available for trending data.

2.02 Section 26 24 13 – Switchboards

.1 Customer meter at main utility service entrance.

.2 Provide BACnet gateways to suit meter protocol output.

2.03 Section 26 27 13 – Electricity Metering

.1 Customer meters to building automation system.

3 Execution

3.01 Installation

.1 In accordance with Section 25 05 02.

End of Section

1 General

1.01 Section Includes

- .1 Common requirements for electrical work.
- .2 Mounting heights for electrical equipment and devices.

1.02 Related Requirements

- .1 Provisions of this section apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.
- .2 Document 00 64 01 – Request for Electronic Files Form.
- .3 Section 08 31 00 – Access Doors and Panels.
- .4 Section 09 91 00 – Painting.
- .5 All sections related to heat tracing.
- .6 Building Automation System integration requirements for Electrical Systems as described in Section 25 96 00.
- .7 This section is to be read in conjunction with Division 00 documents, and Division 01 specification sections, which take precedence as described in CCDC 2-2020.
 - .1 General Conditions.
 - .2 Supplementary General Conditions.
 - .3 General Requirements.

1.03 Intent

- .1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter.
- .2 Leave complete systems ready for continuous and efficient satisfactory operation.
- .3 Discipline and Trade Jurisdiction:
 - .1 In accordance with CCDC 2-2020 GC 1.1.9: Neither the organization of the Specifications nor the arrangement of Drawings shall control the Contractor in dividing the work among Subcontractors and Suppliers.
 - .2 MasterFormat's organizational structure used in a project manual does not imply how the work is assigned to various design disciplines, trades, or subcontractors. MasterFormat is not intended to determine which particular elements of the project manual are prepared by a particular discipline. Similarly, it is not intended to determine what particular work required by the project manual is the responsibility of a particular trade. A particular discipline or trade is likely to be responsible for subjects from multiple Divisions, as well as from multiple Subgroups.

1.04 Specifications Language and Style

- .1 These specifications are written in the imperative mood and in streamlined form. The imperative language is directed to Contractor, unless stated otherwise.

- .2 Complete sentences by reading "shall", "Contractor shall", "shall be", and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.
- .3 Fulfill and perform all indicated requirements whether stated imperatively or otherwise.
- .4 When used in the context of a Product, read the word "provide" to mean "supply and install to result in a complete installation ready for its intended use."

1.05 Drawings and Specifications

- .1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications, which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Consultant in writing before submitting Bid. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.
- .2 All drawings and all Divisions of these specifications shall be considered as a whole, and work of this Division shown anywhere therein shall be furnished under this Division.
- .3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of conductors and wiring is not assured. Exact requirements are governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions are to be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.
- .4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job. Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other, as well as other obstructions.
- .5 Determine final locations of major work within ceiling spaces based on the largest equipment first.
- .6 Unless otherwise shown or specified, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by the area construction. Install services as high as possible to conserve headroom and/or ceiling space. Notify the Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.
- .7 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made at no additional cost to the Owner.
- .8 Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc. may not be shown, but where such items are required by other sections of the specifications of where there are required for proper installation of the work, such items are to be furnished and installed.
- .9 Before ordering any conduit, cable tray, conductors, wireways, raceway bus duct, fittings, etc., verify all pertinent dimensions at the job site and be responsible for their accuracy.
- .10 If obvious ambiguities or omissions are noticed when tendering refer same to the Consultant for a ruling and obtain the ruling in writing in the form of an Addendum. Claims for extras for ambiguities or omission of items brought to the attention of the Consultant after the award of a contract which, due to the nature of the ambiguity or omission, should have been brought to the attention of the Consultant during the tendering period, will not be allowed.
- .11 The drawings are performance drawings, diagrammatic, and show locations for apparatus and materials. The drawings are intended to convey the scope of work and do not intend to show Architectural and

Structural details. The locations shown are approximate, and may be altered, when approved by the Consultant, to meet requirements of the material and/or apparatus, other equipment and systems being installed, and of the building. Do not scale drawings.

- .12 Control devices, equipment requiring maintenance, junction boxes, and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.
- .13 Be responsible for making necessary changes, at no additional cost, to accommodate structural and building conditions that were foreseeable by a review of existing conditions or a review of drawings prepared by other disciplines.
- .14 Where drawings indicate that acoustic tile ceiling is being suspended below existing plaster ceilings, coordinate the design of framework used to support this suspended ceiling, lighting, diffusers, and other components that are mounted within or through ceiling. Do not mount devices to suspended ceilings. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire rating.
- .15 Provide any fitting, offset, transformation, etc., required to suit architectural and structural details but not shown.

1.06 Work Restrictions

- .1 Do all cutting, patching, and making good to leave in a finished condition and to make the several parts of the Work come together properly. Co-ordinate work to keep cutting and patching to a minimum.
- .2 Quality of workmanship and materials used in patching, making good and refinishing of existing construction and/or compartments shall be of a standard equal to that specified for new construction and if not specified, equal to or exceeding that of original existing work.
- .3 Prior to cutting openings, examine wall, floor, and ceiling construction for buried electrical cables and pipes; and take adequate protection. Conduct cable locating tests to locate buried cables in existing work.

1.07 Allowances

- .1 Cash allowances are to be carried as indicated in Section 01 21 00 for the items indicated, each including all equipment, wiring material, labour, incidentals, profit, overhead, taxes, etc.
 - .1 Electric utility requirements for new service.

1.08 Substitution Procedures

- .1 Additionally, "Approved equal" shall be defined as a substitution approved by the Consultant.
- .2 If during the tender bid process, the bidding contractor wishes to substitute the specified equipment for an "Approved equal", the bidding contractor must submit shop drawings to the Consultant before the tender close for approval. If no substitution request is made, the as-specified equipment is that to be provided.
- .3 Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required to be used in this contract.
- .4 This contractor, at his option, may use equipment as manufactured by any of the listed manufacturers. This Contractor is responsible to ensure that all items submitted by these other manufacturers meets are requirements of the drawings and specification and fits in the allocated space. The final determination of a product being equivalent is to be determined by the Consultant when a catalog number is not listed, or listed in part.

- .5 Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Consultant as described in the General Provisions of the Contract for Submittals. The Contractor bears full responsibility for the unnamed manufacturers' equipment adequately meeting the intent of the design. The Owner or the Consultant may reject manufacturer at time of shop drawing submittal.
- .6 In addition to manufacturer's products base specified or named as acceptable, other manufacturers of products may be proposed as substitutions to the Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products base specified or named as acceptable. Certify in writing to the Consultant that proposed substitution meets space, power, design, energy consumption, and other requirements of base specified or acceptable product. It is understood that there will be no increase in Contract Price by reason of any changes to associated equipment, mechanically, electrically, structurally, or architecturally, required by acceptance of proposed substitution. The Consultant has sole discretion in accepting any such proposed substitution of product. Indicate any proposed substitutions in areas provided on Bid Form. Do not order such products until they are accepted in writing by the Consultant.

1.09 Contract Modification Procedures

- .1 Refer to Section 01 26 00.
- .2 Whenever the Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of work from that required by Contract Documents, prepare, and submit to the Consultant for review, a quotation being proposed cost for executing change or revision.
- .3 Quotation is to be a detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .4 Unless otherwise specified in Division 00, Division 01, or as identified in the Owner/Contractor agreement, allowable maximum percentages for overhead and profit are to be 7% and 5% respectively.
- .5 Unless otherwise specified in Division 00, or Division 01, following additional requirements apply to all quotations submitted:
 - .1 When change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is to be subtracted from cost of additional work before overhead and profit percentages are applied to additional work.
 - .2 Electrical material labour unit costs are to be in accordance with National Electrical Contractors Association (NECA) Manual of Labor Units (MLU), less 25%.
 - .3 Costs for journeyman and apprentice labour must not exceed prevailing rates at time of execution of Contract and must reflect actual personnel performing work.
 - .4 Cost for site superintendent must not exceed 10% of total hours of labour estimated for change or revision, and change or revision must be such that site superintendent's involvement is necessary.
 - .5 Overhead percentage will be deemed to cover quotation costs other than actual site labour and materials, and rentals.
 - .6 Quotations, including those for deleted work, to include a figure for any required change to Contract time.
- .6 The Consultant reserves the right to request backup quotations for any materials and/or rentals included within the quotation.

- .7 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit a proper quotation to enable Consultant to expeditiously process quotation and issue a Change Order will not be grounds for any additional change to Contract time.
- .8 Make requests for changes or revisions to work to Consultant in writing and, if Consultant agrees, will issue Notice of Change.
- .9 Do not execute any change or revision until written authorization for the change or revision has been obtained from the Consultant.

1.10 Coordination

- .1 Refer to Section 01 30 00.
- .2 Coordinate work with other trades to avoid conflict and to provide correct rough-in and connection for equipment furnished under other trades that require electrical connection. Inform Contractors of other trades of the required access to and clearances around electrical equipment to maintain serviceability and code compliance.
- .3 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.
- .4 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Co-operate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trades.
- .5 Coordinate utility service outages with the Owner. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.
- .6 Co-ordinate work with all trades to ensure a proper and complete installation. Notify all trades concerned of the requirement for openings, sleeves, inserts, and other hardware necessary for the installation and, where work is to be integrated with the work of other trades or is to be installed in close proximity with the work of other trades, carefully co-ordinate the work prior to installation.
- .7 Working Detail Drawings
 - .1 The contractor is to prepare working detail drawings supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of materials and or apparatus occur, or where the work due to architectural and structural considerations involves special study and treatment. Such drawings may be prepared jointly by all trades affected, or by the one trade most affected with due regard for and approval of the other trades, all as the Consultant will direct in each instance. Such drawings must be reviewed by the Consultant before the affected work is installed.
 - .2 Carry out all alterations in the arrangement of work which has been installed without proper study and approval, even if in accordance with the contract documents, in order to make such work come within the finished lines of walls, floors and ceilings, or to allow the installation of other work, without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.

1.11 Submittal Procedures

- .1 Refer to Section 01 30 00.

- .2 Before delivery to site of any item of equipment, submit shop drawings complete with all data, pre-checked and stamped accordingly, for review by the Consultant. Indicate project name on each brochure or sheet, make reference to the number and title of the appropriate specification section, type identifier such panelboard ID or luminaire type as indicated on appropriate schedule, and provide adequate space to accommodate the Consultant's review stamp(s).
- .3 Verify field measurements and affected adjacent Work are coordinated, including passageway clearances for movement of equipment into location.
- .4 Submit shop drawings to the Consultant in electronic (PDF) format, as coordinated after award of contract. Where submittals are derived from digital originals, do not print and rescan documents; submittals made as such will be immediately rejected.
- .5 Submit a schedule of shop drawings within one week after award of contract. Group submittals by specification division as appropriate.
- .6 Shop Drawings
 - .1 Submit for review, properly identified shop drawings showing in detail the design and construction of all equipment and materials as requested in sections of the specification governed by this Section.
 - .2 Obtain and comply with the manufacturer's installation instructions.
 - .3 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", stamp each copy with your company name, date each copy with the submittal date, and sign each copy. Shop drawings which are received and are not endorsed, dated, and signed will be returned for re-submittal.
 - .4 The Consultant will stamp shop drawings as follows:
 - .1 Reviewed ()
 - .2 Reviewed as Modified ()
 - .3 Revise and Re-Submit ()
 - .4 Not Reviewed ()
 - .5 If "REVIEWED" is checked-off, the shop drawing is satisfactory. If "REVIEWED AS MODIFIED" is checked-off, the shop drawing is satisfactory subject to requirements of remarks put on shop drawing copies. If "REVISE AND RE-SUBMIT" is checked-off, the shop drawing is entirely unsatisfactory and must be revised in accordance with comments written on shop drawing copies and resubmitted. If "NOT REVIEWED" is checked-off, the shop drawing is in error of submission, not applicable for this project.
 - .6 This review by the Consultant is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Consultant approved the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor, and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the contract documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for co-ordination of the work as well as compliance with codes and inspection authorities such as CSA, etc.
- .7 Confirm layouts of major electrical equipment rooms with the dimensions of as-procured equipment, and submit a layout sketch to the Consultant showing the major equipment and required clear spaces. The

contractor may, at their option, revise the layout of the major electrical equipment rooms, but take responsibility for these new layouts and meeting the requirements of the local electrical utilities. Capture final room layouts on as-built drawings.

1.12 Submittals

- .1 The Contractor is to submit dimensioned drawings or sketches that indicates the dimensions of the procured equipment, demonstrates that the equipment will fit in the allocated spaces, and demonstrates that manufacturer and code required clear spaces are provided.
- .2 Include sketches for the following locations that includes at minimum, major equipment such as switchboards, panelboards, splitters, transformers, generators, transfer switches, major wall mounted or floor mounted telecommunications equipment, and fire alarm panels, passive graphics, and annunciator panels.
 - .1 Main Electrical Room.
 - .2 Telecommunications rooms.
 - .3 Mechanical rooms (layouts to be coordinated with mechanical trade).

1.13 Safety Requirements

- .1 Refer to Section 01 30 00.
- .2 Be responsible for the safety of workers and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations prevail.

1.14 Regulatory Requirements

- .1 Refer to Section 01 41 00.
- .2 Codes and Standards
 - .1 Ontario Electrical Safety Code including all bulletins and amendments.
 - .2 Ontario Building Code and its referenced standards.
 - .3 Applicable CSA and ULC standards.
 - .4 All work shall be in accordance with Owner's Design Guidelines.
- .3 Permits and Fees
 - .1 Obtain and pay for all permits and fees required for the execution and inspection of the electrical work and pay all charges incidental to such permits. Submit to Electrical Inspection Department and Supply authority necessary number of drawings and specifications for examination and approval prior to commencement of work. Arrange and pay for any special inspection of equipment specified if and when required.
 - .2 Apply, pay and obtain all permits as required for the electrical work.
 - .3 Upon substantial completion of your work, supply and turn over to the Consultant all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.
- .4 Patents

- .1 Pay all royalties and licence fees, and defend all suits or claims for infringement of any patent rights, and save the Owner, Architect, Project Manager and Consultants harmless of loss or annoyance on account of suit, or claims of any kind for violation or infringement of any letters patent or patent rights, by this Subcontractor or anyone directly or indirectly employed by him or by reason of the use by him or them of any part, machine, manufacture or composition of matter on the work, in violation or infringement or such letters patent or rights.

1.15 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 CSA C235:19, Preferred voltage levels for AC Systems up to 50 000 V.
 - .3 Do underground systems in accordance with CSA C22.3 No. 7-15, Underground systems, except where specified otherwise.
 - .4 Ontario Electrical Safety Code (29th edition/2024), and all bulletins.
- .2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Electrical utility requirements and local applicable codes and regulations.
- .5 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
 - .1 IEEE 100-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
- .6 2024 Ontario Building Code.
- .7 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.16 Definitions

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

1.17 Quality Assurance

- .1 Refer to Section 01 40 00.
- .2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.
- .3 Ensure that all workmanship, all materials employed, all required equipment, and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.
- .4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

- .5 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Consultant. Any unsatisfactory workmanship will be replaced at no extra cost.
- .6 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this specification. Electrical Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all electrical equipment and materials in dry locations.
- .7 Provide foreman in charge of this work at all times.
- .8 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.
- .9 Governing Federal, Provincial and Municipal codes and regulations will be considered minimum standards for the work and where these are at variance with the drawings and specification, the more stringent ruling will apply.
- .10 Where any code, regulation, bylaw, or standard is quoted it shall mean the current edition including all revisions or amendments at the time of the tender.
- .11 In case of conflict, the codes and regulations take precedence over the Contract Documents. In no instance reduce the standard or scope of work or intent established by the drawings and specifications by applying any of the codes referred to herein.

1.18 Quality Control

- .1 Refer to Section 01 40 00.
- .2 Provide a full time Superintendent to oversee and coordinate all sub-trades in these divisions.

1.19 Temporary Utilities

- .1 Refer to Section 01 50 00.
- .2 Do not use any of the permanent facility systems during construction except as may be specified, or unless written approval is obtained from the Consultant.
- .3 The use of permanent facilities for temporary construction service will not affect in any way the commencement day of the warranty period.
- .4 Temporary heating during the construction period will be provided as described in Division 01.

1.20 Temporary Facilities and Controls

- .1 Refer to Section 01 50 00.
- .2 Prior to start of each work period in occupied area, install temporary protection to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.
- .3 Take necessary steps to ensure that required firefighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

1.21 Product Requirements

- .1 Refer to Section 01 61 00.
- .2 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.
- .3 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical Inspection Services, or other government agency.
- .4 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.
- .5 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.
- .6 Materials shall be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified, shall be approved before being used.
- .7 Equipment items shall be standard products of approved manufacturers. Identical units of equipment shall be of same manufacturer. In any unit of equipment, identical component parts shall be of same manufacturer, but the various component parts comprising the unit need not be of one manufacturer.
- .8 Chemical and physical properties of materials and design performance characteristics and methods of construction and installation of items of equipment, specified herein, shall be in accordance with latest issue of applicable Standards or Authorities when such are either mentioned herein, or have jurisdiction over such materials or items of equipment.
- .9 Materials shall bear approval labels as required by Code and/or Inspection Authorities.
- .10 Install materials in strict accordance with manufacturer's recommendations.
- .11 Include items of material and equipment not specifically noted on Drawings or mentioned in Specification but which are necessary to make a complete and operating installation.
- .12 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.
- .13 Unless otherwise noted, equipment and material specifications in Sections of the Specification governed by this Section are based on products of a manufacturer selected by the Consultant for the purpose of setting a standard of quality, size, performance, capacity, appearance, and serviceability.
- .14 In most instances the names of acceptable manufacturers are also stated for materials and equipment, and you may base your tender price on equipment and materials produced by either the specified manufacturer or a manufacturer listed as acceptable.
- .15 For any items of equipment, material, or for any system where acceptable manufacturers are not stated, you must provide only the equipment, material or system specified.
- .16 If materials or equipment manufactured and/or supplied by a manufacturer named in the specifications are used in lieu of products of the manufacturer noted as "basis of design", be responsible for ensuring that the substituted material or equipment is equivalent in size, performance and operating characteristics to the specified materials or equipment, and it shall be understood that all costs for larger starters, additional space, larger power feeders, and changes to associated or adjacent work required as a result of providing materials and equipment named as acceptable in lieu of the specified product will be borne by the Contractor.

- .17 In addition to the manufacturers specified or named as acceptable, the Contractor may propose substitute manufacturers of equipment and/or apparatus to the Consultant for acceptance, listing in each case a corresponding credit for each substitute proposed, however, the tender price must be based on apparatus or materials specified or named as acceptable. Certify in writing to the Consultant that the substitute meets all space, power, design, and all other required of the specified or equivalent material or apparatus. In addition, it shall be understood that all costs for larger starters, space, power feeders, and changes to associated equipment, mechanical and/or electrical, required by acceptance of proposed substitutions, will be borne by the party making the proposal. Substitute equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.
- .18 Where a manufacturer is not listed for a particular product, it will be deemed to mean that the Contractor will provide the specified manufacturer's product.

1.22 Examination and Preparation

- .1 Refer to Section 01 70 00.
- .2 Examine the existing equipment, the site and surrounding areas and be fully informed as to the conditions and limitations under which the work has to be executed. Claims for additional costs will not be entertained with respect to conditions which could reasonably have been ascertained by an inspection prior to Tender closing.
- .3 Examine work upon which your work depends. Report in writing defects in such work. Application of your work shall be deemed acceptance of work upon which your work depends.
- .4 Drawings are, in part, diagrammatic and are intended to convey scope of work and indicate general and approximate location, arrangement and sizes of equipment, piping, and similar items. Obtain more accurate information about locations, arrangement and sizes from study and coordination of drawings, including shop drawings and manufacturers' literature and become familiar with conditions and spaces affecting these matters before proceeding with work.
- .5 Where job conditions require reasonable changes in indicated locations and arrangements, make such changes with approval of the Consultant at no additional cost to the Owner. Similarly, where existing conditions interfere with new installation and require relocation, such relocation is included in work.

1.23 Cutting and Patching

- .1 Refer to Section 01 70 00.
- .2 The Electrical Contractor will be responsible for all cutting and patching required for the electrical installation. Structural members are not to be cut without the consent of the Consultant.
- .3 All cutting and patching required under Division 26, Division 27, and Division 28 shall be in accordance with Division 01. Layout such work for approval before undertaking same.
- .4 Cutting shall be kept to an absolute minimum and performed in a neat and workmanlike manner using the proper tools and equipment. Caution shall be exercised in all cutting and procedures to ensure that concealed services are not affected. Do not cut if in doubt. Request the Consultant's presence to determine if concealed services exist.
- .5 Assume responsibility for prompt installation of Work in advance of concrete pouring or similar Work. Should any cutting or repairing of finished/unfinished Work be required because such installation was not done, employ the particular trade, whose Work is involved, to do such cutting and patching. Pay for any resulting costs. Layout such Work for approval before undertaking same.

1.24 Cleaning and Waste Management

- .1 Refer to Section 01 74 00.
- .2 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this trade. At the completion of this work, the electrical installation is to be left in a clean and finished condition to the satisfaction of the Consultant.
- .3 Clean and repair existing materials and equipment which remain or are to be reused.
- .4 Luminaires to be reinstalled: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.
- .5 Assume responsibility for removing tools and waste materials on completion of Work, and leave Work in clean and perfect condition.

1.25 Starting and Adjusting

- .1 Refer to Section 01 77 00.
- .2 Conduct acceptance tests to demonstrate that the equipment and systems actually meet the specified requirements. Tests may be conducted as soon as conditions permit, and consequently make all changes, adjustments, or replacements required as the preliminary tests may indicate prior to the final tests. Tests shall be as specified in various sections of this Division. Carry out tests in the presence of the Consultant. Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project. The Electrical Contractor shall be in charge of the plant during tests. He shall assume responsibility for damages in the event of injury to the personnel, building, equipment, and shall bear all costs for liability, repairs, and restoration in this connection. Submit test results.
- .3 Make tests of equipment and wiring at times requested.
- .4 Tests shall include meggered insulation values, voltage and current readings to determine balance of panels and feeders under full load, and operation of each piece of equipment for correct operation.
- .5 Supply meters, materials and personnel as required to carry out these tests.
- .6 Test electrical work to standards and function of Specification and applicable codes in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.
- .7 Connect single phase loads so that there is the least possible unbalance of the supply phases.
- .8 Submit all test results in report format.
- .9 Trial Usage
 - .1 The Consultant reserves the right to use any system, piece of equipment, device, or material for such reasonable lengths of time and at such times as may be required to make a complete and thorough test of the same, or for the purpose of learning operational procedures, before the final completion and acceptance of the work. Such tests shall not be construed as evidence of acceptance of the work, and it is agreed and understood that no claim for damage will be made for injury or breakage to any part or parts of the above due to the aforementioned tests, where such injuries or breakage are caused by a weakness or inaccuracy of parts, or by defective materials or workmanship of any kind. Supply all labour and equipment required for such tests.

- .2 Perform and pay for all costs associated with any testing required on the system components where, in the opinion of the Consultant the equipment manufacturer's ratings or specified performance is not being achieved.

1.26 Closeout Procedures

- .1 Refer to Section 01 77 00.
- .2 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.
- .3 Building Permit Compliance
 - .1 Provide a minimum of 10 business days notice to the Consultant for scheduling of Consultant's occupancy inspection.
 - .2 Prior to requesting the Consultant's letter "Review of General Conformance" for submission to the municipal building department to allow occupancy, the following items must be complete and submitted to the Consultant, as applicable:
 - .1 General
 - .1 Submit all applicable inspection reports from Authorities Having Jurisdiction.
 - .2 Continuity of fire separations at service penetrations must be complete.
 - .2 Electrical
 - .1 Provide Certificate of Acceptance from Electrical Inspection Department.
 - .2 Any devices not installed must have the wiring made safe and terminated in an outlet box complete with cover.
 - .3 All outlets must have cover plates installed. All electrical equipment not located in service rooms must have covers and/or doors installed complete.
 - .4 Emergency lighting system must be operational and tested by the Contractor. Where battery units and remote heads are indicated on the drawing, provide certification letter from equipment manufacturer indicating the system meets code requirements.
 - .5 Simulate normal power failure within the premises in the presence of the consultant and the Owner's representative. Test and verify exit lights and emergency lighting operations under emergency conditions. Submit letter of certification copy to the Consultant stating that the systems have been tested, witnessed by the Consultant or the Owner's representative, etc., and the methods of installation and performance are satisfactory to all parties.
 - .6 All exit lights must be installed and operational.
 - .3 Electronic Safety and Security
 - .1 Fire alarm system and devices must be operational. Submit fire alarm verification report per CAN/ULC-S537, and submit audibility test. Indicate tap settings of all signalling devices.
 - .2 Functional testing of the fire alarm system and interconnected systems per CAN/ULC-S1001 must be completed.

- .3 If any of the above items have not been completed at the time of Consultant's Inspection, and the letter of "assurance of professional field review and compliance" cannot be issued, any costs for subsequent Inspections will be charged to the Contractor.

1.27 Closeout Submittals

- .1 Refer to Section 01 78 00.
- .2 Project Record Documents
 - .1 Provide extra sets of white prints on which to make, as the job progresses, all approved changes and deviations from the original drawings. Complete as-built drawings accurately marked up in red ink must be submitted for review by the Consultant before the contract is considered to be completed.
 - .2 Changes and deviations include those made by addenda, change orders, and supplemental instructions, and changes and deviations to be marked on the white print record drawings indicated on supplemental drawings issued with addenda, change orders, and supplemental instructions. Maintain the "as-built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.
 - .3 Upon substantial completion of the work, obtain a set of reproducible white prints of the drawings and neatly amend the print in accordance with the marked-up white prints to produce a true "as-built" set of drawings.
 - .4 As-built drawings are to indicate all circuiting as installed and all distribution junction box locations as well as conduit routes.
 - .5 As-Built AutoCAD drawings
 - .1 Submit completed Document 00 64 01 to the Consultant for release of the Consultant's AutoCAD files.
 - .2 Transfer the information from the "as-built" white prints to the files, and submit to the Consultant for review.
 - .3 Employ a competent computer draftsman to indicate changes on the electronic set of as-built drawings. Provide drawings in PDF and AutoCAD formats.
 - .4 Submit three (3) USB flash drives including as-built drawings in AutoCAD format, one with each O&M manual.
 - .5 Provide three (3) sets of full size as-built drawings in hard copy format, one with each O&M manual.
 - .6 As-built Single Line Diagram
 - .1 Provide in Main Electrical Room one wall mounted copy of as-built Single Line Diagram on 6 mm (1/4 in) foam board.
 - .2 As-built Single Line Diagram to indicate manufacturer name and catalogue numbers of as-installed products.
- .3 Operations and Maintenance (O&M) Data
 - .1 Submit two complete sets of Operation and Maintenance instruction manuals in hard copy, and one in electronic format. Include in each copy of the manual:

- .1 Verification certificates for installation of life safety systems by the manufacturer's representative.
- .2 A copy of "reviewed" shop drawings.
- .3 Complete explanation of operating principles and sequences.
- .4 Recommended maintenance practices and precautions.
- .5 Complete wiring and connection diagrams.
- .6 Certificates of guarantees.
- .2 Ensure that operating and maintenance instructions are specific and apply to the model and types of equipment provided.
- .3 Include attendance records for each training session in the O&M manual.
- .4 Warranty documentation.

1.28 Warranty

- .1 Submit a written guarantee to the Owner for one year from the date of acceptance. This guarantee shall bind the contractor to correct, replace or repair promptly any defective equipment workmanship without cost to the Owner.
- .2 All equipment, materials and workmanship shall be unconditionally guaranteed for a minimum period of one year from the date of acceptance.
- .3 Provide warranty certificates, wherever given or required, in excess of the normal warranty period showing the name of the firm giving the warranty, dated and acknowledged, on specific equipment and systems.
- .4 Warranties for temperature controls and building automation systems will start on the date of verification of acceptance by the Consultant.
- .5 Include these certificates with the maintenance and operating manuals in the appropriate sections.

2 Products – Not Used

3 Execution

3.01 Concrete Work

- .1 Refer to Division 03 – Concrete, and Section 26 05 29.
- .2 Provide all concrete work required for the electrical work. Reinstall surfacing as per architectural requirements.
- .3 Provide a 100 mm (4 in) high concrete housekeeping pad for floor mounted electrical distribution equipment, such as the following:
 - .1 Transformers.
 - .2 Switchgear and switchboards.
 - .3 Distribution panelboards.

- .4 Engine Generators.
- .5 Uninterruptible Power Supplies and batteries.
- .6 Transfer Switches.

3.02 Lintels

- .1 Refer to Division 04 – Masonry.
- .2 Lintels for openings in masonry shall conform with requirements of by-laws, and as approved by the Structural Engineer.
- .3 Pay all costs for lintels over openings, required solely by the electrical trades, not shown on architectural or structural drawings.

3.03 Metals

- .1 Refer to Division 05 – Metals.
- .2 Steel construction required solely for the work of this trade, and not shown on architectural or structural drawings shall be provided by this Division to the requirements of Division 05.

3.04 Flashing and Sheet Metal

- .1 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.
- .2 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.

3.05 Firestopping

- .1 Provide firestopping in accordance with Section 07 85 00 and Section 26 05 44.13.
- .2 Ensure that fire ratings of floors and walls are maintained.
- .3 Provide ULC classified firestopping products by 3M, Hilti, STI, or approved equal which have been tested in accordance with CAN/ULC-S115.
- .4 Pack clearance spaces, fill all spaces between openings, pipes and ducts passing through fire separations and install firestopping systems in accordance with the appropriate ULC system number for the products and type of penetration.
- .5 Install firestopping systems using personnel trained or instructed by the product manufacturer.

3.06 Access Doors

- .1 Provide access doors in accordance with Section 08 31 00.
- .2 Before commencing installation of work, coordinate with other trades and prepare on a set of reflected ceiling plans and wall elevations, complete layouts of access doors. Submit these layouts for Consultant's review and show exact sizes and locations of such access doors. Locate and arrange the work to suit.
- .3 Group conduit work to ensure the minimum number of access doors is required.
- .4 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

3.07 Painting and Finishes

- .1 Refer to Section 09 91 00.
- .2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .3 Repair and finish factory finished equipment, damaged, or scratched during installation, in an approved manner.
- .4 All structural steel including hangers, brackets, supports and other ferrous metals shall be shop or factory prime painted wherever practicable. Wherever structural steel including hangers, brackets, supports, and other ferrous metals cannot be shop or factory prime painted, wire brush to remove all traces of rust, clean of all traces of dirt, oil, and grease, and apply one coat of an approved rust inhibiting primer in accordance with CGSB-GB-40d, and leave ready to receive finish paint.
- .5 Primary and final painting for Work, other than items specified as factory primed or finished, will be performed as described in Division 09 – Finishes.
- .6 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps etc., to have galvanized finish or paint finish over corrosion-resistant primer.
- .7 All panelboards, motor starters etc., to be factory finished with baked on enamel. All enamel to be baked on gloss over corrosion resistant primer.
- .8 Touch up minor damage to finish on factory finished equipment. Items suffering major damage to finish shall be replaced at the direction of the Consultant.
- .9 Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.
- .10 Provide all exposed ferrous metal work on equipment with at least one factory prime coat, or paint one prime coat on job. Clean up or wire brush all equipment, etc., before painting.
- .11 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.08 Location of Outlets

- .1 Refer to Architectural drawings for dimensions denoting exact locations.
- .2 The Consultant reserves the right to change the location of outlets to within 3 m from the point indicated on the plans without extra charge providing the Contractor is advised before installation is made.
- .3 Location of lighting, convenience, telephone, power, and communication outlets shall be subject to change, without extra cost to Owners, provided information is given prior to installation. No extra amount will be paid for extra labour and materials for relocating outlets up to 3000 mm from their original location nor will credits be anticipated where relocation up to 3000 mm reduces materials and labour. Other cases will be considered on their individual merits.
- .4 Coordinate location of boxes with latest architectural drawings and instructions to suit door swings, millwork etc. prior to rough-in.

3.09 Mounting Heights and Device Locations

- .1 Refer to architectural drawings for exact location of electrical equipment and devices.

- .2 Architectural elevations take precedence over electrical elevations. If there are conflicts between architectural and electrical, adjust locations of electrical equipment at no additional cost to the Owner.
- .3 Prior to roughing-in, the contractor is to mark locations of electrical equipment and devices for conflicts with architectural, studs, etc. If conflicts are noted, inform the Consultant for a decision prior to commencing the rough-in.
- .4 Mounting heights of equipment and devices listed below is from finished floor to centreline of equipment, unless specified or indicated otherwise.
- .5 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .6 Install electrical equipment at following heights above finished floor (AFF). Dimensions are to centre of device unless indicated otherwise.
 - .1 Power door operator push buttons: 1000 mm.
 - .2 HVAC thermostats and manual HVAC controls: 1200 mm.
 - .3 Local switches, and manual lighting control devices:
 - .1 1100 mm.
 - .2 Locate on lock side of door.
 - .4 System furniture service fittings: to suit furniture layout.
 - .5 Wall receptacles:
 - .1 General: min. 400 mm AFF.
 - .2 Above top of counters: 175 mm.
 - .3 Above top of continuous baseboard heater, or mechanical heating/radiation units: 75 mm to bottom of device.
 - .4 In fan rooms, mechanical rooms, and electrical rooms: 1100 mm.
 - .5 For electric ranges: 130 mm.
 - .6 Outlets in raceways or millwork to be located as per Architectural details.
 - .7 Door bell pushbuttons: 1100 mm.
 - .8 Panelboards: as indicated in Section 26 24 16.
 - .9 Emergency lighting remote heads: 300 mm below finished ceiling, or 2400 mm AFF for exposed areas or areas with ceiling height above 2750 mm (9 ft).
 - .10 Communications:
 - .1 Typical communication outlets (voice and data): 400 mm.
 - .2 Communications outlets for wall mounted telephones, intercom, or similar: 1100 mm.
 - .3 Television outlets: 200 mm below finished ceiling.
 - .4 Wall mounted public address speakers: 2100 mm.

- .5 Clocks: 2100 mm.
- .11 Access control card readers and keypads: 900 mm.
- .12 Fire alarm manual stations: 1100 mm.
- .13 Wall mounted fire alarm audible devices, including bells or horns:
 - .1 2300 mm to the top of the device in areas of ceiling height 2450 mm or greater.
 - .2 150 mm below the finished ceiling for ceiling heights less than 2450 mm, measured to the top of the device.
- .14 Wall mounted fire alarm visible signal devices, including strobes: 2300 mm.
- .15 Fire Alarm emergency telephones: 1400 mm.

3.10 Manufacturer's Instructions

- .1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.
- .2 Follow manufacturer's instructions where they cover points not specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.11 Tests and Acceptance

- .1 The operation of the equipment and electrical system does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfills the requirements of the drawings and the specifications.
- .2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.
- .3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition, with raceway and conduit systems properly grounded, wiring free from grounds, shorts, and that the entire installation is free from any physical defects.
- .4 Provide labour and material to conduct the integrated systems testing of interconnected life safety systems in accordance with CAN/ULC-S1001-11, and provide written report for Consultant's review. Ensure all required trade contractors are present on site as directed by the Integrated Testing Coordinator during the CAN/ULC-S1001 functional testing. Refer to Section 01⁹¹26.13.

3.12 Closeout Activities

- .1 Refer to Section 01 77 00 and 01 78 00.
- .2 In the presence of the Owner, demonstrate the proper operation of all systems.
- .3 Instruct the Owner's designated representatives in all aspects of the operation and maintenance of systems and equipment listed in the trade sections governed by this Section. Obtain in writing from the Consultant a list of the Owner's representatives qualified to receive instructions.

- .4 Arrange for and pay for the services of qualified service technicians and other manufacturer's representatives required for instruction of specialized portions of the installation.

End of Section

1 General

1.01 Section Includes

- .1 Work in existing facilities.
- .2 Electrical demolition.

1.02 Related Requirements

- .1 Section 02 41 19 – Selective Demolition.

1.03 Scheduling

- .1 Refer to Section 01 14 00, and Section 01 73 00.
- .2 All work in the existing building, other than minor works required to permit construction of the new Work, is to be performed in such a manner as to not disrupt the building operations.
- .3 All systems are to be kept in full operation during normal building hours.
- .4 Coordinate any noise generating works that disrupt the building operation to be carried out after/before normal operating hours.

2 Products

2.01 Materials

- .1 Materials and equipment for patching and extending work: As specified in individual sections.

3 Execution

3.01 Examination

- .1 Verification of Conditions
 - .1 Verify field measurements and circuiting arrangements are as shown on Drawings.
 - .2 Verify that abandoned wiring and equipment serve only abandoned facilities.
 - .3 Demolition drawings are based on visual field observations and conditions derived from existing drawings, and do not assess the interiors of electrical equipment. Report discrepancies to the Consultant before disturbing existing installation.
 - .4 Beginning of demolition means installer accepts existing conditions.
- .2 Tracing Existing Electrical Circuits
 - .1 Trace all circuits in the area of work listed as existing, and verify existing conditions prior to any modifications as indicated.
 - .2 Where drawings indicate “connect to existing circuit”, use a spare breaker, where available. Otherwise, verify existing load with a meter and advise the Consultant if the additional load will cause a circuit to trip.

- .3 Where provided panelboard schedules indicate "Existing Circuit" or similar, provide the correct description for the circuit. Existing Circuit will not be acceptable in the final panelboard schedules submitted as part of closeout submittals.
- .3 Existing Cabling in Return Air Plenums
 - .1 In ceilings being used as a return air-plenum, Contractor to review existing low-voltage cabling uncovered as part of the work.
 - .2 Immediately notify the Consultant if any cables identified are not plenum rated (i.e. CMP, or FT6 rated).
- .4 Existing feeders to remain.
 - .1 Where the drawings call for the re-use of existing feeders and re-connection to new equipment, (such as when equipment is replaced like-for-like), confirm the size and quantity of conductors of the existing feeder, and provide lug kits on new equipment suitable for the existing feeder.

3.02 Preparation

- .1 Coordinate utility service outages with utility company.
- .2 Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- .3 Existing electrical service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switch overs and connections. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- .4 Existing Telephone System: Maintain existing system in service. Notify Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area.
- .5 Existing Fire Alarm System: Maintain existing system in service. Minimize outage duration. Provide fire watch as required. Make temporary connections to maintain service in areas adjacent to work area.

3.03 Demolition

- .1 Disconnect electrical systems in walls, floors, and ceilings scheduled for removal.
- .2 Demolish and extend existing electrical work to Section 02 41 19, and this Section.
- .3 Remove, relocate, and extend existing installations to accommodate new construction.
- .4 Remove abandoned wiring to source of supply.
- .5 When relocating or removing equipment, should any circuits be abandoned, the conductors to these circuits must be removed or properly terminated as detailed in Ontario Electrical Safety Code (OESC) bulletin 12-25-6, or latest revision.
- .6 Provide knockout fillers when removing circuits from any panelboard or splitter.
- .7 Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- .8 Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

- .9 Disconnect and remove abandoned panelboards and distribution equipment.
- .10 Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- .11 Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- .12 Repair adjacent construction and finishes damaged during demolition and extension work.
- .13 Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.
- .14 Maintain continuity of existing services for other circuits/devices serving areas outside the Work area. Provide additional wiring/conduits/boxes etc. to suit existing services to be maintained, and also implement new Work as detailed.

3.04 Restoration

- .1 Install relocated materials and equipment under the provisions of Division 01.

3.05 Cleaning

- .1 Clean and repair existing materials and equipment which remain or are to be reused.
- .2 Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.
- .3 Waste Management
 - .1 Turn over designated equipment to the Owner.
 - .2 Dispose of unwanted materials and equipment.

3.06 Protection

- .1 Maintain access to existing electrical installations which remain active. Modify installation or provide access panels as appropriate.

End of Section

1 General

1.01 Section Includes

- .1 Building wire and cable.
 - .1 Armoured cable.
 - .2 Metal clad cable.
 - .3 Fire resistive cables.
 - .4 Wiring connectors and connections.
- .2 Permitted voltage drop for feeder and branch circuits.

1.02 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 0.3:09 (R2023), Test methods for electrical wires and cables.
 - .4 CSA C22.2 No. 48:15 (R2020), Nonmetallic sheathed cable.
 - .5 CSA C22.2 No. 51:20, Armoured cables.
 - .6 CSA C22.2 No. 52:17 (R2022), Underground secondary and service-entrance cables.
 - .7 CSA C22.2 No. 65-18 (R2022), Wire connectors.
 - .8 CSA C22.2 No. 75:17 (R2022), Thermoplastic insulated wires and cables.
 - .9 CSA C22.2 No. 123:16 (R2021), Aluminum sheathed cables.
 - .10 CSA C22.2 No. 131:17 (R2022)14, Type TECK 90 cable.
- .2 NECA (National Electrical Contractors Association) - Standard of Installation.
- .3 NETA (International Electrical Testing Association) - ATS-2021 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .4 CAN/ULC-S139:2017 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.

1.03 Coordination

- .1 Where wire and cable destination is indicated, and routing is not shown, determine exact routing and lengths required.

1.04 Closeout Submittals

- .1 Record Documents: Indicate as-constructed feeder sizes on single line diagram.
- .2 Megger test results.

- .3 Fire resistive cables: manufacturer's certification that the cables have been installed in accordance with the manufacturer's instructions.

1.05 Qualifications

- .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

2 Products

2.01 Manufacturers

- .1 American Wire Group.
- .2 BICC Phillips.
- .3 General Cable.
- .4 Nexans.
- .5 Prysmian.
- .6 Southwire.

2.02 Regulatory Requirements

- .1 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

2.03 Conductor Material

- .1 Submit bid based on copper conductors only.
- .2 Aluminum: Not permitted.

2.04 Building Wire

- .1 RW90:
 - .1 Single copper conductor.
 - .2 Minimum 12 AWG for branch circuit wiring.
 - .3 Minimum 14 AWG for 120 V control wiring.
 - .4 Chemically cross-linked polyethylene insulation.
 - .5 Rated for 90°C, 600 V.
 - .6 Suitable for handling to -40°C.
 - .7 For interior installations in conduit.
- .2 RWU90:
 - .1 Single copper conductor.
 - .2 Minimum 12 AWG for branch circuit wiring.

- .3 Minimum 14 AWG for 120 V control wiring.
- .4 Chemically cross-linked polyethylene insulation.
- .5 Rated for 90°C, 1000 V.
- .6 Suitable for handling to -40°C.
- .7 For exterior installations, direct buried, or in conduit.
- .3 T90 Nylon:
 - .1 Single copper conductor.
 - .2 Thin wall PVC insulation with nylon covering.
 - .3 Rated for 90°C, 600 V.
 - .4 May be used up to size 10 AWG for interior installations.
 - .5 Base conduit fill on RW90 cable diameters.

2.05 Armoured Cable

- .1 General
 - .1 Connectors: standard as required, complete with anti-short rings.
 - .2 Runs to be limited to fixture drops, and runs to devices in walls and partitions, maximum horizontal runs in exposed areas and ceiling spaces to be 1.8 m (6 ft).
 - .3 Do not daisy chain (leap frog) luminaires with armoured cable.
- .2 Type AC:
 - .1 Two, three or four copper conductors rated RW90, 1000 V.
 - .2 Bare copper ground wire.
 - .3 Insulation Voltage Rating: 600 V.
 - .4 Insulation Temperature Rating: 90°C (194°F).
 - .5 Insulation Material: Thermoplastic.
 - .6 Overall interlocked aluminum tape armour.
- .3 Type SPC90:
 - .1 Use for LED lighting, fluorescent dimming controls, and other SMART building applications.
 - .2 Colour coded cable with power, control, and signal under one cable.
 - .3 12-2C Power with a 16-2C Control.
 - .4 Bare copper ground wire.
 - .5 Insulation Voltage Rating: 600 V.
 - .6 Insulation Temperature Rating: 90°C (194°F).

- .7 Insulation Material: Thermoplastic.

2.06 Fire Resistive Cables

- .1 General:
 - .1 2 hour fire rating to CAN/ULC-S139 and to meet 2024 Ontario Building Code rule 3.2.7.10.
 - .2 Alternative means of compliance:
 - .1 Conduits encased in a minimum of 50 mm (2 in) of concrete.
 - .2 Be protected by a fire rated assembly listed to achieve the minimum fire rating as indicated.
- .2 Manufacturers:
 - .1 nVent Pyrotenax 1850 series Mineral Insulated (MI) cable.
 - .2 VITALink MC Brand Type MC-RC90, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code 'FHIT7' or 'FHJR7', dated 19 May 2015). This cable is not to be installed in conduit.
 - .1 Request quotation from manufacturer or manufacturer's representative for field certification of installed Vitalink cables prior to requesting Consultant's construction field review.
 - .2 Power cable must be installed according to UL protocol FHIT7.120 – Electrical circuit integrity systems certified in Canada.
 - .3 Prysmian Lifeline RC90 cable.
 - .1 Installation in accordance with UL protocol FHIT7-51, and FHIT7-51A.
 - .2 System makes use of Remke connectors and Resolve boxes, with no substitutions.
- .3 Substitution Limitations:
 - .1 Substitutions may only be considered by the Consultant if the product is listed by ULC under ULC Category Codes 'FHIT7' or 'FHJR7'.

2.07 TECK90 Cable

- .1 Single, three, or four conductors as indicated on drawings.
- .2 Cable to CSA C22.2 No. 131.
- .3 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .4 Insulation: Cross-linked polyethylene (XLPE), type RW90, rating: 600 V.
- .5 Inner jacket: polyvinyl chloride.
- .6 Armour: interlocking aluminum.

- .7 Overall covering: thermoplastic.
- .8 Fastenings:
 - .1 One-hole steel straps to secure surface cables 50 mm diameter and smaller. Two-hole steel straps for cables larger than 50 mm diameter.
 - .2 Channel type supports for two or more cables at 1500 mm centres.
 - .3 Threaded rods: 6 mm diameter to support suspended channels.
- .9 Connectors: Watertight, approved for TECK cable.

2.08 Conductor Pulling Lubricant

- .1 Where pulling lubricant is required, use non-wax based cable lubricants compatible with cable manufacturer recommendations, such as American Polywater.

2.09 Connectors

- .1 Armoured cable connectors must be proper squeeze type connectors and plastic anti-short bushings at terminations.
- .2 Connectors for conductors connecting to devices as per local governing electrical requirements to be equal to IDI Electric (Canada) Ltd., "Ideal" No. 451, No. 452, and No. 453, "Wing-Nut", CSA certified, 600 V, rated pressure type connectors.
- .3 For conductors sized 3/0 AWG and greater, provide long barrel double crimp, two (2) hole compression type lug connectors, unless otherwise noted.

2.10 Wiring Termination

- .1 Lugs, terminals, or screws used for termination of wiring to be suitable for copper conductors. Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring. Maintain phase sequence and colour coding throughout.
- .2 Splice wire, up to and including 6 AWG, with nylon insulated expandable spring type connectors.
 - .1 Thomas & Betts – Marr Max series.
- .3 Splice large conductors using compression type connections insulated with heat shrink sleeves.
 - .1 Thomas & Betts – 5400 Series lugs & heat shrink type #s series.

3 Execution

3.01 Examination

- .1 Verify that field measurements are as indicated.
- .2 Wire and cable routing indicated is approximate unless dimensioned.
- .3 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.
- .4 Voltage Drop

- .1 Ensure voltage drop in power and control conductors is in accordance with the requirements of the OESC.
- .2 Size conductors accordingly when sizes are not identified.
 - .1 Feeder conductors: maximum voltage drop of 2%.
 - .2 Branch circuit conductors: maximum voltage drop of 3%.
- .5 Verify that mechanical work likely to damage wire and cable has been completed.
- .6 Verify that raceway installation is complete and supported.

3.02 Preparation

- .1 Completely and thoroughly swab raceway before installing wire.

3.03 Installation

- .1 Route wire and cable as required to meet project conditions.
- .2 Install cable to CSA C22.1 and per manufacturer's installation guidelines.
- .3 Conduit and cable supports:
 - .1 All wiring to be installed in EMT at all exposed areas unless otherwise specified.
 - .2 All mechanical equipment to be connected with liquid tight flexible conduit.
 - .3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.
- .4 Conductors
 - .1 Provide separate neutral for each circuit. Common neutrals not permitted.
 - .2 Use solid conductor for feeders and branch circuits 10 AWG and smaller.
 - .3 Use stranded conductors for control circuits.
 - .4 Use conductor not smaller than 12 AWG for power and lighting circuits.
 - .5 Use conductor not smaller than 16 AWG for control circuits.
 - .6 Use 10 AWG conductors for 20 A, 120 V branch circuits longer than 25 m.
- .5 Pulling conductors
 - .1 Pull all conductors into raceway at same time.
 - .2 Use suitable wire pulling lubricant for building wire 4 AWG and larger.
 - .3 Neatly train and lace wiring inside boxes, equipment, and panelboards.
 - .4 Protect exposed cable from damage.
- .6 Connectors
 - .1 Use suitable cable fittings and connectors.

- .2 Clean conductor surfaces before installing lugs and connectors.
- .3 Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- .4 Use split bolt connectors for copper conductor splices and taps 6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 per cent of insulation rating of conductor.
- .5 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
- .6 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- .7 Identification
 - .1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
 - .2 Where colour-coded tape is utilized, apply a minimum of 50 mm (2 in) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.
 - .3 Utilize colour coding on bussing in panels and, switchgear, disconnects, and metering cabinets to match conductor colour coding.

3.04 Conductors, Wires, and Cables

- .1 Provide fire rated conductors or provide a fire rated assembly around conductors used for life safety applications as described in 2012 OBC 3.2.7.10.
- .2 Indoor wiring installed in conduit, unless otherwise noted: 600 V "RW90 XLPE".
- .3 Wiring in channel back of fluorescent and LED lighting fixtures: 600 V type GTF or TEW.
- .4 Lighting and power branch circuit wiring:
 - .1 Copper, minimum 12 AWG.
 - .2 Home runs to lighting and receptacle panels, which exceed 22 m (75 ft) in length: minimum 10 AWG.
- .5 Size wires for 2 per cent maximum voltage drop to farthest outlet on a maximum 80% loaded circuit.
- .6 Outdoor wiring: "RWU90 XLPE".
- .7 Conductors shall be colour coded. Conductors 10 AWG and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size 8 AWG and larger may be colour coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible.
- .8 Colour coding as follows:
 - .1 Phase "A" – Red.
 - .2 Phase "B" – Black.
 - .3 Phase "C" – Blue.

- .4 Control – Orange.
- .5 Ground – Green.
- .6 Neutral – White.
- .9 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

3.05 Site Tests and Inspections

- .1 Perform continuity tests of all feeders, motor circuits, and branch circuits.
- .2 Perform insulation-resistance test (megger test) on each feeder. Submit report to the Consultant.

End of Section

1 General

1.01 Section Includes

- .1 Low-voltage control cabling.
- .2 Control-circuit conductors.

1.02 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 0.3:09 (R2023), Test methods for electrical wires and cables.
 - .4 CSA C22.2 No. 48:15 (R2020), Nonmetallic sheathed cable.
 - .5 CSA C22.2 No. 51:2014, Armoured cables.
 - .6 CAN/CSA C22.2 No. 65-18 (R2022), Wire connectors (Trinational standard with NMX-J-543-ANCE and UL 486A-486B).
 - .7 CSA C22.2 No. 75:17 (R2022), Thermoplastic insulated wires and cables.
 - .8 CSA C22.2 No. 208:18 (R2023), Fire alarm and signal cable.
- .2 NECA (National Electrical Contractors Association) – Standard of Installation.

1.03 Qualifications

- .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.04 Coordination

- .1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

2 Products

2.01 Regulatory Requirements

- .1 Conform to CSA C22.1.
- .2 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

2.02 Low Voltage Wiring

- .1 LVT:
 - .1 Multi conductor PVC insulated.
 - .2 Bare copper ground conductor.
 - .3 Overall PVC jacket.

- .4 Rated 30 V.
- .5 CMP (FT6) rated if cable is exposed.
- .6 CMR (FT4) rated if cable is installed in conduit.
- .2 Category 5e Network Cabling.
 - .1 CMP (FT6) rated if cable is exposed.
 - .2 CMR (FT4) rated if cable is installed in conduit.

2.03 Terminations and Splices

- .1 All terminations and splices shall be of an approved type for the conductors being used.
- .2 Where conductors are terminated or spliced, it shall be done in the following manner:
 - .1 Where a single solid conductor is terminated in a device under one screw or clamping mechanism, no additional terminating hardware is required.
 - .2 Where multiple or stranded conductors are terminated in a device under one screw or clamping mechanism, self insulated crimp-on cable ends or approved equal shall be used up to and including 10 AWG sized conductors. Approved compression lugs shall be used for larger conductor sizes.
 - .3 Where multiple conductors are spliced, properly sized Wing Nut connectors, or approved equal, shall be used for up to two 8 AWG or three 10 AWG conductors. Pressure type sleeve cable connectors, splices, tee's, etc., shall be used for all larger size connections and terminations.
 - .4 Insulate all bare surfaces of splices with heat shrink sleeving or equivalent.
 - .5 Conductors connected to ground rods for service or equipment grounding or to building structural or architectural elements shall be terminated, connected, and spliced using a thermoweld process or approved non-mechanical compression type connectors.
- .3 Install all service and feeder conductors as continuous lengths without breaks, measured and cut based on site dimensions.

3 Execution

3.01 Examination

- .1 Verify that mechanical work likely to damage wire and cable has been completed.
- .2 Verify that raceway installation is complete and supported.
- .3 Verify that field measurements are as indicated.
- .4 Wire and cable routing indicated is approximate unless dimensioned.

3.02 Preparation

- .1 Completely and thoroughly swab raceway before installing wire.

3.03 Installation

- .1 Route control cabling as required to meet project conditions.

- .2 Install cable to the CSA C22.1.
- .3 Conduit and supports
 - .1 All wiring to be installed in EMT at all exposed areas and in partitions unless otherwise specified.
 - .2 All mechanical equipment to be connected with liquid tight flexible conduit.
 - .3 Support cables above accessible ceiling, using spring metal clips to support cables from structure. Do not rest cable on ceiling panels.
- .4 Conductors
 - .1 Use stranded conductors for control circuits.
 - .2 Use conductor not smaller than 16 AWG for control circuits.
- .5 Pulling conductors
 - .1 Pull all conductors into raceway at same time.
 - .2 Neatly train and lace wiring inside boxes, equipment, and panelboards.
 - .3 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.
 - .4 Protect exposed cable from damage.
- .6 Connectors
 - .1 Use suitable cable fittings and connectors.
 - .2 Clean conductor surfaces before installing lugs and connectors.
 - .3 Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and smaller.
 - .4 Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- .7 Identification
 - .1 Identify and colour code wire and cable to Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
 - .2 Where colour coded tape is utilized, apply a minimum of 50 mm (2 in) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

End of Section

1 General

1.01 Section Includes

- .1 Grounding electrodes and conductors.
- .2 Equipment grounding conductors.
- .3 Bonding.
- .4 The terms “connect” and “bond” are used interchangeably in this Specification and have the same meaning.

1.02 Related Requirements

- .1 Section 27 05 26 – Grounding and Bonding for Communications Systems.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 0.4:17 (R2022), Bonding of electrical equipment.
 - .4 CSA C22.2 No. 41:22, Grounding and bonding equipment (Trinational standard with NMX-J-590-ANCE and UL 467).
 - .5 CSA C22.2 No. 75:17 (R2022), Thermoplastic insulated wires and cables.
- .2 ANSI/TIA/EIA J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .3 Institute of Electrical and Electronics Engineers, Inc.
 - .1 IEEE 81-2012 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
- .4 InterNational Electrical Testing Association (NETA):
 - .1 NETA ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.04 Action Submittals

- .1 Product Data: Provide for grounding electrodes and connections.

1.05 Informational Submittals

- .1 Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- .2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 Closeout Submittals

- .1 Project Record Documents: Record actual locations of components and grounding electrodes.
- .2 Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.07 Qualifications

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' experience.

1.08 Regulatory Requirements

- .1 Products: Listed and classified testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.01 Manufacturers

- .1 B-Line by Eaton.
- .2 Hubbell (Burdny).
- .3 Panduit.
- .4 Thomas & Betts.

2.02 Performance Criteria

- .1 Grounding System Resistance: 5 ohms.
- .2 Provide all equipment grounding as required regardless of whether it has been shown on drawings or called for in this specification. Arrange grounds so that under normal operating conditions no injurious amount of current will flow in any grounding conductor.

2.03 Grounding and Bonding Conductors

- .1 Electrical grounding conductors shall be CSA C22.2 No. 75 insulated stranded copper, except that sizes 10 AWG and smaller shall be solid copper. Insulation colour shall be continuous green for all equipment grounding conductors.
- .2 Bonding conductors shall be ASTM B8 bare stranded copper, except that sizes 10 AWG and smaller shall be ASTM B1 solid bare copper wire.

2.04 Rod Electrodes

- .1 Material: Copper-clad steel.
- .2 Diameter: 19 mm.
- .3 Length: 3000 mm.

2.05 Ground Rods

- .1 Copper clad steel, 19 mm (3/4 in) diameter by 3000 mm (10 ft) long, conforming to CSA C22.2 No. 41.
- .2 Quantity of rods shall be as required to obtain the specified ground resistance.

2.06 Splices and Termination Components

- .1 Components shall meet or exceed CSA C22.2 No. 41, and be clearly marked with the manufacturer, catalog number, and permitted conductor size(s).

2.07 Ground Connections

- .1 Below Grade: Exothermic-welded type connectors.
- .2 Above Grade:
 - .1 Bonding Jumpers: compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 - .2 Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

2.08 Ground Terminal Blocks

- .1 At any equipment mounting location (e.g. backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted, provide screw lug-type terminal blocks.

2.09 Splice Case Ground Accessories

- .1 Splice case grounding and bonding accessories shall be supplied by the splice case manufacturer when available. Otherwise, use 6 AWG insulated ground wire with shield bonding connectors.

2.10 Mechanical Connectors

- .1 Material: Bronze.

2.11 Wire

- .1 Material: Stranded copper.
- .2 Foundation Electrodes: 2/0 AWG.
- .3 Grounding Electrode Conductor: Size to meet Ontario Electrical Safety Code requirements.

2.12 Grounding Well Components

- .1 Well Pipe: 200 mm by 600 mm long concrete pipe with belled end.
- .2 Well Cover: Cast iron with legend "GROUND" embossed on cover.

3 Execution

3.01 Examination

- .1 Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 Installation

- .1 General
 - .1 Ground in accordance with the Ontario Electrical Safety Code, as shown on drawings, and as hereinafter specified.

- .2 System Grounding:
 - .1 Secondary service neutrals: Ground at the supply side of the secondary disconnecting means and at the related transformers.
 - .2 Separately derived systems (transformers downstream from the service entrance): Ground the secondary neutral.
- .3 Equipment Grounding: Metallic structures (including ductwork and building steel), enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity with electrical circuits shall be bonded and grounded.
- .4 Ground electrical equipment and wiring in accordance with Ontario Electrical Safety Code and Local Inspection Authority's Rules and Regulations.
- .5 Install grounding conductors, outside Electric Rooms and Electrical Closets in conduit and conceal where possible. Make connections to water mains, all metallic piping systems, neutral and equipment with brass, copper or bronze bolts and connectors or weld using Cadweld or Thermoweld processes.
- .6 Provide grounding conductors, sized as per Code, and connect to grounding bus or water main wherever non-raceways are installed.
- .2 Provide grounding electrode conductor and connect to reinforcing steel in foundation footing. Bond steel together.
- .3 Provide bonding to meet Regulatory Requirements.
- .4 Bond together metal siding not attached to grounded structure; bond to ground.
- .5 Install ground grid under access floors indicated.
- .6 Bond together each metallic raceway, pipe, duct, and other metal object entering space under access floors. Bond to underfloor ground grid. Use 6 AWG bare copper conductor.
- .7 Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- .8 Ground Resistance
 - .1 Grounding system resistance to ground not to exceed 5 ohms. Make necessary modifications or additions to the grounding electrode system for compliance without additional cost to the Owner. Final tests shall assure that this requirement is met.
 - .2 Resistance of the grounding electrode system shall be measured using a four-terminal fall-of-potential method as defined in IEEE 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.
 - .3 Services at power company interface points shall comply with the power company ground resistance requirements.
- .9 Ground Rod Installation
 - .1 Drive each rod vertically in the earth, not less than 3000 mm (10 ft) in depth.

- .2 Where permanently concealed ground connections are required, make the connections by the exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.
- .3 Where rock prevents the driving of vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve the specified resistance.
- .10 Inaccessible Grounding Connections
 - .1 Make grounding connections, which are buried or otherwise normally inaccessible (except connections for which periodic testing access is required) by exothermic weld.
- .11 Secondary Equipment and Circuits
 - .1 Main Bonding Jumper: Bond the secondary service neutral to the ground bus in the service equipment.
 - .2 Metallic Piping, Building Steel, and Supplemental Electrode(s):
 - .1 Provide a grounding electrode conductor sized per code between the service equipment ground bus and all metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in the metallic piping. All connections to electrodes shall be made with fittings that conform to CSA C22.2 No. 41.
 - .2 Provide a supplemental ground electrode and bond to the grounding electrode system.
 - .3 Conduit Systems:
 - .1 Ground all metallic conduit systems. All metallic conduit systems shall contain an equipment grounding conductor.
 - .2 Non-metallic conduit systems shall contain an equipment grounding conductor, except that non-metallic feeder conduits which carry a grounded conductor from exterior transformers to interior or building-mounted service entrance equipment need not contain an equipment grounding conductor.
 - .3 Conduit containing only a grounding conductor, and which is provided for mechanical protection of the conductor, shall be bonded to that conductor at the entrance and exit from the conduit.
 - .4 Feeders and Branch Circuits: Install equipment grounding conductors with all feeders and power and lighting branch circuits.
 - .5 Boxes, Cabinets, Enclosures, and Panelboards:
 - .1 Bond the equipment grounding conductor to each pull box, junction box, outlet box, device box, cabinets, and other enclosures through which the conductor passes (except for special grounding systems for intensive care units and other critical units shown).
 - .2 Provide lugs in each box and enclosure for equipment grounding conductor termination.
 - .3 Provide ground bars in panelboards, bolted to the housing, with sufficient lugs to terminate the equipment grounding conductors.
 - .6 Receptacles shall not be grounded through their mounting screws. Ground with a jumper from the receptacle green ground terminal to the device box ground screw and the branch circuit equipment grounding conductor.

- .7 Raised Floors: Provide bonding of all raised floor components.
- .12 Corrosion Inhibitors
 - .1 When making ground and ground bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- .13 Conductive Piping
 - .1 Bond all conductive piping systems, interior and exterior, to the building to the grounding electrode system. Bonding connections shall be made as close as practical to the equipment ground bus.

3.03 Field Quality Control

- .1 Perform inspections and tests listed in NETA ATS, Section 7.13.

End of Section

1 General

1.01 Section Includes

- .1 Conduit and equipment supports.
- .2 Anchors and fasteners.

1.02 References

- .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (29th edition/2024).
- .3 CECA – Canadian Electrical Contractors Association.

1.03 Action Submittals

- .1 Submit detail, sealed by Contractor retained structural engineer for struct channel support for stacked transformers.

1.04 Closeout Submittals

- .1 Submit the following in the Operation and Maintenance Manual for products used over the course of the project:
 - .1 Product Data: Provide manufacturer's catalogue data for fastening systems.
 - .2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.05 Regulatory Requirements

- .1 Provide products listed and classified by Canadian Standards as suitable for purpose specified and shown.

2 Products

2.01 Manufacturers

- .1 B-line by Eaton.
- .2 Burndy Canada Ltd. (Hubbell).
- .3 Erico Caddy.
- .4 E. Myatt & Co. Inc.
- .5 Hilti Canada.
- .6 Thomas & Betts.
- .7 Unistrut.

2.02 General

- .1 All supporting devices, strut channel, threaded rod, anchors, etc. to be used shall be of the “hot dipped” galvanized type. Electrogalvanized components will not be accepted.
- .2 Materials and Finishes: Provide adequate corrosion resistance.
- .3 Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
- .4 Anchors and Fasteners:
 - .1 Concrete Structural Elements: Use expansion anchor and preset inserts.
 - .2 Steel Structural Elements: Use beam clamps and welded fasteners.
 - .3 Concrete Surfaces: Use self-drilling anchors and expansion anchors.
 - .4 Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts and hollow wall fasteners.
 - .5 Solid Masonry Walls: Use expansion anchors and preset inserts.
 - .6 Sheet Metal: Use sheet metal screws.
 - .7 Wood Elements: Use wood screws.

2.03 Anchors and Hangers

- .1 Hangers for electrical conduit shall be galvanized after fabrication.
- .2 Perforated strapping: not permitted.

2.04 Inserts

- .1 Use only factory-made threaded or toggle type.
- .2 Where inserts cannot be placed, use factory-made expansion shields for light weights, where approved by the Consultant.
- .3 Do not use powder-activated tools except with the written permission of the Consultant.

2.05 Sleeves

- .1 Through interior walls, use standard weight steel pipes, conduit, or 18 gauge galvanized steel. Cut flush with finished surfaces. Check room finish schedules.
- .2 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.
- .3 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4 in) above finished floors, and cut flush with underside of floor.

2.06 Steel Channel

- .1 Description: Painted steel.

2.07 Supports

- .1 Steel supports in wet or dry locations to be galvanized after fabrication.
- .2 Where galvanized members are bolted together use cadmium plated bolts.
- .3 For hanger rods use minimum 10 mm (3/8 in) diameter steel threaded rod. Use clevis type attachment.
- .4 Provide minimum 100 mm (4 in) high concrete bases for all floor mounted equipment.

2.08 Supports and Bases

- .1 Submit proposed method of attachment of hangers and beam clamps, to cellular steel deck for approval before proceeding with Work.
- .2 Supply and erect special structural Work required for the installation of electrical equipment. Provide anchor bolts and other fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .3 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets.
- .4 Provide channel or other metal supports where necessary, to adequately support lighting fixtures. Do not use wood unless wood forms part of the building structure.
- .5 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members, required between beams for supporting conduits and cables.
- .6 Provide any additional supports required from existing concrete construction for any piping or equipment, by drilling same and installing expansion bolt cinch anchors.
- .7 Do not use explosive drive pins in any section of Work without obtaining prior approval.

2.09 Stacked Transformer Supports

- .1 Stacking of transformers is only allowed if all other options have been exhausted due to lack of space. Stacking is only applicable to floor mount applications and is not allowed for ceiling or wall mount configurations. Stacking shall comply with the following requirements:
 - .1 The transformer stacked on top is the same size or smaller than the transformer below.
 - .2 The OESC clearance requirements for each individual transformer is satisfied.
 - .3 The ambient temperature must not exceed 30°C.
- .2 Strut channel structure to support transformers shown on Drawings to be stacked above another transformer.
- .3 Provide sheet metal heat diversion shield between stacked transformers. Install shield at an angle as not to trap heat.

2.10 Concrete Bases and Housekeeping Pads

- .1 Provide concrete bases of dimensions where indicated, but not less than 100 mm (4 in) larger in both directions than supported unit, and 100 mm (4 in) high, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Chamfer edges.

- .2 Use 20 MPa (3000 psi) 28 day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 – Concrete.
- .3 Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 450 mm (18 in) centres around full perimeter of base.
- .4 Anchor equipment to concrete base.
- .5 Provide a housekeeping pad for floor mounted equipment, including but not limited to the following:
 - .1 Transformers.
 - .2 Switchgear and switchboards.
 - .3 Distribution panelboards.

2.11 Concrete Anchors

- .1 Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- .2 Drilled expansion anchors for anchors set in concrete block or poured concrete after the concrete has set. Size the insert and number of anchors so that the maximum load per anchor does not exceed the manufacturer's recommendation.
- .3 U-channel concrete inserts shall be 12 gauge steel 1-5/8 in square with insert anchors 1 3/8 in long and 100 mm (4 in) on centre.
- .4 Install anchor bolts to elevations required for proper attachment to supported equipment.

2.12 Plywood Equipment Boards

- .1 Plywood Equipment Boards: preservative treated, and kiln dried; thickness as indicated, or if not indicated, not less than 19 mm (3/4 in) deep. Provide marine grade plywood where subject to moisture conditions.
- .2 Paint plywood board white, or to match adjacent finishes. Leave the fire-retardant label unpainted for verification by the Consultant and by Authority Having Jurisdiction (AHJ).
- .3 Unless otherwise noted, boards shall be painted with two coats of good grade weatherproof flat gray non-conductive fire-retardant paint on all sides and edges (prior to mounting) and plumbed in a true vertical position. Provide nominal 13 mm (1/2 in) rustproof spacers between back of plywood and wall. Cut, fit, and place plywood equipment boards accurately in location, alignment, and elevation to support and anchor electrical materials and equipment. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members. Attach to substrates as required to support applied loads. Maintain at least 100 mm (4 in) from bottom of plywood equipment boards and the finished floor surface.
- .4 Unless directed otherwise in field, plywood equipment boards shall be 2440 mm (8 ft) high by 19 mm (3/4 in) deep by length shown on drawings (as dimensioned or as scaled) or length as required to accommodate equipment if not indicated on drawings. Unless directed otherwise in field, provide plywood equipment boards for all indoor surface mounted panelboards and systems "head-end" equipment for all applications where located in mechanical or electrical rooms/areas and only where specifically shown on drawings for all other applications.

2.13 Roof Supports

- .1 High-density polyethylene platform and base, height adjustable with rounded corners and edges to reduce likelihood of roof penetration.
- .2 Large surface area to spread the weight of supported objects including conduits, and cable trays over a large surface footprint.
- .3 No penetration of the waterproof membrane.
- .4 Self drains water, rot proof, and sunlight resistant.
- .5 Manufacturers:
 - .1 Thomas & Betts Superstrut Adjustable Universal Support.
 - .2 Eaton Dura-Blok series.

3 Execution

3.01 Installation

- .1 Obtain permission from the Consultant before drilling or cutting structural members.
- .2 Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- .3 Install surface-mounted cabinets and panelboards with minimum of four anchors.
- .4 In wet and damp locations use steel channel supports to stand cabinets and panelboards 25 mm (1 in) off wall.
- .5 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- .6 Provide inserts, sleeves, equipment supports and hangers, sealing of sleeves and openings, as required for all electrical work. Ensure that the load onto structures does not exceed the maximum loading per square metre as shown on Structural Drawings or as directed by the Consultant.
- .7 Provide insets, holes, anchor bolts and sleeves in time when walls, floors, and roof are erected.
- .8 Place insets only in structural members and not in the finishing material.
- .9 Secure all supports and hangers to the structure unless noted otherwise.
- .10 Suspend hanger rods from approved concrete inserts and from beam clamps. Obtain Consultant's approval before welding to steel structural members.
- .11 Secure supports to precast concrete members to inserts originally cast into the members or by rods passing between the members and connected to a steel plate bearing.
- .12 Sealing of Sleeves and Openings to Maintain Fire Rating
 - .1 Use Dow-Corning #3-6548 'Silicone RTV' foam, Thomas & Betts "Flamesafe" firestop system, Electrovert 'Flameseal' firestop putty, or approved equal materials installed in accordance with the manufacturer's specifications and recommendations.

- .2 Submit data sheets for review prior to installation.
- .13 Supports
 - .1 All conduits, panels, etc. to be securely and adequately supported.
 - .2 Where more than three conduits run together, conduit racks to be used.
 - .3 Single runs of conduit to be supported by galvanized conduit straps or ring bolt type hangers. Tie wire or perforated metal strap hangers will NOT be accepted.

End of Section

1 General

1.01 Section Includes

- .1 Rigid metal conduit.
- .2 Flexible metal conduit.
- .3 Liquid tight flexible metal conduit.
- .4 Electrical metallic tubing (EMT).
- .5 Rigid PVC conduit.
- .6 Fittings and conduit bodies.

1.02 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 45.1:22 – Electrical rigid metal conduit – steel.
 - .4 CSA C22.2 No. 56-17 (R2022), Flexible metal conduit and liquid-tight flexible metal conduit.
 - .5 CSA C22.2 No. 83.1:07 (R2022), Electrical Metallic Tubing – Steel.
 - .6 CSA C22.2 No. 211.1-06 (R2021), Rigid types EB1 and DB2/ES2 PVC conduit.
 - .7 CSA C22.2 No. 211.2-06 (R2021), Rigid PVC (unplasticized) conduit.
 - .8 CSA C22.2 No. 227.1:19 (R2023), Electrical nonmetallic tubing.
 - .9 CSA C22.2 No. 227.2.1:19 (R2023), Liquid-tight flexible nonmetallic conduit.
 - .10 CSA C22.2 No. 2420-09 (R2019), Belowground reinforced thermosetting resin conduit (RTRC) and fittings.

1.03 Record Documentation

- .1 Accurately record actual routing of conduits larger than 51 mm (2 in).
- .2 Accurately record actual routing of all conduits installed below grade, regardless of size, including whether direct buried or installed in concrete duct bank.

1.04 Regulatory Requirements

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and shown.

1.05 Delivery, Storage, and Handling

- .1 Accept conduit on site. Inspect for damage.

- .2 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.06 Project Conditions

- .1 Verify that field measurements are as shown on drawings.
- .2 Verify routing and termination locations of conduit prior to rough-in.
- .3 Conduit routing, if shown on drawings, is approximate unless dimensioned. Route as required to provide a complete wiring system.

2 Products

2.01 Manufacturers

- .1 Where products are listed in this section based on a single manufacturer, the equivalent product from the following manufacturers is acceptable:
 - .1 Appleton.
 - .2 Columbia-MBF.
 - .3 Crouse-Hinds by Eaton.
 - .4 Hubbell.
 - .5 Thomas & Betts Ltd.

2.02 Rigid Metal Conduit

- .1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel, threaded.
- .2 Epoxy coated conduit: to CSA C22.2 No. 45, with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Fittings and conduit bodies: Material to match conduit.

2.03 Flexible Metal Conduit

- .1 Flexible metal conduit: to CSA C22.2 No. 56, interlocked steel construction.
- .2 Fittings: CSA C22.2 No. 56.

2.04 Liquid Tight Flexible Metal Conduit

- .1 Description: Interlocked steel construction with PVC jacket.
- .2 Fittings: CSA C22.2 No. 56.

2.05 Electrical Metallic Tubing (EMT)

- .1 Description: CSA C22.2 No. 83.1; galvanized tubing.
- .2 Fittings and Conduit Bodies: CSA C22.2 No. 83.1; steel type.

2.06 Non-Metallic Conduit

- .1 Rigid Type EB1 PVC Conduit: to CSA C22.2 No. 211.1.

- .2 Rigid Type DB2/ES2 PVC Conduit: to CSA C22.2 No. 211.1.

2.07 Conduit, Fittings, and Accessories

- .1 Conduit accessories, conduits and fittings conforming to CSA Standard C22.2 No. 18-1972.
- .2 Provide rain tight connectors, couplings, fittings, junction boxes, pull boxes and surface outlet boxes shall be used for surface conduit installations exposed to moisture or in sprinklered buildings.
- .3 Rigid conduit bushings:
 - .1 Thomas & Betts Ltd. - Series 5031.
- .4 EMT Connectors:
 - .1 Thomas & Betts Ltd. - Steel City TC121A series.
- .5 Ground Bushings:
 - .1 Thomas & Betts – Blackjack or 1220 series.
- .6 Flexible conduit connectors:
 - .1 Thomas & Betts Ltd. - Series 3110.
 - .2 EMT couplings: steel concrete tight to match connectors.
- .7 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.
 - .1 Thomas & Betts – 8125 series.
- .8 Terminate EMT entering boxes or enclosures with nylon insulated steel concrete tight connectors.
- .9 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.
 - .1 Thomas & Betts – 5332 series.

3 Execution

3.01 Preparation

- .1 Produce layout sketches of conduit runs through mechanical and electrical service areas, through corridors, and other congested areas in order to resolve any interferences with other work, and to determine the most efficient route to run the conduit.

3.02 Installation

- .1 Minimum size: 21 mm (3/4 in) unless otherwise specified.
- .2 Conceal all conduit except in mechanical rooms and electrical rooms, or unless otherwise indicated in this specification, or noted on the drawings. Surface conduit work is not permitted unless specifically noted.
- .3 Install wiring in conduit unless otherwise specified. Where conduit sizes are not shown on drawings, provide conduits sized in accordance with Ontario Electrical Safety Code, CSA C22.1. When conduits are indicated, they are the minimum size required, and must be increased to suit the length of run or voltage drop requirements.
- .4 Conduit use:

- .1 Unless otherwise specified below or shown on the drawings, all systems shall be installed in electrical metallic tubing (EMT).
- .2 Equipment subject to vibration:
 - .1 Use liquid tight flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.
- .3 Outdoor locations, above grade: use rigid steel.
- .4 Underground: Use rigid PVC conduit for wiring in slabs on grade, and wiring below grade.
- .5 Wet and damp locations:
 - .1 Use rigid steel.
 - .2 Use liquid tight flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.
- .6 Dry locations:
 - .1 Concealed in metal stud partitions:
 - .1 Use electrical metallic tubing.
 - .2 Use of AC90 (Bx) as described in Section 26 05 19.
 - .2 Concealed in concrete: Use electrical non-metallic tubing or rigid PVC.
 - .3 Exposed areas: Use electrical metallic tubing.
 - .4 Use flexible metal conduit for connections to transformers, motors, and equipment, subject to vibration and movement.
 - .5 Use liquid tight flexible metal conduit below raised floors for connections to all devices.
 - .6 Aluminium conduit may be used, in lieu of steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.
 - .7 Use epoxy coated conduit in corrosive areas.
- .7 Equipment in sprinklered spaces:
 - .1 Provide CSA certified sealing rings for rigid steel galvanized conduit and CSA certified raintight connectors for steel galvanized electrical metallic tubing (EMT) where conduits enter the top or the sides of enclosures.
- .8 Telecommunications conduits: in accordance with Section 27 05 28.
- .5 Arrangement and supports:
 - .1 Arrange supports to prevent misalignment during wiring installation.
 - .2 Arrange conduit to maintain headroom and present neat appearance.
 - .3 Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.

- .4 Group related conduits; support using conduit rack.
 - .5 Construct rack using steel channel; provide space on each for 25 per cent additional conduits.
 - .6 Fasten conduit supports to building structure and surfaces to Section 26 05 29.
 - .7 Do not support conduit with wire or perforated pipe straps.
 - .8 Remove wire used for temporary supports.
 - .9 Do not attach conduit to ceiling support wires.
 - .10 Route exposed conduit parallel and perpendicular to walls.
 - .11 Route conduit installed above accessible ceilings parallel and perpendicular to walls.
 - .12 Route conduit in and under slab from point-to-point.
 - .13 In damp and unheated areas, avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
 - .14 Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.
- .6 Clearances:
- .1 Maintain adequate clearance between conduit and piping.
 - .2 Maintain 300 mm (12 in) clearance between conduit and surfaces with temperatures exceeding 40°C.
- .7 Conduit bends:
- .1 Install no more than equivalent of three 90 degree bends between boxes.
 - .1 Use conduit bodies to make sharp changes in direction, as around beams.
 - .2 Use hydraulic one-shot bender to fabricate bends in metal conduit larger than 50 mm size or provide prefabricated conduit bends.
- .8 Install wall entrance seals where conduits pass through exterior walls below grade.
- .9 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.
- .10 Cut conduit square using saw or pipe cutter; de-burr cut ends.
- .11 Bring conduit to shoulder of fittings; fasten securely.
- .12 Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- .13 Use conduit hubs or sealing locknuts to fasten conduit and to cast boxes.
- .14 Provide suitable pull string in each empty conduit except sleeves and nipples.
- .15 Ground and bond conduit to Section 26 05 26.
- .16 Identify conduit to Section 26 05 53.

- .17 Flexible conduit and armoured cable will be accepted for a maximum length of 1500 mm for final connection to lighting fixtures. Do not connect from fixture to fixture.

3.03 Cleaning

- .1 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

End of Section

1 General

1.01 Section Includes

- .1 Wall and ceiling outlet boxes.
- .2 Pull and junction boxes.

1.02 Related Requirements

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 27 16 – Electrical Cabinets and Enclosures.
- .3 Section 26 27 26 – Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.
- .4 Section 26 27 26.13 – Floor Box Assemblies.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 18.1:13 (R2022), Metallic Outlet Boxes (Tri-national standard, with UL 514A and ANCE NMX-J-023/1).
 - .4 CSA C22.2 No. 40:17 (R2022), Junction and Pull Boxes.
 - .5 CSA C22.2 No. 85:14 (R2023) – Rigid PVC Boxes and Fittings.

1.04 Closeout Submittals

- .1 Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.05 Regulatory Requirements

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.01 Outlet Boxes

- .1 Sheet Metal Outlet Boxes: CSA C22.2 No. 18.1, galvanized steel.
 - .1 Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 13 mm male fixture studs where required.
 - .2 Concrete Ceiling Boxes: Concrete type.
- .2 Non-metallic Outlet Boxes: CSA C22.2 No. 18.1.

- .3 Cast Boxes: CSA C22.2 No. 18.1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- .4 Wall Plates for Finished Areas: As specified in Section 26 27 26.

2.02 Pull Boxes and Junction Boxes

- .1 Sheet Metal Boxes: CSA C22.2 No. 18.1, galvanized steel.
- .2 Hinged Enclosures: As specified in Section 26 27 16.
- .3 Surface Mounted Cast Metal Box: CSA C22.2 No. 18.1, Type 4; flat-flanged, surface mounted junction box:
 - .1 Material: Cast aluminum.
 - .2 Cover: Provide with ground flange, neoprene gasket, and stainless steel cover screws.

2.03 Outlet Boxes

- .1 Conform to CSA C22.2 No. 18.1.
- .2 Where 103 mm (4 in) square outlet boxes are installed in exposed concrete or cinder block finished areas, blocks will be cut as described in Division 04 as instructed under this Section. Cut openings to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Use of mortar to patch up openings that are cut too large or to patch ragged edges is not permitted.
- .3 Ceiling boxes: 103 mm (4 in) octagon or square, complete with fittings, where required to support fixtures.
- .4 Switch, receptacle, and telecommunication outlet boxes:
 - .1 103 mm (4 in) square with plaster ring, where flush mounted in walls and partitions, as required.
 - .2 Iberville 1104 series box, or equal, where flush mounted in wood or drywall, with stud fasteners as required.
 - .3 Masonry boxes in masonry walls.
- .5 Where boxes are surface mounted in unfinished areas they shall be FS conduits.
- .6 Standard outlet boxes manufactured from code gauge galvanized steel.
- .7 Provide a suitable outlet box for each light, switch, receptacle, or other outlet, approved for the area it is to be installed.
- .8 Support outlet boxes independently of conduit and cable.
- .9 Locate outlet boxes, mounted in hung ceiling space, so they do not obstruct or interfere with the removal of lay-in ceiling tiles.
- .10 Offset outlet boxes, shown back to back in partitions, horizontally a minimum 150 mm (6 in) to minimize noise transmission between adjacent rooms.
- .11 Use gang boxes at locations where more than one device, of the same system only, is to be mounted. Utilize separate boxes for each system.
- .12 Use tile wall covers where 103 mm (4 in) square outlet boxes are installed in exposed concrete or cinder block in finished areas.

- .13 Provide flush mount boxes, panels, cabinets, and electrical devices, which are installed in finished areas, with suitable flush trims and doors or covers, unless specifically noted otherwise.
- .14 Provide pre-formed polyethylene vapour barriers for all boxes located in walls with internal vapour barriers.

3 Execution

3.01 Examination

- .1 Verify locations of floor boxes prior to rough-in.

3.02 Installation

- .1 Install boxes to CSA C22.1.
- .2 Install in locations as shown on drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
- .3 Set wall mounted boxes at elevations to accommodate mounting heights indicated.
- .4 Electrical boxes are shown on drawings in approximate locations unless dimensioned. Adjust box location up to 3 m (10 ft) if required to accommodate intended purpose.
- .5 Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26.
- .6 Maintain headroom and present neat mechanical appearance.
- .7 Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- .8 Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 150 mm (6 in) from ceiling access panel or from removable recessed luminaire.
- .9 Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods.
- .10 Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- .11 Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- .12 Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- .13 Use flush mounting outlet box in finished areas.
- .14 Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- .15 Do not install flush mounting box back-to-back in walls; provide minimum 150 mm (6 in) separation. Provide minimum 600 mm (24 in) separation in acoustic rated walls.
- .16 Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- .17 Use stamped steel bridges to fasten flush mounting outlet box between studs.
- .18 Install flush mounting box without damaging wall insulation or reducing its effectiveness.

- .19 Use adjustable steel channel fasteners for hung ceiling outlet box.
- .20 Do not fasten boxes to ceiling support wires.
- .21 Support boxes independently of conduit.
- .22 Use gang box where more than one device is mounted together. Do not use sectional box.
- .23 Use gang box with plaster ring for single device outlets.
- .24 Use cast outlet box in exterior locations exposed to the weather.
- .25 Use cast outlet box in wet locations.
- .26 Set floor boxes level.
- .27 Large pull boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.
- .28 Provide painted cover plate screwed onto junction box to match adjacent material colour finish for all junction and outlet boxes. Where empty boxes or boxes allocated for future services are installed with conduit, provide cover plate. If the box is provided a circuit, provide circuit label in accordance with Section 26 05 53.

3.03 Adjusting

- .1 Adjust floor box flush with finish flooring material.
- .2 Adjust flush-mounting outlets to make front flush with finished wall material.
- .3 Install knockout closures in unused box openings.

3.04 Cleaning

- .1 Clean interior of boxes to remove dust, debris, and other material.
- .2 Clean exposed surfaces and restore finish.

End of Section

1 General

1.01 Section Includes

- .1 Metal Raceway is an enclosed pathway used for surface distribution of branch circuit electrical wiring, and cabling for voice, data, multi-media, low voltage, and optical fiber. Raceway is typically installed in existing building structures, or after construction is complete. A complete raceway system includes raceway, covers, mounting hardware, various fittings, and outlet boxes installed at specific locations. Specific codes and standards apply to electrical wires and telecommunications cables that are deployed within metal raceway. Compliance to codes and standards is required for installation, grounding and bonding, and cable deployment.

1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

1.03 Quality Assurance

- .1 Product free from defects in material or workmanship.
- .2 Materials and work specified in this document shall comply with, and are not limited to the codes, standards, and regulations listed below.
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 National Electrical Manufacturer's Association (NEMA)
 - .1 ANSI/NEMA WD 6-2021: Wiring Devices – Dimensional Specifications.
 - .2 ANSI/NEMA 250-2020: Enclosures for Electrical Equipment.
 - .4 UL 94, Standard for Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing.
- .3 Performance Requirements:
 - .1 Metal raceway and fittings UL Listed and CSA certified.

1.04 Submittals

- .1 Product Data Sheet.
- .2 Manufacturer's Instructions.
- .3 Product Catalog Literature.
- .4 Product Drawings.

1.05 Warranty

- .1 Product is warranted free of defects in material or workmanship.
- .2 Product is warranted to perform the intended function within design limits.

2 Products

2.01 Manufacturers

- .1 Wiremold Legrand.
- .2 Hubbell.
- .3 Thomas & Betts Canada.

2.02 Surface Mounted Raceway, General

- .1 The raceway and all system components must be UL Listed and exhibit non-flammable self-extinguishing characteristics tested to comparable specifications of UL 94V-0. The raceway base and cover shall be manufactured by rigid compound, available in ivory or white colours, and allow for field painting.

2.03 Two-Channel Metal Raceway

- .1 Surface metal raceway, single or complete with snap-in divider to form 2 compartments for power and data, with removable cover. Width to suit application while keeping code and telecommunication standard filling ratios.
- .2 Elbows, couplings, end caps, device brackets and faceplates for power, data and voice, and fittings manufactured as accessories for wireway supplied. 120 V power receptacles and mounting for voice/data.
- .3 Finish: Designer Grey.
- .4 Basis of Design: Wiremold DS4000 series.

3 Execution

3.01 Preparation

- .1 Submit layout drawings of the raceway system for reviewed prior to installation.
- .2 Installation of metal raceway in wet areas is not permitted.
- .3 Manufacturer's instructions for installing raceway and fittings shall be followed by the installer.
- .4 All wall surfaces, or other permanent structures to which raceway is mounted shall be finished complete.

3.02 Installation

- .1 Mount base and cover together to wall or structure using the appropriate fasteners and clips, per manufacturer's instructions.
- .2 Securely support raceway in intervals not exceeding 3 m (10 ft) or per manufacturer's instructions.
- .3 Install fittings and device boxes in the specified locations, per manufacturer's instructions and per contract drawing specifications.
- .4 Completed raceway installation shall be mechanically continuous and connected to all electrical outlets, device boxes, and enclosures with no gaps or exposed cuts.
- .5 Provide insulated ground wire for power raceways per OESC requirements. Raceway shall not be used as the primary ground path.

- .6 Prior to wire and cable installation, the raceway system shall be installed complete, including insulating bushings, adapters, fittings, outlets, boxes, and enclosures. Unused raceway openings shall be closed.
- .7 Make wiring connections with the proper approved insulated wire connectors or lugs. Exposed conductors at harness wiring junctions are not permitted regardless of connection method.
- .8 Provide a physical barrier in raceway and boxes to separate power and communication wiring.
- .9 Install covers on raceway, boxes and fittings after wiring is complete, or if wire and cable installation is to be done at a later date.

3.03 Field Quality Control

- .1 Verify layout of system to contract drawings.
- .2 Raceway system shall be free of dents, scratches, bare metal edges, and exposed uneven cuts.
- .3 Securely fasten all outlets, boxes, and enclosures walls or permanent structures.
- .4 Verify that all wiring junctions or connections have no exposed conductors prior to energizing the circuits.
- .5 Verify that all bonding locations are code and standards compliant.
- .6 Verify that power and communications wiring are separated by a physical barrier in raceway and boxes.

End of Section

1 General

1.01 Section Includes

- .1 Sleeves, sealing of sleeves and openings, as required for all electrical work.

1.02 References

- .1 CAN/ULC-S101-14, Standard methods of fire endurance tests of building construction and materials.
- .2 CAN/ULC-S115:2013, Standard method of fire tests of firestop systems.

1.03 Submittals

- .1 Submit data sheets for firestopping in accordance with Section 01 30 00.
- .2 Submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .3 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .4 Submit dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for Electrical work.

2 Products

2.01 Sleeves

- .1 Galvanized steel sleeves:
 - .1 24 gauge with an integral flange at one (1) end to secure sleeve to formwork construction.
 - .2 Schedule 40 pipe.
- .2 Schedule 40 PVC sleeves.

2.02 Sleeve Seals

- .1 Manufacturers
 - .1 Hilti Canada.
 - .2 Specified Technologies Inc.
 - .3 3M Canada Inc.
 - .4 Tremco.
 - .5 A/D Fire Protection Systems.
 - .6 Nelson.
- .2 Asbestos-free, elastomeric materials and intumescent materials, tested, listed, and labelled by ULC in accordance with CAN/ULC-S101, and CAN/ULC-S115 for installation in ULC designated firestopping, and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) no less than fire rating for surrounding construction.

- .3 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.
- .4 Maintain fire rating of separation in accordance with architectural drawings.

3 Execution

3.01 Installation

- .1 Where conduits and conductors pass through structural poured concrete, provide sleeves of type suitable for application, and approved by local governing codes.
- .2 Sleeves in concrete slabs, except as noted below, are to be 24 gauge or equivalent, with an integral flange to secure sleeves for formwork construction.
- .3 Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required are to be lengths of Schedule 40 pipe sized to extend 100 mm (4 in) above floor.
- .4 Sleeves in poured concrete walls and foundation are to be Schedule 40 pipe.
- .5 Through interior walls, use standard weight steel pipes, conduit, or galvanized steel. Cut flush with finished surfaces. Check room finish schedules.
- .6 Through exterior walls above grade, floors, and roof use standard weight steel pipes, machine cut, flush with finished surface inside and to suit flashing outside.
- .7 Through exterior walls below grade, water-proofed floors, and other water-proof walls, use heavy weight cast iron pipes, machine cut. Extend sleeves 100 mm (4 in) above finished floors, and cut flush with underside of floor.
- .8 Size sleeves, unless otherwise noted, to leave 13 mm (1/2 in) clearance around conduit, duct, conductor, etc. Void between sleeves and conduit, duct, conductors, etc., to be packed and sealed for length of sleeves as in accordance with article entitled "Sleeve Seals" specified in this Section. Pack and seal sleeves set in exterior walls with governing authority approved materials suitable for application and pack both ends of sleeves watertight with approved permanently flexible and water tight materials. Coordinate exact responsibility of work with General Trades Contractor.
- .9 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work. Completely and accurately dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .10 Supply sleeves of a water protecting type in accordance with detail found on drawings for installation in following locations:
 - .1 in Mechanical and Fan Room floor slabs, except where on grade.
 - .2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets.
 - .3 in floors equipped with waterproof membranes.
- .11 "Gang" type sleeving to be permitted only with approval of Owner and reviewed with the Consultant.
- .12 Terminate sleeves for work which is exposed, so that sleeve is flush at both ends with wall, partition, or slab surface such that sleeve may be covered completely by escutcheon plates.

- .13 Sleeves are not required in interior walls and dry area floors where conduit is installed ahead of floor construction.
- .14 Seal all openings and sleeves after installation of equipment:
 - .1 With an approved material to maintain fire rating where sleeves and openings pass through fire separations and floors.
 - .2 With an approved material to maintain fire rating for sleeves and openings provided for future equipment.
 - .3 Flash all conduits and systems passing through roof or built into an outside wall, or a waterproof floor.
 - .4 Provide copper flashing for sleeves passing through exterior walls or waterproof floors.
- .15 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 07.
- .16 Firestop sleeves in accordance with the manufacturer's specifications and recommendations.

End of Section

1 General

1.01 Section Includes

- .1 Tested firestop systems used in penetrations for the passage of cables, conduit, and other electrical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.02 Related Requirements

- .1 Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
 - .1 Section 07 85 00 – Firestopping and Smoke Seals
 - .2 Section 27 05 44 – Sleeves and Sleeve Seals for Communications Pathways and Cabling.

1.03 References

- .1 Underwriter’s Laboratories (UL) and Underwriters Laboratories of Canada (ULC):
 - .1 Test Requirements: CAN/ULC-S115:2023, Standard Method of Fire Tests of Firestop Systems.
 - .2 Underwriters Laboratories of Canada (ULC) runs CAN/ULC-S115:2023 under their designation of ULC-S115:2023 and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.
 - .3 Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115 are given a cUL listing and are published by UL in their “Products Certified for Canada (cUL) Directory.
 - .4 CAN/ULC-S101-14, Fire Endurance Tests of Building Construction and Materials.
 - .5 CAN/ULC 102:2019 (R2024), Standard Test Method for Surface Burning Characteristics of Building Materials.
- .2 ASTM:
 - .1 Omega Point Laboratories runs ASTM E814 and publishes the results annually in their “Omega Point Laboratories Directory”.
 - .2 Inspection Requirements: ASTM E2174, “Standard Practice for On-site Inspection of Installed Fire Stops.”, and ASTM E2393 Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
 - .3 Test Requirements: ASTM E2307, “Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus”.
 - .4 ASTM D6904, “Standard Practice for Resistance to Wind Driven Rain for Exterior Coatings Applied on Masonry”.
 - .5 ASTM C679, “Standard Test Method for Tack-Free Time of Elastomeric Sealants”.
- .3 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments.
- .4 Ontario Building Code.
- .5 Ontario Electrical Safety Code.

1.04 Definitions

- .1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.05 Submittals

- .1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with submittal procedures.
- .2 Manufacturer's engineering judgment identification number and drawing details when no ULC or cUL system is available for an application. Engineered judgment must include both project name and contractor's name who will install firestop system as described in drawing.
- .3 Submit material safety data sheets provided with product delivered to project site.
- .4 Submit shop drawings in accordance with submittal procedures.
 - .1 Submit complete cUL, ULC, or equivalent approved systems for all applications. Ensure the listing is clearly noted on the submittal.

1.06 Closeout Submittals

- .1 On completion of firestopping and smoke sealing installation, submit a Letter of Assurance to the Consultant certifying the firestopping and smoke sealing installation has been carried out throughout the building to electrical service penetrations and that installation has been done in strict accordance with requirements of the Ontario Building Code, any applicable municipal bylaws, ULC requirements, and manufacturer's instructions.

1.07 Quality Assurance

- .1 Fire-Test-Response Characteristics: Provide through-penetration fire stop systems and fire-resistive joint systems that comply with specified requirements of tested systems.
- .2 Firestop System installation must meet requirements of CAN/ULC-S115 tested assemblies that provide a fire rating as shown in Section 2.1 Clauses 4, 5, 6, and 7 below.
- .3 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- .4 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- .5 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Firestop Council.

1.08 Installer Qualifications

- .1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having the necessary training to install manufacturer's products per specified requirements. A supplier's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

- .2 Installation Responsibility: assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source firestop specialty contractor.
- .3 The work is to be installed by a contractor with at least one of the following qualifications:
 - .1 FM 4991 approved contractor.
 - .2 ULC approved contractor.
 - .3 Manufacturer's accredited fire stop specialty contractor.
- .4 Installer: Minimum 3 years experience with fire stop installation.

1.09 Delivery, Storage, and Handling

- .1 Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and ULC or cUL label where applicable.
- .2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at project site.
- .3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- .4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- .5 Do not use damaged or expired materials.

1.10 Project Conditions

- .1 Do not use materials that contain flammable solvents.
- .2 Scheduling
 - .1 Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
 - .2 Schedule installation of Drop-In firestop devices after placement of concrete but before installation of the pipe penetration. Diameter of sleeved or cored hole to match the listed system for the device.
 - .3 Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- .3 Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- .4 Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
- .5 During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

2 Products

2.01 Performance Requirements

- .1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
- .2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- .3 Provide a round fire-rated cable management device whenever cables penetrate fire rated walls, where frequent cable changes and additions may occur. The fire-rated cable management device shall consist of a corrugated steel tube with zinc coating, contain an inner plastic housing, intumescent material rings, and inner fabric smoke seal membrane. The length of the sleeve shall be 315 mm (12.4 inches). The fire-rated cable management device shall contain integrated intumescent firestop wrap strip materials sufficient to maintain the hourly rating of the barrier being penetrated. The fire-rated cable management device shall contain a smoke seal fabric membrane or intumescent firestop plugs sufficient to achieve the L-Rating requirements of the barrier type. Install device per the manufacturer's published installation instructions.
- .4 Penetrations in Horizontal Assemblies: Provide firestopping with ratings determined in accordance with CAN/ULC-S115. For penetrations through a Fire Wall or horizontal Fire Separation provide a firestop system with a "FT" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.
- .5 W-ratings: in accordance with Section 07 84 00.
- .6 Provide a firestop system with an Assembly Rating as determined by CAN/ULC-S115 which is equal to the time rating of construction joint assembly.
- .7 Penetrations in Smoke Barriers: Provide firestopping with ratings determined in accordance with CAN/ULC-S115.
 - .1 L-Rating: Not exceeding 5.0 CFM/sqft of penetration opening at both ambient and elevated temperatures.
- .8 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.
- .9 Rain and water resistance: provide perimeter joint sealant tested in accordance with ASTM D 6904 with less than 1 hour tack free time as tested in accordance with ASTM C 679.

2.02 Manufacturers

- .1 Manufacturer List:
 - .1 AD Fire Protection Systems.
 - .2 Hilti (Canada) Corporation
 - .3 3M.
 - .4 Specified Technologies, Inc. (STI).
 - .5 Tremco, Inc.

- .2 Substitutions: Where a specific manufacturer is noted in this Section, equivalent products from the manufacturers listed above may be used, subject to compliance with through penetration firestop systems and joint systems listed in the ULC Fire Resistance Directory – Volume III, or UL Products Certified for Canada (cUL) Directory.

2.03 Materials

- .1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
- .2 Accessories: provide components for each firestopping and smoke seal systems that are needed to install fill materials. Use only components specified by firestopping material manufacturer, and approved by the qualified testing agency. Accessories include, but are not limited to, the following items:
 - .1 Permanent forming, damming, and backing material.
 - .2 Temporary forming material.
- .3 Pre-formed firestop devices for use with non-combustible and combustible pipes (closed and open systems), conduit and/or cable bundles penetrating concrete floors and/or gypsum walls:
 - .1 Hilti Tub Box Kit (CP 681) for use with tub installations.
 - .2 Hilti Cast-In Place Firestop Device (CP 680-PX) for use with XFR pipe.
 - .3 Hilti Cast-In Place Firestop Device (CP 680-M) for use with non-combustible penetrants.
 - .4 Hilti Speed Sleeve (CP 653) for use with cable penetrations.
 - .5 Hilti Firestop Drop-In Device (CFS-DID) for use with non-combustible and combustible penetrants.
 - .6 Hilti Cast-in Firestop sleeve (CFS-CID MD P) and (CFS-CID MD M) for use with combustible and non-combustible pipes through metal deck.
 - .7 Hilti Firestop Block (CFS-BL).
 - .8 STI SpecSeal series SSC Firestop Collars.
 - .9 STI SpecSeal series LCC Firestop Collars.
- .4 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT).
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
 - .2 Hilti Fire Foam (CP 620)/CP 660.
 - .3 Hilti Flexible Firestop Sealant (CP 606).
 - .4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
 - .5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
- .5 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe.

- .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
- .6 Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles.
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX).
 - .2 Hilti Fire Foam (CP 620)/660.
 - .3 Hilti Flexible Firestop Sealant (CP 606).
 - .4 Hilti Firestop Silicone Sealant Gun Grade (CFS-S SIL GG).
 - .5 Hilti Firestop Silicone Sealant Self Leveling (CFS-S SIL SL).
- .7 Firestop Putty Pads: Intumescent, non-hardening putty pads to be installed on metallic and non-metallic electrical switch and receptacle boxes to reduce horizontal separation between boxes to less than 610 mm (24 in):
 - .1 STI SpecSeal Series SSP Firestop Putty Pads.
 - .2 Hilti Firestop Putty Pad (CP 617).
- .8 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
 - .1 Hilti Firestop Block (CFS-BL).
 - .2 Hilti Composite Sheet (CFS-COS).
 - .3 Hilti Firestop Mortar (CP 637).
 - .4 Hilti Fire Foam (CP 620)/660.
 - .5 Hilti Firestop Board (CP 675T).
- .9 Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways.
 - .1 Hilti Firestop Block (CFS-BL).
 - .2 Hilti Firestop Board (CP 675T).
- .10 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating gypsum or masonry walls.
 - .1 Hilti Speed Sleeve (CP 653) with integrated smoke seal fabric membrane.
 - .2 Hilti Firestop Cable Collar (CFS-CC).
 - .3 Hilti Firestop Sleeve (CFS-SL SK).
 - .4 Hilti Retrofit Sleeve (CFS-SL RK) for use with existing cable bundles.
 - .5 Hilti Gangplate (CFS-SL GP) for use with multiple cable management devices.
 - .6 Hilti Gangplate Cap (CFS-SL GP CAP) for use at blank openings in gangplate for future penetrations.

- .11 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected.
 - .1 Hilti CFS-BL Firestop Block (for walls and floors).
 - .2 Hilti CFS-PL Firestop Plug (for walls and floors).
- .12 Cast-In-Place Firestop Device: Single component molded firestop device installed on forms prior to concrete placement with totally encapsulated, tamper-proof integral firestop system and smoke sealing gasket. Device shall allow for a concrete floor thickness of minimum 63 mm (2-1/2 in) up to 914 mm (36 in) without the use of field applied extension tubing:
 - .1 STI SpecSeal CID Cast-In Firestop Device.
 - .2 Hilti CP 680 Cast-In Place Firestop Device (for floors only).
- .13 For single or cable bundles up to 25 mm (1 in) diameter penetrating gypsum, masonry, concrete walls or wood floor assemblies.
 - .1 Hilti CFS-D Firestop Cable Disc.

3 Execution

3.01 Installers

- .1 Labour Use to Install Firestop Systems
 - .1 To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements.

3.02 Preparation

- .1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - .1 Verify penetrations are properly sized and in suitable condition for application of materials.
 - .2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - .3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
 - .4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
 - .5 Do not proceed until unsatisfactory conditions have been corrected.

3.03 Coordination

- .1 Coordinate construction of openings, penetrations to ensure that the fire stop systems are installed according to specified requirements.
- .2 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
- .3 Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

- .4 Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector.

3.04 Installation

- .1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory or Omega Point Laboratories Directory.
- .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.
 - .1 Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.
 - .2 Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
 - .3 Protect materials from damage on surfaces subjected to traffic.

3.05 Field Quality Control

- .1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- .2 Keep areas of work accessible until inspection by applicable code authorities.
- .3 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops", or other recognized standard.
- .4 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- .5 Manufacturer's Field Services: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly.

3.06 Identification and Documentation

- .1 The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration location on the entire project.
- .2 The Documentation Form for through penetrations is to include:
 - .1 A Sequential Location Number.
 - .2 The Project Name.
 - .3 Date of Installation.
 - .4 Detailed description of the penetration location.
 - .5 Tested System or Engineered Judgment Number.
 - .6 Type of assembly penetrated.
 - .7 A detailed description of the size and type of penetrating item.
 - .8 Size of opening.
 - .9 Number of sides of assemblies addressed.

- .10 Hourly rating to be achieved.
- .11 Installer's Name.
- .3 Copies of these documents are to be provided to the general contractor at the completion of the project.
- .4 Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
 - .1 The words: "Warning-Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."
 - .2 Contractor's Name, address, and phone number.
 - .3 Through-Penetration firestop system designation of applicable testing and inspecting agency.
 - .4 Date of Installation.
 - .5 Through-Penetration firestop system manufacturer's name.
 - .6 Installer's Name.

3.07 Adjusting and Cleaning

- .1 Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- .2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

End of Section

1 General

1.01 Section Includes

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

1.02 Related Requirements

- .1 Section 26 27 26 – Wiring Devices.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.2 No. 42-10 (R2020), General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA C22.2 No. 42.1-13 (R2017), Cover plates for flush-mounted wiring devices (Bi-national standard, with UL 514D).
 - .3 CSA C22.2 No. 55-15 (R2020), Special Use Switches.
 - .4 CSA-C22.2 No. 111-18 (R2023), General-Use Snap Switches (Trinational standard with UL 20 and NMX-J-005-ANCE).

1.04 Submittals

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.

2 Products

2.01 Outdoor Receptacle Pedestals

- .1 Aluminum pedestal complete with pedestal cap, gaskets, grounding lug, and all require accessories.
- .2 Minimum 75 mm by 75 mm (3 inch by 3 inch) cross section.
- .3 Drain hole.
- .4 Final mounting height of wiring device shall be no greater than 1200 mm above finished grade, including concrete base.
- .5 Pedestal will be approved using field evaluation or special inspection and marked by a certification organization accredited by (SCC) standards council of Canada such as "CSA" or "QPS" or "ESA" or "ENTECLA" or "UL".
- .6 Complete with base flange for concealing anchor bolts.
- .7 Receptacles to be oriented minimum 45 degrees down from horizontal to minimize cable strain.
- .8 Provide bracket for management of cables, or coiling of excess cable length.

2.02 Foundations for Pedestals

- .1 Provide foundations for lighting standards in accordance with manufacturer's recommendations. Submit Equipment Foundation Data in accordance with referenced standards in this section.
- .2 Concrete Foundations:

.1 Provide concrete bases as specified in Section 03 30 53.

.3 Anchor Bolts

.1 Provide concealed galvanized high strength steel rod anchor bolts, in accordance with manufacturer's instructions.

2.03 Special Receptacles

.1 Voltage and configurations as indicated on drawings.

.2 Receptacles of one manufacturer throughout project.

2.04 Receptacle Cover Plates

.1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.

.2 Cover plates from one manufacturer throughout project.

.3 While-in-use weatherproof cover spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches for outdoor applications. Cover shall be suitable for wet locations whether or not a plug is inserted in the receptacle.

.4 All outdoor wiring device cover plates to be labeled with riveted 3-ply engraved laminated nameplate identifying panel and circuit number for each device, and receptacle configuration.

3 Execution

3.01 Installation

.1 Receptacle Pedestal

.1 Cut opening required on gasket for wiring access and concrete screw holes.

.2 Install galvanized steel concrete screws to secure pedestal to concrete base.

.3 Apply a bead of sealant at top of pedestal for weatherproofing.

.4 Ground pedestal in accordance with Section 26 05 29.

.5 Install receptacles as indicated.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Mount receptacles at height in accordance with Section 26 05 00 as indicated.

.3 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.02 Waste Management

- .1 Separate and recycle waste materials in accordance with Section 01 74 00.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Owner's Representative.

End of Section

1 General

1.01 Section Includes

- .1 This section provides minimum acceptance requirements for vibration isolation for all electrical equipment, conduit, and piping.

1.02 Related Requirements

- .1 Concrete work is described in Division 03 and Section 26 05 29.
- .2 Acoustic Consultant's report.
- .3 Section 26 22 13 – Low-Voltage Distribution Transformers.

1.03 Submittals

- .1 All outdoor mounted equipment shall be restrained for the highest wind speed as specified by the project's structural engineer, the governing building code(s) or the authority having jurisdiction.
- .2 Submit shop drawings for all devices specified herein and as indicated and scheduled on the drawings. Submittals shall indicate full compliance with the device specification in Part 2. Any deviation shall be specifically noted and subject to engineer approval. Submittals shall include device dimensions, placement, attachment, and anchorage requirements.

1.04 Closeout Submittals

- .1 Submit a letter from vibration isolation manufacturer to certify correct installation of products, as specified in Part 3 of this Section.

1.05 Quality Assurance

- .1 All vibration isolation systems shall be by one manufacturer.
- .2 Unless otherwise directed by the local authority having jurisdiction, the following codes and standards will apply:
 - .1 International Building Code 2009.
 - .2 American Society of Civil Engineers 7-05.
 - .3 Ontario Building Code, Latest Edition.
- .3 Manufacturer's Qualifications: Firms regularly engaged in manufacture of vibration control products of type, size, and capacity required, whose products have been in satisfactory use in similar service for not less than 5 years.

2 Products

2.01 Manufacturers

- .1 Vibro-Acoustics.
- .2 Kinetics Noise Control.
- .3 BVA Systems.
- .4 Vibron Limited.

- .5 Mason Industries.

2.02 Vibration Isolation

- .1 Springs: All springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. All springs except internal nested springs shall have an outside diameter not less than 0.8 of the compressed height of the spring. Ends of springs shall be square and ground for stability. Laterally stable springs shall have k_x/k_y ratios of at least 0.9. All springs shall be fully colour-coded to indicate capacity – colour striping is not considered adequate.
- .2 Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be hot dipped galvanized, powder-coated enamel, or painted with rust-resistant paint.
- .3 Isolators:
 - .1 Vibration Isolation Pads: Type N – Neoprene pad type isolators, 10 mm (3/8”) minimum thick, ribbed on both sides.
 - .1 Type NSN – Sandwich neoprene pad type isolators, with 10 mm (3/8”) minimum thick ribbed neoprene pads bonded to each side of a 3.5 mm (10 ga) minimum galvanized metal plate. Isolator pads shall be selected to ensure that deflection does not exceed 20% of isolator free height.
 - .2 Rubber-in-Shear Floor Mounts: Type RD – “Double-deflection” neoprene isolators, with neoprene-coated metal surfaces, and top and bottom surfaces ribbed. Isolators shall have bolt holes in the base.
 - .3 Restrained Spring Floor Mounted Isolators: Type CSR – Laterally stable, vertically restrained spring isolators with welded steel housings and heavy top plates for supporting equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (1/4”) thick, bonded to the base plate. Housings shall include vertically restraining limit stops. Minimum clearance around the restraining bolts and between the housing and the spring shall be 13 mm (1/2”). Top plate and restraining bolts shall be out of contact with the housing during normal operation and neoprene grommets shall be incorporated to minimize short-circuiting of restraining bolts. For outdoor applications, housing must be hot-dip galvanized. For indoor applications, powder-coated finish for the housing is acceptable.

3 Execution

3.01 General

- .1 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation manufacturer to ensure adequate space and prevent edge breakout failures. Pads and piers must be adequately doweled into structural slab.
- .2 Coordinate locations and sizes of structural supports with locations of vibration isolators (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).
- .3 Isolated equipment, duct and piping located on roofs must be attached to the structure. Intermediate supports between the restraint and structure that are not attached to the structure must be approved by the restraint manufacturer.

3.02 Vibration Isolation

- .1 Ensure housekeeping pads have adequate space to mount equipment and isolator housings and shall also be large enough to ensure adequate edge distance for isolator anchors.

- .2 Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.
- .3 Engine-generator set silencers and associated exhaust piping shall be supported with Type SHR isolators with a minimum 40 mm (1-1/2 in) static deflection.
- .4 Equipment Isolation:

Eqpm Type	HP and Other	RPM	Floor Span											
			Slab on Grade			Up to 6 m (20 ft)			6 m to 9 m (20 ft to 30 ft)			9 m to 12 m (30 ft to 40 ft)		
			Base Type	Isolator Type	Min. Defl.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.	Base Type	Isolator Type	Min. Defl., in.
Transformers and UPS's														
All	All	All	N/A	NSN	3 mm (0.12")	N/A	NSN	3 mm (0.12")	N/A	NSN	3 mm (0.12")	NM	RD/NSN	6 mm (0.25")
Engine-Driven Generators														
All	All	All	N/A	CSR	19 mm (0.75")	N/A	CSR	38 mm (1.50")	N/A	CSR	64 mm (2.50")	N/A	CSR	89 mm (3.50")
Notes:	(1) Units that are suspended overhead shall use isolation hangers in place of floor mounted isolators with equal or greater deflection.													
	(2) Floor spans are defined as the distance between structural support columns or walls.													

- .5 There shall be no rigid contact of isolated equipment with shaft walls, floor slabs, partitions, or non-flexible conduits connections.
- .6 Where recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.

3.03 Site Tests and Inspections

- .1 After installation, arrange and pay for the vibration isolation product manufacturer, or representative, to visit the site to verify that the vibration isolation systems are installed and operating properly, and shall submit a certificate so stating. Verify that isolators are adjusted, with springs perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.

End of Section

1 General

1.01 Section Includes

- .1 Nameplates and labels.
- .2 Wire and cable markers.
- .3 Conduit markers.
- .4 Receptacle labels.
- .5 Signage.

1.02 Related Requirements

- .1 Section 09 91 00 – Painting.
- .2 Section 27 05 53 – Identification for Communications Systems.

1.03 Submittals

- .1 Product Data: Provide catalogue data for nameplates, labels, and markers.
- .2 Provide shop drawings of nameplates for Consultant's review prior to fabrication (scale 1:1).
- .3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.04 Regulatory Requirements

- .1 Provide products listed and classified by CSA Group as suitable for the purpose specified and indicated.

2 Products

2.01 Nameplates and Labels

- .1 Nameplates:
 - .1 Engraved three-layer laminated plastic, letters on contrasting background.
 - .2 Colours to match existing building system, where applicable. If no building system exists, use the following:
 - .1 347/600 volt system: White text on Blue background.
 - .2 120/208 volt system: Black text on White background.
 - .3 Fire Detection system: White text on Red background.
 - .4 Emergency Lighting system: Red text on White background.
 - .5 LV systems: White text on Green background.
 - .6 120/208 volt Uninterruptable Power Supply (UPS): White text on Orange background.
 - .3 Confirm colours with the Consultant prior to ordering nameplates.

- .2 Equipment Nameplates to indicate:
 - .1 Equipment/Panelboard ID.
 - .2 Ampacity.
 - .3 Voltage.
 - .4 Number of Phases.
 - .5 Number of wires in system.
 - .6 Interrupting Capacity.
 - .7 Size, number of poles, Panelboard ID, and circuit number of upstream overcurrent protection device.
 - .1 Location of upstream device if not in the same room.
- .3 Coordination Study Labels to Section 26 05 73.16.
- .4 Arc Flash Study Labels to Section 26 05 73.19.
- .5 Locations:
 - .1 Distribution panelboards, and individual distribution panelboard branch breakers.
 - .2 Receptacle panelboards.
 - .3 Each electrical distribution and control equipment enclosure.
 - .4 Uninterruptible Power Supply.
 - .5 Mechanical Equipment.
 - .6 UPS receptacles.
 - .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
 - .8 Terminal cabinets, junction boxes, and pull boxes: indicate system and voltage.
 - .9 Transformers: indicate capacity, primary and secondary voltages.
- .6 Letter Size:
 - .1 Use 3 mm letters for identifying individual equipment and loads.
 - .2 Use 6 mm letters for identifying grouped equipment and loads.
- .7 Labels:
 - .1 Mechanically fastened with sheet metal screws, with 5 mm white letters on black background.
 - .2 White letters on red background for UPS and equipment, and devices downstream of UPS.
 - .3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
 - .4 Wording on nameplates and labels to be reviewed by the Consultant prior to manufacturing.
 - .5 Allow for minimum of twenty-five (25) letters per nameplate and label.

- .6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.

2.02 Wiring Identification

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

2.03 Wire Markers

- .1 Description: tape, split sleeve, or tubing type wire markers.
- .2 Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes and each load connection.
- .3 Legend:
 - .1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
 - .2 Control Circuits: Control wire number indicated on shop drawings.

2.04 Conduit and Box Markers

- .1 Colour code conduits, boxes, and metallic sheathed cables.
- .2 Location: Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours to match equipment nameplate background colour:
 - .1 347/600 volt system: Blue.
 - .2 120/208 volt system: Black.
 - .3 Fire Alarm system: Red.
 - .4 Emergency Lighting system: Red/White.
 - .5 LV Systems (EPO, Remote Monitoring, Generator Control, Communications): Green.
 - .6 120/208 volt Uninterruptable Power Supply (UPS): Orange.
- .4 Confirm colours with the Consultant prior to commencing rough-in.

2.05 Junction and Pull Boxes

- .1 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers.
- .2 Spray painting: not permitted.
- .3 Paint colours to be in accordance with following schedule:

- .1 Lighting: yellow.
 - .2 Normal power: blue.
 - .3 Emergency power: orange.
 - .4 Fire alarm: red.
 - .5 Communications systems including telephone and data: green.
 - .6 Miscellaneous signals: brown.
- .4 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed. Identify source panelboard for power circuits.

2.06 Branch Breaker Labels

- .1 General:
 - .1 Legibly identify every circuit and circuit modification as to its clear, evident, and specific purpose or use. Include sufficient detail to allow each circuit to be distinguished from all others.
 - .2 Label spare positions that contain unused overcurrent devices or switches.
 - .3 Do not describe any circuit in a manner that depends on transient conditions of occupancy.
- .2 Switchboards, distribution panelboards, enclosed breakers, and disconnect switches:
 - .1 Locate identification at each switch.
 - .2 Branch breaker nameplates on switchboards, distribution panelboards and switchboards, and generator load breakers to indicate:
 - .1 Locate identification at each switch on a switchboard.
 - .2 Identification of downstream equipment fed from the breaker.
 - .1 Location of downstream device if not in the same room.
 - .3 Breaker size and number of poles.
 - .4 Interrupting Capacity.
 - .5 Circuit number (where applicable).
 - .6 Do not describe any circuit in a manner that depends on transient conditions of occupancy.
- .3 Lighting and Receptacle Panelboards:
 - .1 Provide a circuit directory that is located on the face or inside of the panel door.
 - .2 Do not describe any circuit in a manner that depends on transient conditions of occupancy.

2.07 Receptacle Labels

- .1 Label all receptacles with the panelboard ID and circuit number.

- .2 Use receptacle labels by electronic labeller Brother P-Touch, model PT-20/25, Dymo-Tape or approved equal.
- .3 Location: On receptacle wall plate.

3 Execution

3.01 Equipment Nameplates from Manufacturers

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.
- .2 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.
- .3 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

3.02 Conduit and Box Identification

- .1 Locate labels as follows:
 - .1 At every end of every conduit, duct, or cable run, adjacent to item of equipment serviced.
 - .2 On each exposed conduit, duct or cable passing through a wall, partition, or floor (one on each side of such wall partition or floor).
 - .3 At intervals of 15 m (50 ft) along every exposed conduit, duct or cable run exceeding 15 m (50 ft) in length.
 - .4 At every access point on concealed conduit duct or cable.
 - .5 At each junction box.
- .2 Place labels so as to be visible from 1500 mm (5 ft) above adjacent floor platform.

3.03 Preparation

- .1 Degrease and clean surfaces to receive nameplates and labels.

3.04 Application

- .1 Confirm colours prior to start of work.
- .2 Install nameplate and label parallel to equipment lines.
- .3 Secure nameplate to equipment front using adhesive.
- .4 Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- .5 Identify conduit using field painting.
- .6 Paint coloured band on each conduit longer than 2 m.
- .7 Paint bands 6 m on centre.

3.05 Labelling

- .1 Colour code wiring consistently throughout the installation and generally match colour coding of internal wiring of pre-wired components.
- .2 Label wiring with point name using Thomas & Betts 12 character polestar metalized labels with 3 rows of characters per label, or equal by Brady. Label to occur as a minimum at both ends and at pull boxes of the wiring run.
- .3 Identify all pull boxes, junction boxes, etc. (installed as part of this project or used by this project) with the exact use of the box. Indelible felt pen marker is acceptable.
- .4 Label light control items with point name using Thomas & Betts 12 character label, or equal by Brady. Label to be black lettering on clear backing.
- .5 Label relays and controllers inside panels using Thomas & Betts 12 character label, or equal by Brady.
- .6 Provide red, 13 mm (1/2 in) diameter, sticker on emergency light fixture frame. Include circuit number on sticker with thin permanent black mark pen.

3.06 Labels and Signs

- .1 Manufacturers' nameplates and CSA labels are to be visible and legible after equipment is installed. Provide warning signs, as specified, or to meet requirements of Inspection Department, Health and Safety, and the Consultant.
- .2 Label power outlets with circuit identification on visible portion of faceplate or surface mounted outlet box.

End of Section

1 General

1.01 Section Includes

- .1 Provide an Arc Flash Hazard Analysis Study per the requirements described in CSA Z462 Standard for Electrical Safety in the Workplace.
- .2 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are obtained in CSA Z462-08, Annex D, or more recent version of the standard as cited by this Section.
- .3 The scope of the studies shall include all existing distribution equipment and all new distribution equipment supplied by the equipment manufacturer under this contract.

1.02 Related Requirements

- .1 Section 26 05 73.16 – Coordination Studies.
- .2 Single Line Diagram.

1.03 References

- .1 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - .1 IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
 - .2 IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
 - .3 IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
 - .4 IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
 - .5 IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - .6 IEEE 1584-2018 - Guide for Performing Arc-Flash Hazard Calculations.
- .2 American National Standards Institute (ANSI):
 - .1 ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 - .2 ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
 - .3 ANSI C37.010-2016 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
 - .4 ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
- .3 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA Z462:24, Workplace electrical safety.

1.04 Submittals

- .1 Submit the arc flash study to the Consultant prior to receiving final review of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
- .2 Upon review by the Consultant, submit the arc-flash study to the local electrical utility for their review and approval.

1.05 Closeout Submittals

- .1 The results of the protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Three (3) bound copies of the complete final report shall be submitted. Additional copies of the complete report with input and output data shall be provided on CD in PDF format.
- .2 The report shall include the following sections:
 - .1 Executive Summary.
 - .2 Descriptions, purpose, basis, and scope of the study.
 - .3 Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short circuit duties.
 - .4 Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
 - .5 Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 - .6 Details of the incident energy and flash protection boundary calculations.
 - .7 Recommendations for system improvements, where needed.
 - .8 Single Line Diagram.
- .3 Arc flash labels (refer to CSA Z462 Annex Q) shall be provided in hard copy only.

1.06 Qualifications

- .1 Arc flash hazard analysis studies shall be conducted under the supervision and approval of a licensed Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- .2 The licensed Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.
- .3 The licensed Professional Electrical Engineer shall have a minimum of eight (8) years of experience in performing power system studies.
- .4 The equipment manufacturer or approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.07 Computer Analysis Software

- .1 The studies shall be performed using the latest revision of the SKM or equivalent.

2 Products

2.01 Manufacturers

- .1 Independent Testing Organizations:
 - .1 AC Tesla.
 - .2 Brosz and Associates.
 - .3 C-INTECH.
 - .4 Eastenghouse.
 - .5 G.T. Wood.
 - .6 Haronitis and Associates Ltd.
 - .7 Qualus (formerly Enkompass).
- .2 Electrical distribution manufacturers:
 - .1 Eaton.
 - .2 Schneider Electric.

2.02 Studies

- .1 The contractor shall furnish an Arc Flash Hazard Analysis Study per CSA Z462, reference Section 4.1.8.2.2, 4.3.3.

2.03 Data Collection

- .1 Contractor shall furnish all data as required by the power system studies. The Engineer performing arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- .2 Source combination may include present and future motors and generators.
- .3 If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.04 Arc Flash Hazard Analysis

- .1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in CSA Z462 Annex D.
- .2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, panelboards, and splitters) where work could be performed on energized parts.
- .3 The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 112.5 kVA where work could be performed on energized parts.
- .4 Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 calories per square centimetre.

- .5 When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.
- .6 The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- .7 The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - .1 Fault contribution from induction motors should not be considered beyond 3-5 cycles.
- .8 Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- .9 For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- .10 When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- .11 Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- .12 Arc Flash calculations shall be based on actual overcurrent protective device clearing time.
- .13 Maximum clearing time will be capped at 2 seconds based on IEEE 1584.
- .14 Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.05 Report Sections

- .1 Incident energy and flash protection boundary calculations:
 - .1 Arcing fault magnitude.
 - .2 Protective device clearing time.
 - .3 Duration of arc.
 - .4 Arc flash boundary.
 - .5 Working distance.

- .6 Incident energy.
- .7 Hazard Risk Category.
- .8 Recommendations for arc flash energy reduction.

3 Execution

3.01 Field Adjustment

- .1 Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- .2 Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- .3 Notify Owner in writing of any required major equipment modifications.

3.02 Arc Flash Warning Labels

- .1 The contractor of the Arc Flash Hazard Analysis shall provide a 90 mm (3.5 in) by 125 mm (5 in) thermal transfer type label of high adhesion polyester for each work location analyzed.
- .2 All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- .3 The label shall include the following information, at a minimum:
 - .1 Location designation.
 - .2 Nominal voltage.
 - .3 Flash protection boundary.
 - .4 Hazard risk category.
 - .5 Incident energy.
 - .6 Working distance.
 - .7 Engineering firm and issue date.
 - .8 Labels shall be machine printed, with no field markings.
- .4 Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - .1 For each 600 volt, and applicable 208 volt panelboard, one arc flash label shall be provided.
 - .2 For each motor control centre, one arc flash label shall be provided.
 - .3 For each low voltage switchboard, one arc flash label shall be provided.
 - .4 For each switchgear, one flash label shall be provided.
 - .5 For medium voltage switches one arc flash label shall be provided.

- .5 Arc Flash Warning Label General Instructions:
- .1 Only qualified electricians who recognize and avoid the electrical and Arc Flash hazards are allowed to place the arc flash warning labels.
 - .2 Electricians should wear suitable PPE, such as electrical safety boots, Safety Glasses, etc. while performing labeling.
 - .3 Generally, arc flash label shall be put on a prominent pre-cleaned place on the front of the electrical equipment (such as switchgear, panel, disconnect switch, generator output breaker). Label should be visible and readable, displayed horizontally, attached flatly and securely, and not allowed to cover other signs or labels on the equipment.
 - .4 Under the special request of the client, labels could be put on the back of the panel door when the panel is located in clean and finished spaces such as an office area.
 - .5 When putting a label on small equipment with no space labeling on the wall just beside the equipment is allowed.
 - .6 Special request may be attached to this General Instruction. For examples, more than one identical label is applied for large equipment; different labels could be applied for different sections of one equipment; for a splitter with several disconnect switches only one label is placed on the splitter for this group.
 - .7 Take the pictures for each label to indicate both names of the label and equipment and labeling area of the equipment. Email these pictures to the Consultant for quality control and record.

End of Section

1 General

1.01 Section Includes

- .1 Electrical connections to equipment specified in other sections.
- .2 Conduit rough-ins for future equipment.

1.02 Related Requirements

- .1 Division 08 – Openings.
- .2 Division 11 – Equipment.
- .3 Division 14 – Conveying Equipment.
- .4 Division 20 – Common Mechanical Requirements.
- .5 Section 20 05 13 – Common Motor Requirements for Mechanical Equipment.
- .6 Division 21 – Fire Suppression.
- .7 Division 22 – Plumbing.
- .8 Division 23 – Heating, Ventilating, and Air Conditioning.
- .9 Division 25 – Integrated Automation.

1.03 References

- .1 NEMA WD 1 - General Color Requirements for Wiring Devices.
- .2 NEMA WD 6 - Wiring Devices - Dimensional Specifications.

1.04 Coordination

- .1 Coordinate work to Section 01 30 00.
- .2 Obtain and review shop drawings, product data, and manufacturer's instructions for equipment provided under other sections.
- .3 Determine connection locations and requirements.
- .4 Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- .5 Sequence electrical connections to coordinate with start-up schedule for equipment.

1.05 Submittals

- .1 Submit to Section 01 30 00.
- .2 Product Data: Provide wiring device manufacturer's catalogue information showing dimensions, configurations, and construction.
- .3 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.06 Regulatory Requirements

- .1 Provide products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

2 Products

2.01 Common Motor Requirements

- .1 Motors up to and including 1/3 hp, shall be 1 phase, 60 Hz, 120 V.
- .2 Motors 1/2 hp and above shall be 3 phase, 60 Hz, 575 V or 208 V.

2.02 Cords and Caps

- .1 Attachment Plug Construction: Conform to NEMA WD 1.
- .2 Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
- .3 Cord Construction: NFPA 70, Type SJO multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- .4 Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

3 Execution

3.01 Conduit Pathways and Rough-Ins

- .1 Where drawings indicate to rough-in conduits for future equipment, or equipment to be provided by the Owner, or other systems as noted on the plans, provide pull string in the conduit, and tag the conduit for the reserved future use/purpose.
- .2 Where circuits breakers, disconnect switches, or other electrical distribution is provided for future equipment, tag the devices with the reserved future use/purpose.

3.02 Wiring of Equipment Provided Under Other Divisions

- .1 Use the following procedures for wiring of motors and equipment provided under other Divisions.
- .2 The following equipment shall be responsibility of the trade supplying the equipment unless otherwise noted, in accordance with the requirements laid out in the individual section, or this division:
 - .1 Motors.
 - .2 Starters.
 - .3 Variable Frequency Drives.
 - .4 Motor Control Centres.
 - .5 Control wiring.
- .3 In every instance, install starter, motor control centre, variable frequency drivers (VFD), etc. and wire to line side of the starter, the Motor Control Centre (MCC), or VFD. Extend wiring from starter, MCC, or VFD to motor as indicated.

- .4 Provide all wiring for starters and VFD's from supply to starter to VFD and to motor. Coordinate requirements with the appropriate trade.
- .5 Provide 500 mm of liquid tight flexible metal conduit for final connection to motor. Provide disconnect switches where required by code, and as indicated on the drawings.
- .6 Where individual starters and controls are grouped together provide a panel for mounting this equipment. Provide a feeder, main fused disconnect and a splitter of adequate size and capacity and wire to line side of the starters on this panel and from starters to motors.
- .7 Equipment, General
 - .1 Ascertain exact locations of starters, motor control centres, motors, etc. from drawings and coordinate exact locations with the supplying trade.
 - .2 Control wiring shall be the responsibility of the supplying trade.
 - .1 Control wiring shall be in accordance with Section 26 05 19, and Section 26 05 23.
 - .2 Control wiring shall be installed in conduit in accordance with Section 26 05 33.13.
- .8 Doors
 - .1 Ascertain exact locations of door operators, actuator push buttons, automatic sensors, and other door hardware.
 - .2 Locate power door operator actuators not less than 600 mm and not more than 1500 mm beyond the door swing where the door opens towards the control.
 - .3 Provide branch circuit wiring for door operators.
 - .4 Provide control and control wiring for all low voltage door interconnections.
- .9 Barrier Free Washrooms
 - .1 Ascertain exact locations of door operator, actuator push buttons, automatic sensors, electronic locking actuator, door lock indicators, and other door hardware.
 - .2 Locate power door operator actuators not less than 600 mm and not more than 1500 mm beyond the door swing where the door opens towards the control.
 - .3 Provide branch circuit wiring for door operators.
 - .4 Provide control and control wiring for all low voltage door interconnections.
- .10 Universal Washrooms
 - .1 Ascertain exact locations of door operator, actuator push buttons, automatic sensors, electronic locking actuator, door lock indicators, and other door hardware.
 - .2 Locate power door operator actuators not less than 600 mm and not more than 1500 mm beyond the door swing where the door opens towards the control.
 - .3 Provide branch circuit wiring for door operator and emergency call system.
 - .4 Provide control and control wiring for all low voltage door interconnections.

- .5 Provide rough-in, boxes, conduit and control wiring for emergency call system, including integration with power door operator, and indicators located inside and outside the universal washroom, and actuator push button.
- .6 Provide one 5-15R duplex receptacle to accommodate the adult-size change table.
- .11 Conveying Equipment (e.g. Elevators): in accordance with Section 26 05 83.14.
- .12 Fire-Suppression
 - .1 Ascertain exact locations of starters, motors, compressors, and pumps from fire suppression drawings and coordinate exact locations with the fire protection trade.
 - .2 Provide branch circuit wiring to pumps, compressors, etc.
- .13 Plumbing Equipment
 - .1 Ascertain exact locations of starters, motor control centres, motors, infra-red plumbing fixture controls from Mechanical Drawings and coordinate exact locations with plumbing trade.
 - .2 Provide branch circuit wiring and an outlet for each infra-red plumbing fixture control.
 - .3 Control wiring shall be the responsibility of the plumbing trade, as described above.
- .14 HVAC Equipment
 - .1 Ascertain exact locations of starters, motor control centres, motors, motorized dampers, VAV boxes, and heating control valves from HVAC drawings and coordinate exact locations with HVAC Division.
 - .2 In the case of unit heaters, reheat coils and cabinet unit heaters, terminate wiring on terminals provided. Control wiring, thermostats, or other control devices shall be the responsibility of the HVAC trade, as described above.
 - .3 Provide branch circuit wiring and an outlet for each motorized damper, variable air volume (VAV) box, or heating control valve. Control wiring shall be the responsibility of the HVAC trade, as described above.
 - .4 Provide 120 V power connections to small exhaust fans, and ceiling fans for all line voltage control devices, including but not limited to wiring through toggle switches, line voltage thermostats, countdown timer switches, or line voltage speed controllers. Refer to mechanical drawings and schedules for control devices and coordinate requirements with HVAC Division.
 - .5 Provide 120 V wiring connections to duplex receptacles integral with air handling unit control panels.
 - .6 Provide 120 V wiring connections to HVAC maintenance receptacles integral with roof mounted HVAC equipment.
 - .7 Provide 120 V wiring connections to lighting fixture/switch combinations integral with air handling units.
- .15 Integrated Automation (Building Automation System)
 - .1 Refer to drawing notes for requirements.
 - .2 Provide 120 V wiring connections to BAS system controllers/panels and other control system or component requiring 120 V power including, but not limited to, VAV boxes, dampers, low voltage transformers, etc.

- .3 From equipment as noted on drawings, extend suitable wiring in conduit from equipment contacts to designated BMS panel serving area, terminating wiring and conduit in a junction box. Leave wiring un-terminated with slack coiled length of minimum 2 m (6 ft) long. Clearly label junction box and wiring end for termination onto BMS panel by respective Mechanical Trade.

3.03 Examination

- .1 Verify that equipment is ready for electrical connection, wiring, and energization.

3.04 Electrical Connections

- .1 Provide a local disconnect switch for all equipment, regardless of if a disconnect switch is shown or not shown on the plans.
- .2 Make electrical connections to equipment manufacturer's instructions.
- .3 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.
- .4 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- .5 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.
- .6 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- .7 Install disconnect switches, controllers, control stations, and control devices as indicated.
- .8 Modify equipment control wiring with terminal block jumpers as indicated.
- .9 Provide interconnecting conduit and wiring between devices and equipment where indicated.

End of Section

1 General

1.01 Section Includes

- .1 Commissioning of all building electrical systems and component including:
 - .1 Testing and adjustment.
 - .2 Demonstration and training.
 - .3 Instructions of all procedures for Owner's personnel.
 - .4 Updating as-built data.
 - .5 Co-ordination of Operation and Maintenance material.
- .2 Provide labour and material to conduct the commissioning process as outlined in this specification section, including the hiring of an Independent Testing Contractor (ITC) as detailed below.
- .3 Provisions of this section shall apply to all sections of Division 26, Division 27, Division 28, and sections related to electrical utilities in Division 33.

1.02 Related Requirements

- .1 Testing and commissioning are called for throughout the individual specifications. This does not relieve this trade from providing all testing and commissioning necessary to ensure that systems and equipment operate as required and that they interface with other systems and equipment as required.
- .2 Section 26 08 50 – Commissioning of Lighting: additional commissioning requirements for commissioning of lighting and lighting controls.

1.03 Commissioning Process Allocation

- .1 The commissioning process shall be allocated a value equal to 5 per cent of the contract. The Electrical Contractor may draw from this allocation as the commissioning process is completed.
- .2 The Electrical Contractor shall submit all test and verification forms. The Consultant will use these forms to calculate percentage complete.
- .3 The Electrical Contractor may claim up to 3 per cent of the contract from this allocation leading up to performance testing. The remaining 2 per cent shall not be paid out until the performance testing, O&M manuals, and training have been completed satisfactorily.

1.04 Definitions

- .1 Cx – Commissioning.
- .2 Commissioning Authority
 - .1 The Commissioning Authority (CxA), also referred to as the Commissioning Consultant, shall be hired by The Owner.
 - .2 The CxA responsibilities shall include:
 - .1 preparing the commissioning plan.
 - .2 co-ordinating with the contractor to schedule tests.
 - .3 preparing a test form manual.

- .4 witnessing selected tests.
- .5 receiving all test forms.
- .6 co-ordinating the contractors training.
- .7 chair the commissioning meetings.
- .3 The Electrical Contractor shall co-operate with the CxA.
- .4 The Electrical Contractor shall provide assistance to the CxA and have personnel available during the performance testing procedure. Each electrical system shall be tested in the operational mode.

1.05 Submittals

- .1 Conform to Section 01 30 00 for requirements for shop drawings and record drawings.
- .2 A commissioning document shall be prepared by the CxA prior to conducting these activities for use by the Commissioning Team.
- .3 The electrical sub-contractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the General Contractor.
- .4 As-built drawings and data books must be available two weeks prior to commissioning for review and use by the consultant and Commissioning Team prior to the start of the commissioning activities.

1.06 Closeout Submittals

- .1 Attendance records for all training sessions.
- .2 Testing reports for system load balance measurements, infra-red test and harmonics tests.

1.07 Quality Assurance

- .1 Provide qualified trades persons, certified testing agencies, factory trained and approved by the Commissioning Team Leader.
- .2 Submit the names of all personnel to be used during the Commissioning activities.

1.08 Warranty

- .1 Equipment and system warranties shall not begin until the system demonstration and turnover has been conducted successfully and accepted by the Owner.
- .2 The Electrical Contractor shall fill out the warranty form listing the equipment and systems and the start and finishing dates for warranty.
- .3 Refer to Division 01 and Section 26 05 00 for the requirements during the warranty period.

2 Products

2.01 Equipment

- .1 The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests specified. The Contractor shall advise the Consultant of instrumentation to be used and the dates the instruments were calibrated.

3 Execution

3.01 The Commissioning Process

- .1 The purpose of the commissioning process is to fully test all building systems including architectural, mechanical, and electrical components and operating procedures by challenging these systems to realistic operation conditions.
- .2 The commissioning process consists of:
 - .1 Shop Drawings and Record Drawings.
 - .2 Installation inspection and equipment verification.
 - .3 Independent testing contractor.
 - .4 Testing of equipment and systems.
 - .5 Commissioning meetings.
 - .6 Operating and maintenance manuals.
 - .7 Operating training.
 - .8 Commissioning Agent testing.
 - .9 Systems Demonstration and turnover.
 - .10 Testing forms.
 - .11 Warranties.

3.02 Preparation

- .1 Provide test instruments required for all activities as defined in the commissioning documents.
- .2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.
- .3 Confirm all scheduled activities have identified personnel available.
- .4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

3.03 System Description

- .1 Perform all start-up operations, control adjustment, trouble shooting, servicing and maintenance of each item of equipment as defined in the commissioning documentation.
- .2 Owner will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.
- .3 Prepare and insert additional data in the operations and maintenance manuals and update as-built drawings when need for additional data becomes apparent during the commissioning exercise.
- .4 Where instruction is specified in the commissioning manual, instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
- .5 Conduct presentation on Owner's premises. Owner will provide space.

3.04 Commissioning

- .1 Commission the components of the electrical system using the NETA Acceptance Testing Specifications.
- .2 Refer to the project commissioning plan prepared by the CxA.
- .3 Commissioning activities for the electrical systems must have available up to date as-built drawing information and accurate Operations and Maintenance Manuals. These documents shall be a major part of this activity.
- .4 Contractor shall be responsible to update all documentation with information and any changes duly noted during the Commissioning exercise.
- .5 Contractor shall arrange for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification. The cost associated with this requirement shall be included as part of the tender price.

3.05 Final Report

- .1 This trade shall assemble all testing data and commissioning reports and submit them to the General Contractor for submission to the Owner.
- .2 Each form shall bear signature of recorder, and that of supervisor of reporting organizer.

3.06 Schedule of Activities

- .1 Commissioning activities shall be conducted based on pre-established schedule with all members of the commissioning team.
- .2 In addition, there will be two meetings held through the contract duration to introduce the parties of the commissioning team, establish the schedules and deadlines for the various activities and review the Commissioning Manual.
- .3 Adhering to the established schedule is very important as the co-ordination and scheduling of the participants will be difficult to alter once this is established. Close co-ordination of this schedule is important.
- .4 In the event project cannot be commissioned in the allotted time slot, the contractor shall pay for all costs associated with assembling the Commissioning Team at a later date. If the contractor has not performed his duties to reach commissioning stage as outlined earlier, he will incur all expenses of other trades and the Commissioning Team due to his non-compliance.

3.07 Installation Inspection and Equipment Verification

- .1 The Electrical Contractor shall co-ordinate with the Electrical Consultant who will inspect the electrical installation.
- .2 The Electrical Contractor shall complete the equipment verification forms for each piece of equipment. The forms shall be included in the operating and maintenance manual. The equipment data shall include:
 - .1 Manufacturers name, address, and telephone number.
 - .2 Distributors name, address, and telephone number.
 - .3 Make, model number and serial number.
 - .4 Voltage and current ratings.

3.08 Independent Testing Contractor

- .1 The Independent Testing Contractor (ITC) shall be hired by the contractor and shall issue reports to the Electrical Consultant.
- .2 The ITC shall conduct load balancing measurements to verify load balancing performed in accordance with Section 26 05 00.

3.09 Testing of Equipment and Systems

- .1 The Electrical Contractor shall be responsible for all tests detailed in this Section, and those tests required by a manufacturer as part of their installation requirements.
- .2 The Electrical Contractor shall schedule all tests which shall be witnessed by the Electrical Consultant or the Commissioning Consultant. The contractor shall complete and sign the testing forms.
- .3 The Electrical Contractor shall conduct tests on the following equipment as a minimum. Refer to the individual specification sections for test procedures.
 - .1 Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
 - .2 Section 26 05 73.16 – Coordination Studies.
 - .3 Section 26 24 13 – Switchboards.
 - .4 Section 26 24 16 – Panelboards.
 - .5 Section 27 51 16 – Public Address Systems.
 - .6 Section 28 10 00 – Access Control.
 - .7 Section 28 46 13 – Fire-Alarm Systems.
- .4 When all testing has been completed and all mechanical and electrical systems are operational the contractor shall conduct system load balance measurements, infra-red test and harmonics tests.

3.10 Commissioning Meetings and Reporting

- .1 The Electrical Contractor shall include the schedule for all tests in the construction schedule.
- .2 The Commissioning meetings shall occur during the regular construction meetings. The testing schedules and the results of all tests shall be reviewed.
- .3 All testing forms and reports associated with the electrical systems shall be directed to the Electrical Consultant, with copies to the Consultant, Commissioning Consultant, and the Owner.
- .4 The forms and reports to be issued shall include:
 - .1 Shop drawings, issued and accepted.
 - .2 Equipment verification forms.
 - .3 Testing forms.
 - .4 Reports resulting from tests.
 - .5 Testing schedule.
 - .6 Minutes of commissioning meetings.

.7 Manufacturers' Certificates.

3.11 Operating and Maintenance Manual

.1 Conform to the specification section for the requirements of the O&M manuals.

3.12 Closeout Activities

.1 Conform to section for requirements for instructions to the Building Owner for each system and equipment.

.2 The training shall be provided by qualified technicians or electricians and shall be conducted in a classroom and at the equipment or system.

.3 The training sessions shall be scheduled, co-ordinated and video recorded by the Contractor.

.4 Each training session shall be structured to cover:

.1 The operating and maintenance manual.

.2 Operating procedures.

.3 Maintenance procedures.

.4 Troubleshooting procedures.

.5 Spare parts.

.5 Submit a course outline to the Electrical Consultant before training commences. Provide course documentation for up to eight people.

.6 The training session shall be scheduled and co-ordinated by the Commissioning Consultant. The Contractor shall video tape the sessions.

.7 Training shall be provided for the following systems:

.1 Electrical Systems including distribution and lighting: 8 hour minimum

.2 Section 27 51 16 – Public Address Systems: 1 hour minimum

.3 Section 28 10 00 – Access Control: 1 hour minimum

.4 Section 28 46 13 – Fire-Alarm Systems: 2 hours minimum

.8 The Electrical Contractor shall conduct a walkthrough of the installation. During the walkthrough the Electrical Contractor shall:

.1 Identify equipment.

.2 Identify electrical panels.

.3 Identify starters and disconnects.

.4 Review the electrical power distribution.

.5 Review the light power distribution.

.6 Review the switchgear.

- .7 Review the general maintenance procedures.

3.13 The Electrical System Demonstration and Turnover

- .1 The system demonstration and turnover to The Owner shall occur when:
 - .1 The installation is complete.
 - .2 The acceptance test conducted by the Electrical Consultant has been completed successfully.
 - .3 Training has been completed.
 - .4 Equipment Operating and Maintenance Manuals have been accepted.
 - .5 System operating manuals have been accepted.
 - .6 Shop-drawings have been updated.
 - .7 As-built drawings have been completed.
 - .8 The commissioning process has been completed successfully and system operation accepted by the Electrical Consultant and Commissioning Consultant.
- .2 The systems demonstration shall be conducted by the Electrical Contractor and manufacturers. The demonstration shall cover a physical demonstration of equipment installation and operation.

3.14 Testing Forms

- .1 The Electrical Contractor and manufacturers shall fill out the forms listed in this section or provide other forms. The forms must be approved by the Electrical Consultant and the Owner before they are used.

End of Section

1 General

1.01 Section Includes

- .1 Common requirements for commissioning of all electric lighting, including interior, exterior, and emergency lighting.
- .2 The party responsible for the functional testing shall not be directly involved in either the design or construction of the project.

1.02 Related Requirements

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 51 19 – LED Interior Lighting.
- .3 Section 26 52 13.13 – Emergency Lighting.
- .4 Section 26 56 19 – LED Exterior Lighting.

1.03 References

- .1 ASHRAE
 - .1 ASHRAE Guideline 0-2005 – The Commissioning Process.
 - .2 ANSI/ASHRAE/IES 90.1-2013 – Energy Standard for Building Except Low-Rise Residential Buildings.
- .2 Illumination Engineering Society (IES)
 - .1 IES DG-29-11 – Design Guide for the Commissioning Process Applied to Lighting and Control Systems.
- .3 Ontario Building Code
 - .1 Supplementary Standard SB-10: Energy Efficiency Requirements, December 22, 2016 update.

1.04 Action Submittals

- .1 Refer to Section 01 33 00.
- .2 Submit sample commissioning forms.

1.05 Closeout Submittals

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Submit commissioning reports.
 - .1 Submit a floor plan or spreadsheet table checklist that indicates each local lighting control device, occupancy sensors, daylighting controls, system component.
 - .2 Submit the system sequence of operation fully describing the equipment components and functionality, including set points and alarm functions.
 - .3 The detailed sequence of operation shall be provided regardless of the completeness and clarity of the sequences in the controls specification and/or drawings.

- .3 The functional testing party shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.

2 Products – Not Used

3 Execution

3.01 Site Tests and Inspections

- .1 Sensor placement and orientation for all sensor types.
- .2 Occupancy sensor function, sensitivity, and time delays.
- .3 Daylight harvesting sensor calibration.
- .4 Manual control placement and operation.
- .5 Automated control operation, including scheduled on/off functions and dimming trims and presets.
- .6 Override operation, access, and functionality.
- .7 Centralized control interfaces and operation.
- .8 Client education of operations.
- .9 Documentation archived to client.

3.02 Functional Testing

- .1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
- .2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:
 - .1 Confirm that the placement, sensitivity, and time-out adjustments for occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.
 - .2 Confirm that time switches and programmable schedule controls are programmed to turn the lights off.
 - .3 Confirm that photosensor controls reduce electric lights levels based on the amount of usable daylight in the space as specified.

End of Section

1 General

1.01 Section Includes

- .1 Occupancy and Vacancy sensors.
- .2 Power packs, and auxiliary relays, momentary switches.
- .3 Timers.
- .4 Daylight harvesting photo sensors.
- .5 Emergency lighting control units.

1.02 Products Installed But Not Supplied Under This Section

- .1 Line voltage manual control devices, as described in Section 26 27 26 – Wiring Devices.

1.03 Related Requirements

- .1 Section 26 08 50 – Commissioning of Lighting.
- .2 Section 26 27 26 – Wiring Devices.
- .3 Section 26 51 19 – LED Interior Lighting.
- .4 Section 26 56 19 – LED Exterior Lighting.

1.04 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 42 – General Use Receptacles.
 - .4 CSA C22.2 No. 42.1 – Cover Plates for Flush Mounted Wiring Devices.
 - .5 CSA C22.2 No. 141 – Emergency lighting equipment.
 - .6 CSA C22.2 No. 184 – Solid-State Lighting Controls.
 - .7 CSA C22.2 No. 184.1 – Solid State Dimming Controls.
- .2 Ontario Building Code.
- .3 UL 924 - Standard for Safety of Emergency Lighting and Power Equipment.
- .4 UL 2043 – Standard for fire test for heat and visible smoke release for discrete products and their accessories installed in air-handling spaces.
- .5 NEMA WD 7 – Occupancy motion sensors standard.

1.05 Submittals

- .1 In accordance with Section 01 33 00.

- .2 Product Data:
 - .1 Submit manufacturer's descriptive literature and product specifications for each product.
 - .2 Manufacturer's product drawings.
 - .3 Manufacturer's installation instructions.
- .3 Where the lighting controls include the option for custom engraving, or custom touchscreen user interfaces on control devices, switches, or scene controllers, the Contractor is to submit proposed engraving/labelling/graphics as part of the shop drawing submittal, for review by the Owner.

1.06 Closeout Submittals

- .1 Documentation of all lighting control system setpoints, sensor sensitivities, occupancy sensor timeouts, and as-programmed sequences of operation to aid in future troubleshooting.
- .2 Lighting controls functional test report.

1.07 Quality Assurance

- .1 Manufacturer Qualifications: Products free of defects in material and workmanship.

1.08 Warranty

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.

2 Products

2.01 Manufacturers

- .1 Wattstopper DLM (Basis of Design).
- .2 Acuity Brands Lighting nLight/Sensorswitch.
- .3 Lutron Vive.
- .4 Cooper Lighting Solutions Greengate DVLP.
- .5 Leviton.

2.02 General Requirements of all Devices

- .1 Manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 per cent.
- .2 Five year warranty and CUL listed.
- .3 All devices specified shall have the ability to be connected on a digital loop and programmed separately.
- .4 All user input devices with two or more buttons have the ability to be programmed as multiple load switching or single load dimming.
- .5 The devices have the ability to be connected as a single room, and also scalable to an enterprise solution.

2.03 Occupancy and Vacancy Sensors

- .1 General:
 - .1 Sensors using passive infrared, ultrasonic, microphonic, and multi-technology adaptive technology.
 - .2 Configurable sensor timeouts.
 - .3 Rating: 24 VDC input voltage.
 - .4 Environmental:
 - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
 - .2 Relative Humidity: 5 per cent to 95 per cent non-condensing.
 - .5 Sensors shall connect with load controller via cat5e cabling with RJ45 terminations.
- .2 Dual Technology Wall Switch Sensor, 24V
 - .1 Available in one or two button configuration.
 - .2 Wattstopper LMDW-100 series (Basis of Design).
 - .3 Utilize a dual sensing verification principle for coordination between ultrasonic and Passive Infrared (PIR) Technologies to reduce likelihood of false triggering.
 - .4 Adjustable sensitivity, PIR 10-100%, Ultrasonic 10-100% in increments of 10%.
 - .5 Coverage up to 25 ft diameter for minor motion, and 35 ft diameter with a field view of 180 degrees.
 - .6 Adjustable automatic-ON or manual-ON operation.
 - .7 Adjustable detection and retrigger technology (PIR/Ultrasonic/both/either).
 - .8 Sensor shall have an adjustable time delay.
 - .9 Sensor shall fit in a single gang box with a typical decora faceplate.
- .3 Dual Technology Ceiling Mounted Sensor, 24V
 - .1 Wattstopper LMDC-100 series (Basis of Design).
 - .2 Adjustable sensitivity, PIR 10-100%, Ultrasonic 10-100% in increments of 10%.
 - .3 Coverage up to 20 ft diameter for minor motion, and 30 ft diameter with a field view of 360 degrees.
 - .4 Adjustable detection and retrigger technology (PIR/Ultrasonic/both/either).
 - .5 Sensor shall have an adjustable time delay.
 - .6 Sensor shall fit in a 1.5 in deep octagon box.
- .4 Dual Technology Corner Mount Sensor, 24V
 - .1 Ceiling or wall mounted as directed.

- .2 Wattstopper LMDX-100 series (Basis of Design).
- .3 Adjustable sensitivity, PIR 10-100%, Ultrasonic 10-100% in increments of 10%.
- .4 Coverage up to 25 ft diameter for minor motion, and 40 ft diameter with a field view of 90 degrees.
- .5 Adjustable detection and retrigger technology (PIR/Ultrasonic/both/either).
- .6 Sensor shall have an adjustable time delay.
- .7 Sensor shall fit in a 4 in square box with mounting plate and base.

2.04 Daylight Harvesting Photo Sensors

- .1 Closed loop photosensor
 - .1 Ceiling mounted, recessed or surface (with bracket).
 - .2 Wattstopper LMLS-400 series (Basis of Design).
 - .3 Spatial response: 100 degrees.
 - .4 Sensor suitable between 1-1,553 foot candles.
 - .5 Environmental:
 - .1 Operating Temperature Range: 0 degrees C to 55 degrees C
 - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing.
- .2 Open loop photosensor
 - .1 Ceiling or wall mounted, recessed or surface (with bracket).
 - .2 Wattstopper LMLS-500 series (Basis of Design).
 - .3 Spatial response: 60 degrees.
 - .4 Sensor suitable between 1-1,500 foot candles.
 - .5 Environmental:
 - .1 Operating Temperature Range: 0 degrees C to 55 degrees C
 - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing.

2.05 Decorator Low Voltage Momentary Switches

- .1 Wattstopper LMSW-100 series (Basis of Design).
- .2 Suitable for switching, dimming and scene selection.
- .3 Available in 1, 2, 3, 4, 5, and 8 button configurations.
- .4 Two RJ45 ports for daisy chaining multiple devices.
- .5 Switch shall fit in a single gang box with a typical decora faceplate.
- .6 Environmental:

- .1 Operating Temperature Range: 0 degrees C to 55 degrees C
- .2 Relative Humidity: 5 per cent to 95 per cent non-condensing.

2.06 Power Packs

- .1 General:
 - .1 Power packs shall have the ability to be daisy chained on one digital loop.
 - .2 Internal relay controlling up to 20A for 120/277VAC or 15A for 347VAC ballast loads total per power pack.
 - .3 Power pack shall be available in 0-10V or forward phase dimming (120/277VAC only) technology.
 - .4 Models of 0-10V dimming technology shall have the option for one, two or three control channels.
 - .5 Power packs are digital and can be configured for pre-set scenes.
 - .6 Wattstopper LMRC-210 series (0-10V or switched) (Basis of Design)
 - .7 Wattstopper LMRC-220 series (forward phase) (Basis of Design)
 - .8 Power pack shall utilize Zero Crossing Circuitry to protect from the effects of inrush current and increase product longevity.
 - .9 Power pack shall be mounted on a 4 in square junction box and is plenum rated for ceiling installation.
 - .10 Power packs shall at minimum meet the following environmental specifications:
 - .1 Operating Temperature Range: 0 degrees C to 55 degrees C
 - .2 Relative Humidity: 5 per cent to 95 per cent non-condensing

2.07 Plug Load Controller

- .1 Plug load controllers shall have the ability to be daisy chained on one digital loop.
- .2 Internal relay controlling up to 20A for 120VAC per power pack.
- .3 Wattstopper LMPL-201 series (Basis of Design)
- .4 Power pack shall utilize Zero Crossing Circuitry to protect from the effects of inrush current and increase product longevity.
- .5 Power pack shall be mounted on a 4 in square junction box and is plenum rated for ceiling installation.
- .6 Power packs shall at minimum meet the following environmental specifications:
 - .1 Operating Temperature Range: 0 degrees C to 55 degrees C
 - .2 Relative Humidity: 5 per cent to 95 per cent non-condensing

2.08 Timer

- .1 Timer used to automatically switch lighting using time of day scheduling, independent of BAS or network controller.

- .2 Supports astronomical, time-based, and photocell based event types.
- .3 Connected by cat5e cable to sensors or controllers as part of the digital loop.
- .4 Complete with 120V input, one LMPB-100 power booster and internal barrier.
- .5 Can be installed in plenum space or wall mount in electrical room.
- .6 Wattstopper LMZC-300 series (Basis of Design)

2.09 Sequences of Operation

- .1 Vacancy Sensor Operation: Manual On, Manual/Auto Off.
- .2 In accordance with ASHRAE 90.1-2013.

3 Execution

3.01 Installation

- .1 In accordance with manufacturer's instructions.
- .2 Low voltage lighting control cabling shall be cat5e
- .3 It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- .4 It is the contractor's responsibility to arrange a pre-installation meeting with manufacturer's factory authorized representative, at Owner's facility, to verify placement of sensors and installation criteria.
- .5 Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.
- .6 Install manual control devices and sensors in accordance with manufacturer's instructions for Vacancy Operation.

3.02 System Startup

- .1 The lighting controls manufacturer's representative shall conduct system startup and submit startup report.

3.03 Site Tests and Inspections

- .1 The lighting controls manufacturer's representative and Contractor shall conduct functional testing and provide report as described in ASHRAE 90.1-2013:
 - .1 Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.
 - .2 When occupant sensors, time switches, programmable schedule controls, or photosensors are installed, at a minimum, the following procedures shall be performed:

- .1 Occupant Sensors
 - .1 Certify that the sensor has been located and aimed in accordance with manufacturer recommendations.
 - .2 For projects with up to seven (7) occupancy sensors, all occupancy sensors shall be tested.
 - .3 For projects with more than seven (7) occupancy sensors, testing shall be done for each unique combination of sensor type and space geometry.
 - .4 For each sensor to be tested, verify the following:
 - .1 Status indicator (as applicable) operates correctly.
 - .2 Controlled lights turn off or dim down to the specified level within the required time (20 minutes, or as noted), as applicable to the space type.
 - .3 For auto-on occupant sensors (occupancy mode), the lights turn on to the permitted level when someone enters the space.
 - .4 For manual-on sensors (vacancy mode), the lights turn on only when manually activated.
 - .5 The lights are not incorrectly turned on by movement in nearby areas or by HVAC operation.
- .2 Automatic Time Switches
 - .1 Confirm that the automatic time switch control is programmed with appropriate weekday, weekend, and holiday (as applicable) schedules.
 - .2 Document for the owner automatic time switch programming, including weekday, weekend, and holiday schedules, as well as all setup and preference program settings.
 - .3 Verify that correct time and date are properly set in the time switch.
 - .4 Simulate occupied condition. Verify and document the following:
 - .1 All lights can be turned on and off by their respective area control switch.
 - .2 The switch only operates lighting in the enclosed space in which the switch is located.
 - .5 Simulate unoccupied condition. Verify and document the following:
 - .1 All non-exempt lighting turns off.
 - .2 Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shut off occurs.
- .3 Daylight Controls
 - .1 All control devices (photocontrols) have been properly located, field-calibrated, and set for appropriate set points and threshold light levels.

- .2 Daylight controlled lighting loads adjust to appropriate light levels in response to available daylight.
- .3 The location where calibration adjustments are made is readily accessible only to authorized personnel.
- .3 The individual(s) responsible for the functional testing shall not be directly involved in either the design or construction of the project and shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria.
- .2 Test lighting controls with fire alarm system in accordance with Section 28 08 46 and Section 28 46 51.
- .3 Commissioning:
 - .1 Submit commissioning report to the Consultant and the commissioning authority for review.

3.04 Training

- .1 Provide training session of minimum 4 hours duration in accordance with Section 01 77 00.

End of Section

1 General

1.01 Section Includes

- .1 Materials and components for dry type distribution transformers up to 600 V primary, equipment identification, and transformer installation.

1.02 References

- .1 ANSI/ASHRAE/IES Standard 90.1-2019 – Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 47-13 (R2023), Air-cooled transformers (dry type).
 - .4 CSA C9:17 (R2022), Dry-type transformers.
 - .5 CSA C802.2-18 (R2023), Minimum Efficiency Values for Dry-Type Transformers.
- .3 IEEE C57.110-2018, IEEE Recommended Practice for Establishing Liquid-Immersed and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents: this standard defines how K-factor is calculated.
- .4 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA ST 20-2021, Dry-Type Transformers for General Applications: sound levels.
- .5 Natural Resources Canada (NRCan):
 - .1 SOR/2018-201, Regulations Amending the Energy Efficiency Regulations, 2016 (also referred to as NRCan 2019).
- .6 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- .7 Ontario Building Code and its referenced standards.
- .8 UL 1561, Standard for Dry-Type General Purpose and Power Transformers.

1.03 Action Submittals

- .1 Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, power, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.

1.04 Informational Submittals

- .1 Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100 per cent rated load, and sound level.
- .2 Submit manufacturer's installation instructions.
 - .1 Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.

- .2 Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 Closeout Submittals

- .1 Record actual locations of transformers in project record documents.
- .2 Document test results from NETA ATS.
- .3 Copies of completed factory reports and testing reports.

1.06 Delivery, Storage, and Handling

- .1 Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations.
- .2 Store so condensation will not form on or in the transformer housing and if necessary, apply temporary heat where required to obtain suitable service conditions. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- .3 Handle to manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.
- .4 Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye, and/or brackets provided for that purpose.

1.07 Warranty

- .1 The transformer shall carry a 1 year warranty from the time of substantial performance.

2 Products

2.01 General

- .1 Transformers shall be standard general purpose dry type unless otherwise indicated on drawings as K-Rated or Harmonic Mitigation type.
- .2 Use transformers of one manufacturer throughout project and in accordance with CSA C22.2 No. 47 and CSA C9.

2.02 Manufacturers

- .1 Manufacturer List:
 - .1 Bemag.
 - .2 Delta Transformer.
 - .3 Eaton.
 - .4 Hammond.
 - .5 Powersmiths.
 - .6 Rex Power Magnetics.
 - .7 Siemens.

- .8 Schneider Electric.
- .9 STI.
- .2 Substitutions: permitted if approved by the Consultant prior to Tender closing date.

2.03 Regulatory Requirements

- .1 Products: Listed and classified by CSA (Canadian Standards Association).
- .2 Efficiency ratings:
 - .1 Meet or exceed the efficiency levels indicated in the following standards:
 - .1 SOR/2018-201 (NRCan 2019).
 - .2 CSA C802.2.
 - .3 ASHRAE 90.1, Table 8.4.4.

2.04 General Purpose Transformers

- .1 NEMA ST-20, factory-assembled, air cooled low-inrush dry type transformer, ratings and voltages as indicated on drawings.
- .2 Single or three phase as indicated on drawings.
- .3 Type: AN/AA ventilated self-cooled.
- .4 Copper windings.
- .5 Finish: Final coating to be ANSI 61 Grey Epoxy Powder.
- .6 T-connected transformers are not acceptable.
- .7 Isolate core and coil from enclosure using vibration-absorbing mounts.
- .8 Impedance: standard (3% to 5% nominal for up to 75 kVA, 4% to 6% for transformers 112.5 kVA and greater).

2.05 K-Factor Rated Transformers

- .1 Provide where indicated on drawings.
- .2 K-Factor Rating: Transformers shall be K-Factor 7, 13, or higher rated and comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
 - .1 Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
 - .2 Indicate value of K-factor on transformer nameplate.

2.06 Primary Voltage

- .1 600 V delta, 3 phase.

2.07 Secondary Voltage

- .1 120/208 V, 3 phase wye.

2.08 Insulation System and Average Winding Temperature Rise

- .1 1 kVA to 15 kVA: Class 185 with 115°C rise.
- .2 16 kVA to 500 kVA: Class 220 with 115°C rise.
- .3 Above 500 kVA: Class 220 with 115°C rise.

2.09 Case Temperature

- .1 Limits in accordance with CSA C22.2 No. 47.

2.10 Winding Taps

- .1 To NEMA ST-20.
- .2 Four full capacity 5 per cent adjustment taps, 2 at 2.5 per cent FCBN (full capacity below nominal) and 2 at 2.5 per cent FCAN (full capacity above nominal).

2.11 Basic Impulse Level

- .1 10 kV BIL.

2.12 Grounding

- .1 Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.13 Mounting

- .1 1 kVA to 15 kVA: suitable for wall mounting.
- .2 16 kVA to 75 kVA: suitable for wall, or floor, as shown.
- .3 Larger than 75 kVA: suitable for floor mounting.

2.14 Coil Conductors

- .1 Continuous windings with terminations brazed or welded.

2.15 Enclosure

- .1 NEMA ST 20, CSA type 2 ventilated, sprinkler-proof. Provide lifting eyes or brackets.
- .2 CSA type 3R for outdoor locations.

2.16 Catcher/Drip Base Plate

- .1 Constructed from galvanized steel sheet metal having the minimum thickness as that of the transformer's enclosure.
- .2 Provide for all transformers that are wall mounted, or suspended off the floor.

2.17 Sound Levels

- .1 To NEMA ST-20 for transformers up to 300 kVA:

- .1 Up to 9 kVA: 40 dB.
- .2 10 kVA – 50 kVA: 45 dB.
- .3 51 kVA – 150 kVA: 50 dB.
- .4 151 kVA – 300 kVA: 55 dB.
- .2 Sound levels 3 dB less than NEMA ST-20 for transformers 301 kVA and greater:
 - .1 301 kVA – 500 kVA: 57 dB.
 - .2 501 kVA – 700 kVA: 59 dB.
 - .3 701 kVA – 1000 kVA: 61 dB.
 - .4 Above 1000 kVA: 3 dB less than NEMA ST-20.

2.18 Nameplate

- .1 Transformer shall have embossed aluminum or stainless steel nameplate indicating, but not restricted to the following:
 - .1 kVA rating.
 - .2 Voltage rating.
 - .3 Impedance.
 - .4 Type.
 - .5 Insulation class.
 - .6 Temperature rise.
 - .7 Connection diagram.
 - .8 Serial number.
- .2 Mark enclosure with kVA value, stencilled in a contrasting colour from enclosure finish, minimum 100 mm character height.

2.19 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53.

2.20 Source Quality Control

- .1 Production test each unit according to NEMA ST 20.

3 Execution

3.01 Installation

- .1 Mounting:
 - .1 Mount dry type transformers up to 75 kVA, on floor, wall, or suspended from ceiling, as indicated on plans.

- .2 For transformers rated greater than 50 kVA, ensure a minimum horizontal working space of 1 m is provided and maintained on the sides of the transformer that provide access to conductor connections, in accordance with 2024 OESC Rule 2-312.
 - .3 Mount dry type transformers rated above 75 kVA on floor.
 - .4 For wall mounted transformers, provide rubber-in-shear isolation mounts above bracket-supported rails secured from the wall.
 - .5 For ceiling mounted transformers, provide trapeze hangers and provide rubber-in-shear isolation mounts.
 - .6 Where a transformer is wall mounted or suspended off the floor, provide a metal catcher/drip base plate, and bolt to the bottom of the transformer below the base channel to conform to CSA C22.2 No. 47. Install in accordance with transformer manufacturer's instructions and recommendations.
 - .7 Mount floor mounted transformers on concrete housekeeping pads, minimum 100 mm (4") thick, and extending a minimum of 150 mm (6") beyond the footprint of the transformer.
 - .8 Mount vibration isolating pads suitable for isolating the transformer noise from the building structure in accordance with Section 26 05 48.13.
- .2 Set transformer plumb and level.
 - .3 Use flexible conduit, under the provisions of Section 26 05 33.13, 600 mm minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
 - .4 Provide grounding and bonding to Section 26 05 26.
 - .5 Ensure adequate clearance around transformer for ventilation.
 - .6 Install transformers in level upright position.
 - .7 Remove shipping supports only after transformer is installed and just before putting into service.
 - .8 Loosen isolation pad bolts until no compression is visible.
 - .9 Make primary and secondary connections in accordance with wiring diagram.
 - .10 Energize transformers after installation is complete.

3.02 Field Quality Control

- .1 Section 01 43 00: Field Inspection, Testing, Adjusting.
- .2 Perform inspections and tests listed in NETA ATS, Section 7.2.

3.03 Adjusting

- .1 Measure primary and secondary voltages and make appropriate tap adjustments.

End of Section

1 General

1.01 Section Includes

- .1 Power distribution panelboards – Circuit breaker type.
- .2 Lighting and appliance branch circuit panelboards.

1.02 Related Requirements

- .1 Section 26 28 16.02 – Molded Case Circuit Breakers.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 5:16 (R2021), Molded Case Circuit Breakers, molded-case switches, and circuit-breaker enclosures.
 - .4 CSA C22.2 No. 29-15 (R2024), Panelboards and Enclosed Panelboards.
- .2 NEMA:
 - .1 NEMA ICS 2-2000 (R2020) – Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 volts.
 - .2 NEMA KS 1-2013 – Heavy Duty Enclosed and Dead-Front Switches (600 volts Maximum).
 - .3 NEMA PB 1-2011 – Panelboards.
 - .4 NEMA PB 1.1-2013 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 volts or Less.
- .3 NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

1.04 Submittals

- .1 Submit in accordance with Section 01 30 00.
- .2 Work of this Section is to be submitted for review after Consultant’s review of Coordination Study per Section 26 05 73.16 is completed.
- .3 Shop drawings shall contain overall panelboard dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one line diagrams with applicable voltage systems.
- .4 Shop drawings:
 - .1 Indicate the following:
 - .1 Outline and support point dimensions.
 - .2 Voltage.

- .3 Main bus ampacity.
- .4 Integrated short circuit ampere rating.
- .5 Circuit breaker arrangement, types, and sizes.
- .2 The following information shall be submitted to the Consultant:
 - .1 Breaker layout drawing with dimensions indicated and nameplate designation.
 - .2 Component list.
 - .3 Conduit entry/exit locations.
 - .4 Assembly ratings including:
 - .1 Short-circuit rating.
 - .2 Voltage.
 - .3 Continuous current.
 - .5 Cable terminal sizes.
 - .6 Product data sheets.
- .3 Where applicable, the following additional information shall be submitted to the Consultant:
 - .1 Key interlock scheme drawing and sequence of operations.
- .5 Submittals for Construction
 - .1 The following information shall be submitted for record purposes:
 - .1 Installation information.

1.05 Closeout Submittals

- .1 Refer to Section 01 78 00.
- .2 Record actual locations of panelboards and record actual circuiting arrangements in project record documents.
- .3 Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- .4 Final as-built drawings and information shall incorporate all changes made during the manufacturing and installation process.
- .5 Include a copy of each panelboard schedule in the Operation and Maintenance manual.

1.06 Maintenance Material Submittals

- .1 Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 – Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 volts or Less.
- .2 Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

- .3 Provide two of each panelboard key.
- .4 Provide final panelboard schedules indicating panelboard data, phasing, breaker sizes, and loads served.

1.07 Quality Assurance

- .1 Regulatory Requirements
 - .1 Products: Listed and classified by CSA (Canadian Standards Association).
- .2 Qualifications
 - .1 Company specializing in manufacturing of panelboard products with a minimum of 20 years' experience.
 - .2 The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
 - .3 For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
 - .4 The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.08 Delivery, Storage, and Handling

- .1 Inspect and report concealed damage to carrier within their required time period.
- .2 Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.
- .3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.
- .4 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

1.09 Warranty

- .1 Warrant specified equipment to be free from defects in materials and workmanship for eighteen (18) months from the date of purchase.

2 Products

2.01 General

- .1 Description: CSA C22.2 No. 29, circuit breaker type.

2.02 Distribution Panelboards – Circuit Breaker Type

- .1 Manufacturers:
 - .1 Square D by Schneider Electric, I-LINE Series.
 - .2 Eaton Cutler-Hammer, PRL 3 and PRL4 Series.
 - .3 Equal by Siemens.

- .2 The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Consultant ten days prior to bid date.
- .3 Panelboard Bus:
 - .1 Copper, ratings as indicated.
 - .2 Provide copper neutral bus for panelboards indicated for 4-wire systems.
 - .3 Provide copper ground bus in each panelboard.
- .4 Short Circuit Ratings:
 - .1 Panelboards rated 600 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 65 000 amperes RMS symmetrical.
 - .2 Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings.
 - .3 Panelboards shall be fully rated.
 - .4 Where indicated, provide circuit breakers ULC listed for application at 100 per cent of their continuous ampere rating in their intended enclosure.
- .5 Minimum integrated short circuit rating: Panelboards rated 240 V shall have minimum integrated short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10 000 amperes RMS symmetrical.
- .6 Molded Case Circuit Breakers: To Section 26 28 16.02.
- .7 Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- .8 Cabinet Front: Surface type, fastened hinge and latch, metal directory frame, finished in manufacturer's standard gray enamel.
- .9 Enclosures: CSA type 2 sprinklerproof complete with drip hood, or as noted.
- .10 Trims shall be equipped with a flush lock.
- .11 Breaker positions labeled as "Spare" or "Space" shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.
- .12 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.

2.03 Branch Circuit Panelboards

- .1 Manufacturers:
 - .1 Square D by Schneider Electric, NQ or NQOD Series.
 - .2 Eaton Cutler-Hammer, POW-R-LINE 1, POW-R-LINE 2, POW-R-LINE 3 Series.
 - .3 Equal by Siemens.
- .2 Description: CSA C22.2 No.29, circuit breaker type, lighting and appliance branch circuit panelboard.

- .3 Panelboard Bus:
 - .1 Copper, ratings as indicated.
 - .2 Provide copper neutral bus in each panelboard.
 - .3 Provide copper ground bus in each panelboard.
 - .4 Provide insulated ground bus where scheduled.
- .4 Minimum Integrated Short Circuit Rating: 10 000 amperes RMS symmetrical for 240 V panelboards, or as indicated.
- .5 Molded Case Circuit Breakers: NEMA AB 1, plug-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers where scheduled. Do not use tandem circuit breakers.
- .6 Current Limiting Molded Case Circuit Breakers where indicated: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- .7 Cabinet Front: Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.
- .8 Enclosure shall be CSA type 2 sprinklerproof complete with drip hood, or as noted.
- .9 Trims shall be equipped with a flush lock.
- .10 Breaker positions labeled as "Spare" or "Space" shall constitute no less than 20 per cent of available breaker positions, whether indicated or not in panelboard schedules.
- .11 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
 - .1 Install circuit breakers in panelboards before shipment.
 - .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .12 Panelboards rated 240 VAC or less shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.
- .13 Bus and breakers rated for symmetrical interrupting capacity, as indicated.
- .14 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .15 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .16 Two keys for each panelboard and key panelboards alike.
- .17 Copper bus with neutral of same ampere rating as mains.
- .18 Mains: suitable for bolt-on breakers.
- .19 Trim with concealed front bolts and hinges.
- .20 Trim and door finish: baked grey enamel.

- .21 The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the drawings. Panelboards shall be fully rated.
- .22 Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
- .23 Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100 A frame and through 100 A trip sizes shall take up the same pole spacing. Circuit breakers shall be ULC listed as type SWD for lighting circuits.
 - .1 Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
- .24 Circuit breakers shall have a minimum interrupting rating of 10 000 A symmetrical at 240 V, and 14 000 amperes symmetrical at 480 V, unless otherwise noted on the drawings.
- .25 Each panel shall be complete with a directory which shall be mounted inside door in a metal frame with clear plastic cover and copy in each Data Book. Use final Room Numbers for directories.
- .26 Panels shall be dead front type in code gauge steel enclosures. All panels shall be sprinkler proof c/w drip hoods as required.
- .27 Panels shall have mains of voltage and capacity, and main and branch breakers, as shown on the drawings. Spaces shall include necessary bus work such that Owners, at a later date, need buy only the breakers.
- .28 Where panels exceed 42 circuits, use multi-section panel with main cross-over solid bus bars unless noted otherwise on drawings. Main bus capacity of each section shall be full size to match cross-over bus.
- .29 Breakers shall have bolted type connections. Multi-pole breakers shall be common trip type with a single handle, suitable for voltage applied and of same manufacture as single pole breakers.
- .30 Panels for 120/208 V, 3-phase, 4-wire systems shall be complete with full size breakers.
- .31 Where shown on drawings or required by code, certain breakers shall include ground fault interrupter.
- .32 Provide lighting and receptacle panels suitable for surface, or flush-mounting type, as shown.
- .33 Provide locking bars on non-switched circuits where panels are used for switching lighting circuits.
- .34 Panels for non-linear loads shall be complete with lugs for double neutrals.
- .35 Panels shall be given a rust-resistant treatment to both tub and trim.
- .36 Flush panels shall have concealed hinges and flush type combination lock latch. Locks shall be chrome plated. Doors shall open minimum 135 degrees. Trims shall have fasteners concealed and shall be prime coated to receive room finish paint.
- .37 Surface mounted panels shall have manufacturer's standard surface door trim complete with lock and latch. Finish shall be grey.
- .38 Recessed panels shall have standard flush trims.
- .39 Co-ordinate panel finish with Room Finish Schedule.

2.04 Molded Case Circuit Breakers

- .1 Breakers: to Section 26 28 16.02.

- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Lock-on devices for 10 per cent of 15 A to 30 A breakers installed as indicated. Turn over unused lock-on devices to Owner.
- .5 Lock-on devices for fire alarm, security, and sprinkler circuits.
- .6 Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

2.05 Construction

- .1 General:
 - .1 Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
 - .2 Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
 - .3 A temporary directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
 - .4 All locks shall be keyed alike.
- .2 Branch Circuit Panelboards:
 - .1 Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.
- .3 Distribution Panelboards:
 - .1 Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.

2.06 Bus

- .1 Lugs: Copper and listed by CSA, or cUL, for use with copper conductors and sized to accept copper conductors of the ampacity specified.
- .2 Main bus bars shall be copper sized in accordance with CSA standards to limit temperature rise on any current carrying part to a maximum of 65°C above an ambient of 40°C maximum.
- .3 A copper system ground bus shall be included in all panelboards.
- .4 Full-size (100 per cent rated) insulated copper neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200 per cent rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.07 Integral Mounted Surge Protective Device

- .1 Where shown on the drawings, furnish panelboards with integral surge protective devices (SPDs), mounted internal to the panelboard.
- .2 Certification:
 - .1 Listed to most recent edition of CSA C22.2 No. 269.2.
 - .2 Products certified by a recognized testing agency accredited by the Standards Council of Canada, and bear a certification mark from that agency indicating acceptance to Canadian standards.
 - .1 Equipment certification by one of the following bodies:
 - .1 Listed by Underwriters Laboratories, Inc. and exhibit the cUL Listing Mark for the category "Surge Protective Devices" or SPD. Provide UL Listing Card under category VZCA7 (SPDs certified for Canada) to confirm compliance to CSA C22.2 No. 269.2, and assigned Voltage Protection Ratings.
 - .2 Listed by ETL.
 - .3 Certified by CSA Group.
 - .2 SPD to be labeled with no less than a 100 kA Short Circuit Current Rating (SCCR).
 - .3 SPD shall be factory installed integral to the panelboard by the original equipment manufacturer, and shall be a product of the same manufacturer as the panelboard and breakers.
 - .4 The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable single-mode modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
 - .5 Electrical Requirements:
 - .1 Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
 - .2 Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
 - .3 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards. End of life mode to be open circuit. Unit with end of life short-circuit mode are not acceptable.
 - .4 Unit shall operate without the need for an external overcurrent protection device (OCPD), and be listed by UL as such. Unit must not require external OCPD or replaceable internal OCPD for the UL Listing.

- .5 Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

Configuration	Protection Modes			
	L-N	L-G	L-L	N-G
Wye	X	X	X	X
Delta	N/A	X	X	N/A
Single Split Phase	X	X	X	X
High Leg Delta	X	X	X	X

- .6 Nominal Discharge Current (In) – All SPDs applied to the distribution system shall have a 20 kA In rating regardless of their SPD Type (includes Type 1 and Type 2) or operating voltage. SPDs having an In less than 20 kA shall be rejected.
- .7 ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:

Voltage	L-N	L-G	N-G
208Y/120	800 V	800 V	800 V
480Y/277	1200 V	1200 V	1200 V
600Y/347	1500 V	1500 V	1500 V
Voltage	L-L	L-G	
480 Delta	1800 V	1800 V	
600 Delta	2500 V	2500 V	

2.08 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 53.
- .2 Nameplate for each panelboard size 4 engraved.
- .3 Nameplate for each branch circuit in distribution panelboards size 2 engraved.
- .4 Complete circuit directory with typewritten legend showing location and load of each circuit.
- .5 Provide an engraved nameplate for each panelboard section.
- .6 Provide copies of all circuit directories in manuals.

2.09 Source Quality Control

- .1 The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and CSA standards.

3 Execution

3.01 Installation

- .1 Install panelboards to CSA C22.1.

- .2 Install panelboards plumb.
- .3 Height: 1800 mm to top of panelboard; install panelboards taller than 1800 mm with bottom no more than 100 mm above floor.
- .4 Provide filler plates for unused spaces in panelboards.
- .5 Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- .6 Provide engraved plastic nameplates under the provisions of Section 26 05 53.
- .7 Ground and bond panelboard enclosure according to Section 26 05 26.
- .8 Locate panelboards as indicated and mount securely, plumb, true, and square, to adjoining surfaces.
- .9 Install surface mounted panelboards on fire rated plywood backboards in accordance with Section 26 05 29. Where practical, group panelboards on common backboard.
- .10 Connect loads to circuits.
- .11 Connect neutral conductors to common neutral bus with respective neutral identified.
- .12 Deliver five (5) duplicate keys for each panel lock to the Owner.
- .13 Mount electrical panels, where possible, with top of trim at uniform height of 2000 mm.
- .14 Cap ends of conduits in accessible locations in ceiling spaces above panels, to allow for future wiring.
- .15 The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.
- .16 Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and Electrical Code requirements.
- .17 After completion of wiring, type directory showing a clear description of each circuit being controlled from panel and place in metal frame inside door.
- .18 Provide circuit breaker handle locks for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
- .19 Provide three 27 mm empty conduits from top of lighting, receptacle, telephone, signal and communication panels recessed in walls, to ceiling space.

3.02 Field Quality Control

- .1 Perform inspections and tests listed in NETA ATS, Section 7.4 for switches, Section 7.5 for circuit breakers.
- .2 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .3 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20 per cent of each other. Maintain proper phasing for multi-wire branch circuits.
- .4 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

3.03 Adjusting

- .1 Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other.
- .2 Maintain proper phasing for multi-wire branch circuits.

End of Section

1 General

1.01 Section Includes

- .1 Indoor aluminum service poles and installation.

1.02 Related Requirements

- .1 Section 12 59 00 – Systems Furniture.
- .2 Section 27 10 00 – Structured Cabling.

1.03 References

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM B31, Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, and Structural Profiles for Electrical Purposes (Bus Conductor).

2 Products

2.01 Manufacturers

- .1 Wiremold.
- .2 Hubbell.
- .3 Canadian Electrical Raceways (CER).

2.02 Indoor Service Poles

- .1 Indoor service pole assembly to meet telephone company requirements.
- .2 Indoor service poles: extruded aluminum sections to ASTM, anodized finish of 10 micrometres thickness.
- .3 Nominal length of poles: [2.8 m] from floor to ceiling, with plus or minus 50 mm adjustment. Total adjustment: 100 mm.
- .4 Service poles approximately 50 mm square with snap-on covers to provide access to wiring without removing unit. Barrier to isolate power from communication systems.
- .5 Service poles with fastening accessories at top of pole to secure to inverted T-Bar ceiling using set screws to permit relocation. Flange at ceiling to conceal wiring.
- .6 Metal sleeve at bottom of pole to conceal vertical adjustment. Reversible grip-tight devices for carpet and tile floors to prevent movement of poles.
- .7 Service poles with two prewired duplex receptacles, two knockout holes for communication. Cord with moulded set extending 3 m from top of pole.

3 Execution

3.01 Installation

- .1 Install service poles as indicated.

- .2 Install service poles in accordance with manufacturer's recommendations. Secure to ceiling and to finished floor. Adjust length as required. Connect cord to receptacle installed in ceiling space.
- .3 Re-adjust service poles as required after telephone cables are installed.

End of Section

1 General

1.01 Section Includes

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

1.02 Related Requirements

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 27 26.13 – Floor Box Assemblies.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 14-18 (R2022), Industrial control equipment.
 - .4 CSA C22.2 No. 42-10 (R2015), General use receptacles, attachment plugs, and similar devices.
 - .5 CSA C22.2 No. 42.1:13 (R2022), Cover plates for flush-mounted wiring devices.
 - .6 CSA C22.2 No. 55:15 (R2020), Special use switches.
 - .7 CSA C22.2 No.111-18 (R2023), General-use snap switches.
 - .8 CSA C22.2 No. 182.1:17 (R2021), Plugs, receptacles, and cable connectors of the pin and sleeve type.

1.04 Informational Submittals

- .1 Submit shop drawings and product data in accordance with Section 01 33 00.
- .2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.
- .3 Submit manufacturer's installation instructions.

2 Products

2.01 Manufacturers

- .1 Eaton.
- .2 Hubbell Bryant.
- .3 Leviton.
- .4 Molex.
- .5 Pass & Seymour (Legrand).

2.02 Wall Switches

- .1 Single pole, double pole, three-way, four-way switches to: CSA C22.2 No. 55 and CSA C22.2 No.111.
- .2 Description: CSA C22.2 No. 111, Commercial Spec Grade, AC only general-use snap switch.
- .3 Local switches shall be 20 A, silent, brown coloured, AC type and CSA certified, specification grade. Provide switches rated to suit system voltage 120 V or 347 V.
- .4 Manually-operated general purpose AC switches with following features:
 - .1 Terminal holes approved for 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
- .5 Voltage: 120 V or 347 V, AC as indicated.
- .6 Current: 20 A.
- .7 Body and Handle: white plastic with toggle handle. Confirm finish colour prior to ordering.
- .8 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
- .9 Example Products (Decorator style):
 - .1 120 V:
 - .1 Hubbell HBL2121 series.
 - .2 347 V:
 - .1 Pass & Seymour 2601-347 series.
- .10 Example Products (Toggle style):
 - .1 120 V:
 - .1 Hubbell HBL1221 (single pole).
 - .2 Hubbell HBL1222 (double pole).
 - .3 Hubbell HBL1223 (three-way).
 - .4 Hubbell HBL1224 (four-way).
 - .2 347 V:
 - .1 Hubbell HBL18221 (single pole).
 - .2 Hubbell HBL18223 (three-way).
 - .3 Pass & Seymour PS372030I.

- .11 Local switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

2.03 Receptacles

- .1 General
 - .1 Description: CSA C22.2 No. 42, Commercial Spec Grade general use receptacles.
 - .2 Device Body: white plastic.
 - .3 Configuration: Type as specified and indicated.
 - .4 Convenience Receptacle: Type 5-15, 5-20 where indicated.
 - .5 GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
 - .6 Data Room Receptacle Types: As indicated on drawings.
 - .7 Receptacles of one manufacturer throughout project.
- .2 Receptacles shall be white coloured, specification grade, unless noted otherwise.
- .3 Receptacles shall be as listed below:
 - .1 15 A, 120 V, single phase grounded duplex receptacle shall be NEMA-U- ground type CSA Configuration 5-15R.
 - .2 20 A, 120 V, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA
 - .3 15 A, 120 V, weatherproof receptacles shall be equal to those above but complete with gasketed cast plate and hinged covers.
- .4 Other types of receptacles shall be provided as shown on Drawings.
- .5 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No. 42 with following features:
 - .1 White urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and riveted grounding contacts.
- .6 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
 - .1 White urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Four back wired entrances, 2 side wiring screws.
- .7 Other receptacles with ampacity and voltage as indicated.

- .8 Example Products
 - .1 Decorator style duplex 5-15R:
 - .1 Pass & Seymour 26252 series.
 - .2 Hubbell HBL2152 series.
 - .2 Decorator style duplex 5-20R:
 - .1 Pass & Seymour 26352 series.
 - .2 Hubbell HBL2162 series.
- .9 Ground Fault Circuit Interrupter (GFCI or GFI) receptacles:
 - .1 Protected by a ground fault circuit interrupter of the Class A type.
 - .2 Any receptacle within 1.5 m (5 ft) of a sink must be GFCI protected.
 - .3 Any receptacle installed outdoors and within 2.5 m of finished grade outdoor must be GFCI protected.
 - .4 Any receptable located on rooftops required for maintenance of HVAC equipment shall be GFCI protected.
- .10 Tamper-resistant receptacles.
 - .1 Marked as such (for example “TR”).
 - .2 To be used in the following spaces:
 - .1 Child care facilities and kindergarten classrooms.
 - .2 Guest rooms and suites of hotels and motels.
 - .3 Preschools and elementary education facilities, including kindergarten facilities.
 - .4 Dwelling units.
 - .3 Example Products:
 - .1 Hubbell BR15WHITR (15 A duplex decorator style).
 - .2 Hubbell BR20WHITR (20 A duplex decorator style).
- .11 USB Charger receptacles: duplex tamper resistant device.
 - .1 USB ports: one type A and one type C USB charging port, 5 A, 5 V.
 - .2 Example: Hubbell USB15AC5WWR.

2.04 Cover Plates

- .1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.
- .2 Cover plates from one manufacturer throughout project.
- .3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

- .4 Stainless steel, vertically brushed, cover plates, thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .7 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
- .8 Switch, receptacle, telephone, and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302. Finish brush marks shall be run in a vertical direction.
- .9 Wet Location and weatherproof devices: receptacles and cover plates shall be suitable for wet locations and provide shielding with and without a plug inserted into the receptacle in accordance with 2024 OESC rule 26-708.
 - .1 Weatherproof Cover Plate: Ultra-rugged polycarbonate and synthetic neoprene rubber:
 - .1 Hubbell ML500GCN series (single-gang):
 - .1 low profile design which expands from 25 mm (1 in) to 75 mm (3 in) for weatherproof protection while an outlet is in use while maintaining the “Extra Duty” ratings.
 - .2 Clear window allows for quick/easy visual inspection.
 - .3 All required gasket and mounting hardware.
 - .4 Pre-configured for GFCI type receptacles.
 - .5 Complete with gaskets to accommodate duplex receptacles or Data outlets.
 - .6 NEMA 3R compliant.
 - .7 Colour: Gray.
 - .2 Hubbell ML2450GCN series (2-gang):
 - .1 low profile design which expands from 25 mm (1 in) to 75 mm (3 in) for weatherproof protection while an outlet is in use while maintaining the “Extra Duty” ratings.
 - .2 Clear window allows for quick/easy visual inspection.
 - .3 All required gasket and mounting hardware.
 - .4 Pre-configured for GFCI type receptacles.
 - .5 Complete with gaskets to accommodate quadplex receptacles or Data outlets.
 - .6 NEMA 3R compliant.
 - .7 Colour: Gray.

2.05 Regulatory Requirements

- .1 Provide products listed and classified by CSA (Canadian Standards Association).

3 Execution

3.01 Examination

- .1 Verify that outlet boxes are installed at proper height.
- .2 Verify that wall openings are neatly cut and will be completely covered by wall plates.
- .3 Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 Preparation

- .1 Provide extension rings to bring outlet boxes flush with finished surface.
- .2 Clean debris from outlet boxes.

3.03 Installation

- .1 Install to CSA C22.1.
- .2 Mounting heights in accordance with Section 26 05 00.
- .3 Install devices plumb and level.
- .4 Install switches with OFF position down.
- .5 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.
- .6 Do not share neutral conductor on load side of dimmers.
- .7 Install receptacles with grounding pole on bottom.
- .8 Connect wiring device grounding terminal to outlet box with bonding jumper.
- .9 Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- .10 Connect wiring devices by wrapping conductor around screw terminal.
- .11 Use jumbo size plates for outlets installed in masonry walls.
- .12 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- .13 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .14 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

- .2 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Connect receptacle grounding terminal to the outlet box with an insulated green ground strap.
- .4 Receptacles to be white for devices connected to normal power circuits.
- .5 Safety shutter type receptacles to be located where shown and required by code and CSA Z32.
- .6 Comply with requirements of CSA Standard Z32, with regards to identifying circuit number and supplying panelboard, permanently identified at outlets. Identify this information in areas on front of each receptacle. In addition, provide typed label on wall below each device faceplate, identifying circuit number and panelboard from where each device is fed. Confirm nomenclature with the Consultant prior to printing of labels and nameplates. Turn over label maker to Consultant/Owner prior to application for Certificate of Substantial Performance of the Work.
- .7 Receptacles for maintenance of HVAC and similar equipment located on rooftops.
 - .1 Provide weatherproof GFI 5-20R receptacles on roof, installed at 750 mm (30 in) above finished roof level, complete with wet location “while in use” “extra duty” cover plate.
 - .2 Locate within 7500 mm (25 ft) of new HVAC equipment, and at least 2000 mm (6.5 ft) away from roof line.
 - .3 Refer to 2024 OESC rules 2-316, 26-708, and 26-710, and OESC bulletin 26-27-4, or latest edition.
- .15 Cover plates:
 - .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
 - .4 Do not install plates until final painting of room or area is completed. Remove protective covering.
 - .5 Confirm exact material, finish, and colour of faceplates for devices in any particular area with the Consultant prior to ordering. Submit sample board as per requirements of Part 1.
 - .6 Provide faceplates with printed self-adhesive label on inside face identifying circuit number and panel feeding device. Turn over label maker to the Consultant prior to application for Certificate of Substantial Performance of the Work.
- .16 Circuit identification: in accordance with Section 26 05 53.

3.04 Field Quality Control

- .1 Inspect each wiring device for defects.
- .2 Operate each wall switch with circuit energized and verify proper operation.
- .3 Verify that each receptacle device is energized.
- .4 Test each receptacle device for proper polarity.
- .5 Test each GFCI receptacle device for proper operation.

3.05 Adjusting

- .1 Adjust devices and wall plates to be flush and level.

3.06 Cleaning

- .1 Clean exposed surfaces to remove splatters and restore finish.

End of Section

1 General

1.01 Summary

- .1 Section Includes
 - .1 In-slab and poke-through style floor monuments for electrical, communications, and audio/video purposes.
- .2 Related Requirements
 - .1 Section 26 27 26 – Wiring Devices.
 - .2 Section 27 15 13 – Communications Copper Horizontal Cabling.

1.02 Reference Standards

- .1 Except as modified by governing codes and by the Contract Documents, comply with the latest applicable provisions and latest recommendations of the following:
 - .1 CSA C22.2 No. 18.1-13 (R2022) - Metallic outlet boxes (Tri-national standard, with UL 514A and ANCE NMX-J-023/1).

1.03 Submittals

- .1 Submit manufacturer's catalog cuts and specifications for all floor boxes, and accessories.

2 Products

2.01 Manufacturers

- .1 Canadian Electric Raceways.
- .2 Hubbell.
- .3 Wiremold (Legrand).
- .4 Wellmark.
- .5 Steel City.

2.02 Floor Boxes

- .1 Floor Boxes: CSA C22.2 No. 18.1, fully adjustable, 38 mm deep.
- .2 Material: Cast metal.
- .3 Shape: Rectangular.
- .4 Service Fittings: As specified in Section 26 27 26.
- .5 Heavy duty lid.

3 Execution

3.01 Coordination

- .1 Coordinate exact pathways of conduits to suit structural conditions.

- .2 Confirm exact conduit sizes with communications trade.
- .3 Install dedicated conduits for power and data and/or A/V for each floor box. Do not daisy chain conduits between floor boxes.

3.02 Installation

- .1 Contractor to verify the thickness of the floor and select the through floor component that fits floor thickness.
- .2 Install floor box so that cover plates are flush with top of finished floor.
- .3 The electrical documents shall not be used for the purpose of establishing locations of floor outlets. The location of such outlets shall be established by the Architect.

End of Section

1 General

1.01 References

- .1 CSA C22.2 No. 248 series.

1.02 Submittals

- .1 Provide submittals in accordance with Section 01 30 00.
- .2 Product Data:
 - .1 Provide fuse performance data characteristics for each fuse type and size above 200 amps. Performance data to include average melting time-current characteristics.
- .3 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 30 00.

1.03 Closeout Submittals

- .1 Documentation on operating any means to reduce the arcing fault clearing time for overcurrent devices so equipped (i.e. rated 1200 A or higher).

1.04 Delivery, Storage, and Handling

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 00.

1.05 Maintenance Material Submittals

- .1 Provide maintenance materials in accordance with Section 01 78 00.
- .2 3 spare fuses of each type and size installed above 600 A.
- .3 6 spare fuses of each type and size installed up to and including 600 A.

2 Products

2.01 Manufacturers

- .1 Bussman by Eaton.
- .2 GEC.
- .3 Littelfuse.
- .4 Mersen.
- .5 Substitutions: not permitted.

2.02 Fuses – General

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.
- .3 Fuses shall be sized as shown, time delay type, and of the same type throughout.
- .4 Fuses shall be CSA certified Class-J for 1 A-600 A or Class-L for 650 A and above.
- .5 Provide the following accessories where indicated or where required to complete installation:
 - .1 Fuseholders: Compatible with indicated fuses.

2.03 Fuse Types

- .1 Class J fuses.
 - .1 Type J1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
 - .2 Type J2, fast acting.
- .2 Class L fuses.
 - .1 Type L1, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
 - .2 Type L2, fast acting.
- .3 Class R fuses.
 - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum, to meet UL Class RK1 maximum let-through limits.
 - .2 Type R2, time delay, capable of carrying 500 per cent of its rated current for 10 seconds minimum.
 - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.

2.04 Fuse Requirements

- .1 Dimensions and Performance: CSA C22.2 No. 248 series, Class as specified or indicated.
- .2 Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- .3 Power Load Feeder Switches: HRC-1 Class J time delay type.
- .4 Other Feeder Switches: HRC-1 Class J time delay type.

2.05 Arc Flash Mitigation

- .1 Provide means to reduce the arc fault clearing time for all fusible disconnects rated 1200 A and higher

2.06 Spare Fuse Cabinet

- .1 Description: Wall-mounted sheet metal cabinet, suitably sized to store spare fuses and fuse pullers specified.

- .2 Doors: Hinged, with hasp for Owner's padlock.
- .3 Finish: Prime finish for field painting.
- .4 Dimensions: Minimum 914 mm by 914 mm by 305 mm (3 ft by 3 ft by 1 ft).

3 Execution

3.01 Installation

- .1 Install fuses to manufacturer's instructions.
- .2 Install fuse with label oriented such that manufacturer, type, and size are easily read.
- .3 Install spare fuse cabinet in electrical room.
- .4 Provide a complete set of fuses in each fusible device supplied under this Division and provide 3 spare fuses for each size used in spare fuse cabinet.

End of Section

1 General

1.01 Section Includes

- .1 Molded-case circuit breakers.
- .2 Molded-case switches.
- .3 Accessories.

1.02 Related Requirements

- .1 Section 26 24 13 – Switchboards.
- .2 Section 26 24 16 – Panelboards.

1.03 References

- .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (29th edition/2024).
- .3 CSA C22.2 No. 5-16 (R2021), Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures.
- .4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.
- .5 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).

1.04 Submittals

- .1 Submit product data in accordance with Section 01 30 00.
- .2 Include time-current characteristic curves for breakers with ampacity of 400 A and above, or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.
- .3 Include termination temperature rating in degrees C.
- .4 Certificate of Origin
 - .1 Prior to any installation of circuit breakers in either a new or existing installation, Contractor must submit three (3) copies of a certificate of origin from the manufacturer, duly signed by the factory and the local manufacturer's representative, certifying that all circuit breakers come from this manufacturer, they are new, and they meet standards and regulations. These certificates must be submitted to the Consultant for review.
 - .2 A delay in the production of the certificate of origin won't justify any extension of the contract and additional compensation.
 - .3 Any work of manufacturing, assembly or installation should begin only after acceptance of the certificate of origin by the Consultant. Unless complying with this requirement, Consultant reserves the right to mandate the manufacturer listed on circuit breakers to authenticate all new circuit breakers under the contract, and that, to Contractor's expense.
 - .4 In general, the certificate of origin must contain:

- .1 The name and address of the manufacturer, and the person responsible for authentication. The responsible person must sign and date the certificate;
- .2 The name and address of the licensed dealer, and the person of the distributor responsible for the Contractor's account.
- .3 The name and address of the Contractor, and the person responsible for the project.
- .4 The name and address of the local manufacturer's representative. The local representative must sign and date the certificate.
- .5 The name and address of the building where circuit breakers will be installed:
 - .1 Project title.
 - .2 End user's reference number.
 - .3 The list of circuit breakers.

1.05 Closeout Submittals

- .1 Documentation on operating any means to reduce the arcing fault cleaning time for breakers so equipped (i.e. rated 1200 A or higher).

2 Products

2.01 General

- .1 Molded-case circuit breakers, Circuit breakers, and Ground-fault circuit-interrupters, Fused circuit breakers, and Accessory high-fault protectors: to CSA C22.2 No. 5.
- .2 Bolt-on Molded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Plug-in Molded case circuit breakers: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .4 Common-trip breakers: with single handle for multi-pole applications.
- .5 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .6 Circuit breakers with interchangeable trips.

2.02 Interrupting Capacity

- .1 Protective devices shall be fully rated, for required available fault current. Series rated shall not be used on this installation.
- .2 Refer to Section 26 24 13, and Section 26 24 16.

2.03 Molded Case Circuit Breakers – General

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

- .2 NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- .3 Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- .4 1-, 2-, or 3-pole bolt on, single-handle common trip voltage as indicated on drawings.
- .5 Overcentre toggle-type mechanism, quick-make, quick-break action. Trip indication is by handle position.
- .6 Calibrate for operation in 40 degree C ambient temperature.

2.04 Molded Case Circuit Breakers – Up to 150 Ampere

- .1 Permanent trip unit containing individual thermal and magnetic trip elements in each pole, unless noted otherwise on drawings.

2.05 Molded Case Circuit Breakers – 151 to 224 Ampere

- .1 Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.

2.06 Molded Case Circuit Breakers – 225 Ampere and Above

- .1 Electronic trip type with adjustments for long-time, instantaneous, and short-time functions.

- .2 Provide ground fault function for breakers greater than 1000 Amps.

- .3 1000 Amp and above:

- .1 Modbus Communications

- .1 Breaker status.

- .1 Open.

- .2 Closed.

- .3 Tripped.

- .2 Cause of trip.

- .3 Time of trip.

- .4 Current at time of trip.

- .5 RMS currents per phase and ground.

- .6 Peak demand.

- .7 Present demand.

- .8 Energy consumption.

- .4 1200 Amp and above:

- .1 Provide handle mechanisms that are lockable in the open (off) position.

- .2 Provided with means to reduce the arc fault clearing time.

2.07 Additional Features

- .1 Provide as indicated on drawings:

- .1 Shunt trip.
- .2 Auxiliary switch.
- .3 Motor-operated mechanism.
- .4 Under-voltage release.
- .5 On-off locking device.
- .6 Handle mechanism.

2.08 Molded-Case Switches

- .1 Molded-case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- .2 Accessories:
 - .1 Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
 - .2 Application Listing: Type HACR for heating, air-conditioning, and refrigerating equipment.

2.09 Enclosed Breakers and Enclosed Molded-Case Switches

- .1 Molded case, front operated, automatic circuit breakers sized as specified on drawings each secured in a CSA type 2 enclosure, flush wall mounting enclosure with steel front panel suitable for sprinklered areas.
- .2 Voltage rating suitable for circuit phase to phase voltage as indicated on drawings.
- .3 Units to include solid state adjustable trip units and contactors. Contactors to be of rating and type to suit application.

3 Execution

3.01 Installation

- .1 Install circuit breakers as per related sections.

End of Section

1 General

1.01 Section Includes

- .1 Fusible and non-fusible enclosed low-voltage disconnect switches from 30 amps to 800 amps.

1.02 Related Requirements

- .1 Section 26 28 13 – Fuses.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 4:16 (R2020), Enclosed and Dead-Front Switches.
 - .4 CSA C22.2 No. 248 series, Low-voltage fuses.
- .2 NETA (International Electrical Testing Association) ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.04 Submittals

- .1 Product Data: Provide switch ratings, and enclosure dimensions.

1.05 Closeout Submittals

- .1 Record actual locations of enclosed switches in project record documents.

2 Products

2.01 Manufacturers

- .1 Eaton Cutler-Hammer.
- .2 Siemens.
- .3 Square D by Schneider Electric.

2.02 Regulatory Requirements

- .1 Products: Listed and classified by CSA or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2.03 Disconnect Switches

- .1 Provide dedicated disconnect switches at electrical equipment.
- .2 Fused or un-fused disconnect or safety switches: Type "A", quick-make, quick-break construction with provision for padlocking switches in either "ON" or "OFF" position.
 - .1 Quick-make, quick-break.
 - .2 Heavy duty industrial type.

- .3 Lockable with up to 3 padlocks.
- .4 Cover interlocked with switch mechanism.
- .5 Viewing window for viewing blades.
- .3 Fused switches equipped with fuse clips designed for Class "J" fuses and designed to reject standard NEC fuses.
- .4 Enclosure: CSA Type 2 sprinkler-proof, or as noted.
- .5 Switches throughout project of same manufacturer.

3 Execution

3.01 Installation

- .1 Provide fused or un-fused safety or disconnect switches as shown and as required by Code.
- .2 Install disconnect switches complete with fuses, if applicable, to CSA C22.1.
- .3 Apply neatly typed adhesive tag on inside door of each fusible switch indicating NEMA fuse class and size installed.
- .4 Provide disconnect switches for connection to equipment as described in Section 26 05 83.
- .5 Coordinate fuse ampere rating with installed equipment. Fuse ampere rating variance between original design information and installed equipment, size in accordance with Bussmann Fusetron 40 degree C recommendations. Do not provide fuses of lower ampere rating than motor starter thermal units.

End of Section

1 General

1.01 Section Includes

- .1 Solid state, light emitting diode (LED) source interior luminaires.
- .2 New, fully integrated luminaires for indoor applications.

1.02 Related Requirements

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 52 13.13 – Emergency Lighting.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).
- .2 DesignLights Consortium (DLC):
 - .1 Solid-State Lighting Technical Requirements v5.1, or latest edition.
 - .2 Where the specifications do not explicitly call for DLC qualified LED luminaires, the technical criteria provided in the DLC Technical Requirements provide the basis of the requirements for this section of the Specification.
- .3 Energy Star:
 - .1 Program Requirements for Luminaires - Eligibility Criteria, Version 1.2, or latest edition.
- .4 Illuminating Engineering Society (IES):
 - .1 IES HB-10-11 – The Lighting Handbook, 10th Edition.
 - .2 IES LM-79-08 – Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
 - .3 IES LM-80-08 – IES Approved Method for Measuring Lumen Maintenance of LED Light Sources.
 - .4 IES TM-21-11 – IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
 - .5 IES TM-30-15 – IES Method for Evaluating Light Source Color Rendition.
- .5 IEEE 1789-2015 – IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers.
- .6 National Electrical Manufacturer’s Association (NEMA):
 - .1 SSL-1-10 – Electronic Drivers for LED Devices, Arrays, or Systems.
 - .2 WD 6 - Wiring Devices - Dimensional Requirements.

1.04 Definitions

- .1 CCT: Correlated colour temperature.
- .2 CRI: Colour-rendering index.
- .3 LED: Light Emitting Diode.
- .4 Lumen: Measured output of lamp and luminaire, or both.
- .5 Luminaire: Complete lighting fixture, including ballast housing if provided.

1.05 Action Submittals

- .1 Refer to Section 01 30 00.
- .2 Product submittals shall be accompanied by product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):
 - .1 Maximum power in Watts.
 - .1 If a transformer is used in conjunction with a driver (for example on some 347 volt lighting circuits), the maximum power shall include the transformer losses.
 - .2 L70 in hours, when extrapolated for the worse case operating temperature. TM-21 report shall be submitted to demonstrate this.
 - .3 Product submittals shall be accompanied by performance data that is derived in accordance with appropriate IESNA testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products.

1.06 Informational Submittals

- .1 Installation instructions.

1.07 Closeout Submittals

- .1 Section 01 78 00: Submittals for project closeout.
- .2 Submit manufacturer's operation and maintenance instructions for each product.
- .3 Warranty information.

1.08 Qualifications

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.09 Regulatory Requirements

- .1 Products shall be listed and classified by CSA (Canadian Standards Association), ULC (Underwriter's Laboratories of Canada), or certified by recognized independent testing organizations that test to CSA standards.
- .2 Products shall be certified by a recognized testing agency accredited by the Standards Council of Canada and bear a certification mark from that agency.

- .3 All luminaires shall be listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations as required.
- .4 Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.

1.10 Delivery, Storage, and Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.11 Warranty

- .1 Refer to Section 01 78 00 and Section 26 05 00.
- .2 The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the luminaires for a period of 5 years after acceptance of the luminaires. Warranty shall cover all components comprising the luminaire.
- .3 All warranty documentation shall be provided to customer prior to the first shipment.
- .4 LED Luminaires shall have a manufacturer's warranty for a period of not less than five years.
- .5 LED boards, drivers and associated components shall have a warranty of 5 years on the LEDs, 5 years on the driver, 10 years on the paint finish.

2 Products

2.01 Manufacturers

- .1 As noted on Lighting Fixture Schedule.

2.02 Indoor LED Luminaires, General

- .1 Initial delivered lumens – thermal losses should be less than 10 per cent when operated at a steady state at an average ambient operating temperature of 25 degrees C, and optical losses should be less than 15 per cent.
- .2 Average Delivered Lumens – Average delivered lumens over 50 000 hours should be minimum of 85 per cent of initial delivered lumens.
- .3 All luminaires shall be tested per IES LM-79 and IES LM-80, and include published L70 data.
- .4 Colour rendition:
 - .1 Interior luminaires with a CRI greater than or equal to 80, or as indicated on the lighting fixture schedule.
 - .2 Where minimum 90 CRI is indicated, the following may be considered acceptable in lieu, subject to confirmation with the Consultant by means of a Request for Interpretation during the bid period:
 - .1 CRI (Ra) \geq 90.
 - .2 CRI (Ra) \geq 80 and R9 (R9) \geq 50.
 - .3 IES Rf \geq 78, IES Rg \geq 100, -1% \leq IES Rcs,h1 \leq 15%.
- .5 Correlated colour temperature as indicated on the lighting fixture schedule.

- .6 Accessibility and Maintenance:
 - .1 All LED luminaires shall be field serviceable, with LED arrays, LED modules, drivers, etc. fully serviceable and easily accessible. In the case of recessed ceiling mounted, and in the case of surface mounted ceiling fixtures, these components must be accessible from below. Luminaires in which any of these components are accessible only from above are not acceptable.
 - .2 Ballasts, drivers, LED arrays, LED modules, and lamps shall be serviceable while the fixture is in its normally installed position. Ballasts or drivers shall not be mounted to removable reflectors or wireway covers unless so specified. In the case of ceiling mounted luminaires, the serviceable components must be accessible from below.
- .7 Housings:
 - .1 Formed to prevent warping and sagging. Housing, trim, and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
 - .2 Sheet steel housings to be minimum 20 gauge.
 - .3 Wireways and fittings: free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.
 - .4 When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
 - .5 Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
 - .6 Drivers shall not be mounted to removable reflectors or wireway covers unless so specified.
- .8 Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
- .9 Metal Finishes:
 - .1 Fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.
 - .2 All metal components of fixtures shall be painted after fabrication to mitigate raw metal edges, and thus prevent premature corrosion.
 - .3 The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt, and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping, or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.
 - .4 Interior light reflecting finishes shall be white with not less than 85 per cent reflectance, except where otherwise shown on the drawing.
- .10 Wiring:
 - .1 Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
 - .2 Supplied complete with a luminaire disconnect plug.

- .11 Control of Visual Perceptions of Temporal Light Modulation (flicker):
 - .1 All electric lights (except decorative lights, emergency lights and other special-purpose lighting) used in regularly occupied spaces meet at least one of the following requirements for flicker:
 - .1 A minimum frequency of 90 Hz at all 10% intervals from 10% to 100% light output.
 - .2 LED products with a “low risk” level of flicker (light modulation) of less than 5%, especially below 90 Hz operation as defined by IEEE standard 1789-2015 LED.

2.03 Drivers, General

- .1 Electronic LED drivers shall be integral to the luminaire, and be designed to be accessible in the field for replacement and servicing.
- .2 Input Voltage:
 - .1 Driver with a voltage range of (120-277) \pm 10% or (347-480) \pm 10%.
 - .2 Refer to lighting fixture schedule.
 - .3 For luminaires connected to a 347 volt circuit and utilizing a natively 120-277 volt driver, provide an appropriately sized step down transformer.
- .3 Input frequency 60 Hz.
- .4 Load regulation: \pm 1 per cent from no load to full load.
- .5 Output ripple less than 10 per cent.
- .6 Output should be isolated.
- .7 Case temperature: rated for -40°C through +80°C.
- .8 Overheat protection, self-limited short circuit protection and overload protected.
- .9 Primary fused.
- .10 Driver life rating not less than 50 000 hours
- .11 Power Factor and Total Harmonic Distortion
 - .1 Power factor of greater than or equal to 0.9 at full load.
 - .2 THD of less than or equal to 20 per cent at full load.
- .12 Dimming Control:
 - .1 Coordinate with Section 26 09 23.
 - .2 0-10 V dimming control typical for all fixtures unless otherwise noted.
 - .3 Control range: 10 per cent to 100 per cent typical, unless noted otherwise.
 - .4 Provide a mock-up to demonstrate the luminaire is free of flicker throughout the dimming range when used with the dimming controllers described in related sections.

2.04 Downlight Luminaires

- .1 Minimum Light Output: 500 lm.
- .2 Zonal lumen density: Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Minimum luminaire efficacy: 45 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K.
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with IES LM-80 testing data and IES TM-21 extrapolation.

2.05 Nominal 610 mm by 610 mm (2 ft by 2 ft) Luminaires for Ambient Lighting of Interior Spaces

- .1 Minimum Light Output: 2 000 lm.
- .2 Zonal lumen density:
 - .1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Spacing Criteria:
 - .1 0 degrees to 180 degrees: 1.0 to 2.0
 - .2 90 degrees to 270 degrees: 1.0 to 2.0
- .4 Minimum luminaire efficacy: 85 lumens per watt.
- .5 Correlated Colour Temperature (CCT): 4000 K.
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with IES LM-80 testing data and IES TM-21 extrapolation.

2.06 Nominal 305 mm by 1220 mm (1 ft by 4 ft) Luminaires for Ambient Lighting of Interior Spaces

- .1 Minimum Light Output: 1 500 lm.
- .2 Zonal lumen density:
 - .1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Spacing Criteria:
 - .1 0 degrees to 180 degrees: 1.0 – 2.0
 - .2 90 degrees to 270 degrees: 1.0 – 2.0
- .4 Minimum luminaire efficacy: 85 lumens per watt.
- .5 Correlated Colour Temperature (CCT): 4000 K.
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with IES LM-80 testing data and IES TM-21 extrapolation.

2.07 Nominal 610 mm by 1220 mm (2 ft by 4 ft) Luminaires for Ambient Lighting of Interior Spaces

- .1 Minimum Light Output: 3 000 lm.
- .2 Zonal lumen density:
 - .1 Minimum 75 per cent between 0 degrees and 60 degrees from nadir.
- .3 Spacing Criteria:
 - .1 0 degrees to 180 degrees: 1.0 – 2.0
 - .2 90 degrees to 270 degrees: 1.0 – 2.0
- .4 Minimum luminaire efficacy: 85 lumens per watt.
- .5 Correlated Colour Temperature (CCT): 4000 K.
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with IES LM-80 testing data and IES TM-21 extrapolation.

2.08 Linear Ambient Luminaires: Direct/Indirect

- .1 Minimum Light Output: 500 lm per foot.
- .2 Zonal lumen density:
 - .1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.
 - .2 Minimum 35 per cent between 90 degrees and 150 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K.
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with IES-LM-80 testing data and IES TM-21 extrapolation.

2.09 Linear Ambient Luminaires: Direct

- .1 Minimum Light Output: 375 lm per foot.
- .2 Zonal lumen density:
 - .1 Minimum 40 per cent between 0 degrees and 60 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K.
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with IES LM-80 testing data and IES TM-21 extrapolation.

2.10 High-Bay Luminaires for Commercial and Industrial Buildings

- .1 Minimum Light Output: 10 000 lm.
- .2 Zonal lumen density:
 - .1 Minimum 30 per cent between 20 degrees and 50 degrees from nadir.
- .3 Minimum luminaire efficacy: 80 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 4000 K.
- .5 Colour Rendition Index (CRI): 70 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 35 000 hours in accordance with IES LM-80 testing data and IES TM-21 extrapolation.

3 Execution

3.01 Verification of Conditions

- .1 Coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, piping, steel, etc.

3.02 Installation

- .1 Install lighting equipment, including but not limited to luminaires, controls, auxiliary devices and the integration of same in strict conformance with all manufacturers' recommendations and instructions the securing of which shall be the responsibility of the Contractor.
- .2 Integrate luminaires with controls in accordance with respective luminaire manufacturers' and controls manufacturers' recommendations and instructions and to provide a complete, trouble-free operation without compromising safety, code and CSA requirements.
- .3 Seal all luminaires for wet locations (i.e. all knock-outs, all pipe and wire entrances, etc.) as is standard industry practice to prevent water from entering luminaires.
- .4 Luminaire Alignment:
 - .1 Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Install recessed luminaires to permit removal from below. Include accessories and materials to meet applicable codes and regulatory requirements.
 - .2 Align luminaires mounted in continuous rows to form straight uninterrupted line.
 - .3 Align luminaires mounted individually parallel or perpendicular to building grid lines.
 - .4 Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Secure to prevent movement.
 - .5 Locate and install luminaires as indicated. Mounting heights and configuration of the luminaires shall be as specified in the Luminaire Schedule portion of the Specification or indicated on the drawings, and where conflicts exist, as approved by the Consultant.
 - .6 Installed all luminaires plumb and true and level as viewed from all directions unless specifically identified otherwise in the Lighting Fixture Schedule. Luminaires shall remain plumb and true without continual adjustment or visibly obvious means beyond what is shown on luminaire submittal drawings.

- .7 For installation in suspended ceilings, ensure that the luminaires are supported such that there is no resultant bowing or deflection of the ceiling system greater than $1/360$ of the length of the total span of the ceiling member.
- .5 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- .6 Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, use a finishing ring painted to match the ceiling to conceal the junction box.
- .7 Suspended Luminaires:
 - .1 Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
 - .2 Suspended luminaires shall be installed plumb and true and level unless specifically identified otherwise in the Luminaire Schedule portion of this Specification and at a height from finished floor as specified on the drawings, details and Luminaire Schedule. In cases where this is impractical, refer to the Consultant for a decision. All appurtenances shall be consistently organized for a neat, uniform appearance.
- .8 Install wall mounted luminaires at height as indicated.
- .9 Accessories:
 - .1 Reflector cones, louvers, baffles, lenses, trims and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.
 - .2 Install accessories provided with each luminaire.
 - .3 All accessories shall be properly installed and adjusted by Contractor in accordance with specification and installation instructions. Any spare items shall be clearly labeled (indicate type of accessory and associated luminaire types).

3.03 Testing and Adjustment

- .1 As required, all adjustable luminaires shall be aimed, focused, locked, etc., by the Contractor under the observation of the Consultant. As aiming and adjusting is completed, locking setscrews and bolts and nuts shall be tightened securely by the Contractor.
- .2 For luminaires with field selectable lumen output and/or CCT, ensure the correct setting matches the intended set points.
- .3 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.
- .4 Where possible, units shall be focused during the normal working day. However, where daylight interferes with seeing lighting effects, aiming shall be accomplished at night.

3.04 Luminaire Supports

- .1 Provide adequate support to suit ceiling system.
- .2 Support luminaires independently of ceiling framing, unless ceiling is certified by the manufacturer to support weight of installed devices. Confirm if T-bar ceilings are metric or imperial and provide luminaires to suit ceiling dimensions.
- .3 Provide chain hangers for new and existing luminaires.

- .4 Install clips to secure recessed grid-supported luminaires in place.
- .5 Fixtures supported by suspended ceiling systems shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Ceiling framing members must be securely attached to each other and to the building structure as required by all applicable codes and standards. Use of integral clips is not acceptable.

3.05 Wiring

- .1 Use SPC90 conductors for final connections to luminaires (including 0-10 V dimming conductors for applicable luminaires).
- .2 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.
- .3 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.
- .4 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .5 Bond products and metal accessories to branch circuit equipment grounding conductor.

3.06 Field Quality Control

- .1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- .2 Make wiring connections to the branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .3 Occupancy Sensors.
 - .1 Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas.
 - .2 Rooms shall have 90 per cent to 100 per cent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room.
 - .3 Exercise proper judgment in executing the work to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components.

3.07 Cleaning

- .1 Thoroughly clean all luminaires and accessories after installation. All fingerprints, dirt, tar, smudges, drywall mud, dust, etc. shall be removed by the Contractor from the luminaire bodies, reflectors, trims, and lens or louvers prior to final acceptance. All reflectors shall be free of paint other than factory-applied, if any. All reflectors, cones and lenses shall be cleaned only according to manufacturers' instructions.
- .2 Clean electrical parts to remove conductive and deleterious materials.
- .3 Remove dirt and debris from enclosures.
- .4 Clean photometric control surfaces as recommended by manufacturer.
- .5 Clean finishes and touch up damage.
- .6 Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Consultant.

3.08 Commissioning

- .1 In accordance with Section 26 08 50.

End of Section

1 General

1.01 Section Includes

- .1 Emergency lighting units with battery back-up for emergency illumination of remote emergency fixtures and internally illuminated exit signs.
- .2 Remote emergency fixtures.

1.02 Related Requirements

- .1 Section 26 51 19 – LED Interior Lighting.
- .2 Section 26 52 13.16 – Exit Signs.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.2 No. 141:15 (R2020), Emergency lighting equipment.
 - .2 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .3 Ontario Electrical Safety Code (29th edition/2024).
- .2 Ontario Building Code.
- .3 National Building Code of Canada.
- .4 Underwriters Laboratories, Inc. (UL):
 - .1 UL 924 – Standard for Safety of Emergency Lighting and Power Equipment.

1.04 Submittals

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

1.05 Closeout Submittals

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

1.06 Extra Materials

- .1 Allow the cost for material and for installation of the following to be installed as directed by the Consultant during construction:
 - .1 An additional five single head emergency remote units.
 - .2 An additional five dual head emergency remote units.

- .3 An additional one battery unit, based on the maximum battery capacity as specified.

1.07 Quality Assurance

- .1 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.
- .2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.
- .3 All units will be certified that they have been tested prior to shipping.

1.08 Delivery, Storage, and Handling

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

1.09 Warranty

- .1 Product is warranted free of defects in material and workmanship.
- .2 Product is warranted to perform the intended function within design limits.
- .3 For batteries in this Section, 12 month warranty period is extended to 24 months.

2 Products

2.01 Emergency Battery Units

- .1 Manufacturers:
 - .1 Lumacell RG24S series.
 - .2 Aimlite.
 - .3 BeLuce (formerly Beghelli).
 - .4 Emergi-Lite.
 - .5 Stanpro.
- .2 Battery Unit Features:

- .1 Self-contained unit equipment for LED emergency lighting shall be manufactured and labeled as certified to meet CSA C22.2 No. 141.
- .2 Housing: Constructed of formed and welded 18 gauge cold rolled steel with knockouts for conduit, finished in baked white enamel. Cabinet suitable for direct or shelf mounting to wall. Removable or hinged front panel for easy access to batteries.
- .3 Charger:
 - .1 Solid-state micro-controller PCB, Pulse-Guard charger, features include; auto-equalized, temperature compensated, current limited, short circuit and reverse polarity protected.
 - .2 Recharges battery within 24 hours in accordance with CSA requirements.
- .4 Transfer: Upon failure of the power supply, or voltage dip below 75 per cent of nominal, a sealed relay automatically and instantaneously connects the battery to the emergency lighting load and disconnects when battery discharge reaches 87.5 per cent expectancy.
- .5 Batteries: seal lead calcium, maintenance free, and 10 year pro-rated service life.
- .6 Auto-test: Unit to perform self-test for 1 minute ever 30 days, 10 minutes on the 6th month, and 30 minutes every 12 months.
- .3 Battery Electrical Features:
 - .1 Input Voltage:120-347 VAC universal input:
 - .1 Provided with plug and receptacle when connected to 120 volt source panelboard.
 - .2 direct connected to 347 volt source panelboard.
 - .2 Output Voltage: 24 VDC; balance loads to battery unit terminals.
 - .1 Normally "Off" output: wattage capacity as indicated for emergency remotes and internally illuminated exit signs.
 - .2 Battery Run Time at full load: must meet OBC minimum, 30 minutes.
 - .3 Voltage regulation: $\pm 5\%$ of nominal maximum.
 - .3 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .4 Lamp heads:
 - .1 Integral on unit, 345 degrees horizontal and 180 degrees vertical adjustment.
 - .2 Lamp type:
 - .1 Two 24 V, 6 W MR16 LED lamps mounted on top of the battery cabinet, shall be injection molded thermoplastic, white finish.
 - .2 Average lamp lumens: 170 lm.
 - .3 Centre Beam Candlepower: 440 cd.
 - .4 Beam angle: 30 degrees.
 - .5 Lamp efficacy: 42.5 lm/W.

- .5 Auxiliary equipment:
 - .1 Ammeter.
 - .2 Voltmeter.
 - .3 Test switch.
 - .4 Time delay relay.
 - .5 Battery disconnect device.
 - .6 AC input and DC output terminal blocks inside cabinet.
 - .7 Shelf Bracket.
 - .8 Cord and single twist-lock plug connection for AC.
 - .9 RFI suppressors.
 - .10 Voltage Sensing Relay:
 - .1 Up to six inputs for line voltage detection from different normal lighting zone. The wire connection from each zone circuit shall be made with terminal blocks.
 - .2 Operation Sequence: In the case of power failure of one or several circuits feeding normal lighting, the output circuit will open and transfer the battery unit(s) in emergency lighting mode.
 - .3 Provide "push to test" push button and a pilot light for each zone circuit for manual testing and service.

2.02 Emergency Lighting Emergency Remote Heads

- .1 Refer to drawings and lighting schedule.
- .2 One or two lamps, shall be injection molded thermoplastic, white finish, lamps shall be MR16 LED 24 V, 540 lumen, 25 degree beam angle, 6 watt.
- .3 Remote heads to be mounted not less than 2100 mm (6'-10") AFF.
- .4 LED MR16 lamps:
 - .1 Lumacell MQM-x-12V4W-LD10 series.
 - .2 Equal by Emergi-Lite.
 - .3 Equal by Stanpro.
 - .4 Equal by Beluce (formerly Beghelli).

3 Execution

3.01 Examination

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

- .1 Visually inspect substrate in presence of Owner.
- .2 Inform Owner 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 Owner.

3.02 Installation

- .1 Install emergency lighting in compliance with local inspection authorities.
- .2 Wiring:
 - .1 Connect battery input to source panelboard. Balance the emergency lighting loads connected to battery output terminal blocks. Provide and connect remote fixtures and internally illuminated exit signs as specified and as required for system performance in compliance with OBC minimum egress illumination requirements. Install remotes in locations as shown on the drawings. Connect all remotes to normally "Off" output from battery units.
 - .2 Contractor is responsible for revisions to system, including relocations, aiming and additional remote heads as determined by testing results. All wiring shall be in accordance with manufacturer's recommendations.
 - .3 Use minimum #10 gauge or heavier if needed to provide a maximum voltage drop of 5 per cent. Consult manufacturer's table for sizing the minimum gage and length of wire runs permitted for connected loads to ensure a maximum voltage drop of 5 per cent from the battery unit to the farthest emergency remote, in accordance with OBC and local inspection authorities.
- .3 Mounting: Suitable for wall mounting, complete with bracket from manufacturer lighting heads, test switch and diagnostic LED indicator shall be visible.
- .4 Provide Voltage Sensing Relays internal or external to battery units to meet the intent of OESC Rule 46-304 (4). Unit equipment shall be installed in such a manner that it will be automatically actuated upon failure of the power supply to the normal lighting in the area covered by that unit equipment.

3.03 Testing and Commissioning

- .1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.
- .2 Contractor is responsible for arranging and cost of a verification test of emergency illumination levels by the manufacturer's representative.
 - .1 Verification test shall be performed with a lux/footcandle meter at 1 m intervals along all paths of egress throughout the space, and record light level readings on floor plans provided by the consultant.
 - .2 The contractor shall also provide consultant with a letter stating the recorded emergency lighting levels meet the OBC requirements of 10 lx (1 fc) average with minimum readings not less than 1 lx (0.1 fc) on the path of egress.
 - .3 The manufacturer is to provide a letter of verification confirming testing and operation of all emergency lighting as well as installation to all applicable codes.
- .3 Contractor is to indicate in the letter the duration of emergency lighting run time that was observed.
- .4 Testing shall be performed during non-daylight hours. Contractor shall aim all remotes to optimise illumination on the floor and stair.

- .5 Contractor shall certify in writing to the Consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.
- .6 Contractor shall notify the Owner and the Consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the Owner.
- .7 Installation shall be in accordance with the electrical code and manufacturer's instructions.
- .8 The Contractor is to submit a letter on Contractor's letterhead confirming the criteria specified above is met, including light levels, and run time, and include a copy of the plans with light levels recorded.
- .9 Provide breaker lock on emergency lighting circuit at source panelboard.

3.04 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by emergency lighting installation.

3.05 Testing, Maintenance, and Warranty Service

- .1 Provide complete instructions for the operation and care of the emergency power supply or unit equipment that shall specify testing at least once every month to ensure security of operation. Instructions to be framed under glass.
- .2 OBC testing obligations: Owner's facility maintenance personnel are required to document one manual test of the battery units each month, and conduct one full discharge test once a year per OBC and CSA C22.2 No. 141 requirements.
- .3 Annual Maintenance: The manufacturer recommends maintenance to be performed by a qualified service provider. Contact the manufacturer for any warranty service.

End of Section

1 General

1.01 Section Includes

- .1 Internally illuminated “Running Man” exit sign units for ordinary location use.

1.02 Related Requirements

- .1 Section 26 52 13.13 – Emergency Lighting: Emergency Battery Units.

1.03 References

- .1 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
 - .3 CSA C22.2 No. 141:15 (R2020), Emergency lighting equipment.
 - .4 CAN/CSA-C860-11 (R2020), Performance of Internally Lighted Exit Signs.
- .2 International Organization for Standardization (ISO)
 - .1 ISO 7010:2011 – Graphical symbols – Safety colours and safety signs.
 - .2 ISO 3864-1:2011 – Graphical symbols -- Safety colours and safety signs -- Part 1: Design principles for safety signs and safety markings
- .3 Ontario Building Code.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 ULC/ORD-924-02, Standard for Emergency Lighting and Power Equipment.
 - .2 CAN/ULC-S572-10, First Edition Standard for Photoluminescent and Self-Luminous Exit Signs and Path Marking Systems.

1.04 Submittals

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data: Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures and maintenance.

1.05 Extra Materials

- .1 Allow the cost for material and for installation of an additional five exit signs, single face or dual face, to be installed as directed by the Consultant during construction. Include 15.24 m (50 feet) of wire and conduit per exit sign.

1.06 Quality Assurance

- .1 Exit signs units shall be ULC Listed and/or CSA Certified to CSA C22.2 No. 141 and CSA C860.

- .2 Furnished products are listed and/or certified by third party agencies as suitable for the intended purpose.
- .3 Manufacturer Qualifications: Products shall be free of defects in material and workmanship.
- .4 All units will be certified that they have been tested prior to shipping.

1.07 Delivery, Storage, and Handling

- .1 In accordance with Section 01 61 00.

1.08 Waste Management and Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 00.

1.09 Warranty

- .1 Product is warranted free of defects in material and workmanship for a minimum of one year from substantial completion.

2 Products

2.01 Exit Signs, General

- .1 Manufacturers
 - .1 Aimlite.
 - .2 BeLuce (formerly Beghelli).
 - .3 Emergi-Lite.
 - .4 Lumacell.
 - .5 Stanpro.
 - .6 Other manufacturers as indicated in Section 26 52 13.13.
- .2 Substitution Limitations:
 - .1 Manufacturer of exit signs to be the same as manufacturer of emergency lighting battery units and remote heads specified in Section 26 52 13.13.
 - .2 No manufacturer substitutions.
- .3 Description
 - .1 Green and White LED Pictogram “Running Man” exit sign.
 - .2 The pictogram sign shall be certified as CSA C22.2 No. 141, and meet ISO 3864-1 and ISO 7010.
 - .3 The pictogram legend shall have a minimum illuminated dimension of 5.9" high and 11.13" with ISO 3864-1 and ISO 7010 pictogram printed on a pure-acrylic panel.
 - .4 The sign shall include a standard single face with optional double-faceplate included.
 - .5 Not acceptable:
 - .1 Red LED EXIT signs.

- .2 Externally illuminated photoluminescent, or non-electrical radioluminescent type of pictogram signs are not acceptable.
- .4 Mounting
 - .1 The canopy shall universal to allow for wall, end, or ceiling mount.
- .5 Electrical
 - .1 The LED light source shall be long-life white Light-Emitting Diodes and shall provide uniform illumination of the pictogram in normal and emergency operation.
 - .2 The sign shall operate with universal 2-wire AC input voltage of 120 to 347 Vac at less than 3 Watts, and universal 2-wire DC input voltage from 6 to 24 Vdc at less than 2.5 Watts for single and double face legends with a single arrow either left or right.
 - .3 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.
 - .4 The pictogram edge-lit exit signs where indicated on the plans in a self-powered configuration shall use a sealed Nickel-Cadmium battery of 2.4 V nominal voltage and shall stay illuminated during emergency operation for at least two hours upon AC failure.

2.02 Extruded Aluminum Pictogram Exit Signs

- .1 Manufacturers
 - .1 Lumacell LA series.
 - .2 Beghelli QR-RM series.
 - .3 Equivalent products from manufacturers as described in Article 2.01 of this specification.
- .2 Materials
 - .1 The housing assembly shall be constructed of extruded aluminum in factory white colour.
 - .2 The housing shall be constructed of rugged extruded aluminum and have a maximum depth of 2-1/2".
 - .3 The faceplate(s) shall be constructed of extruded aluminum and shall incorporate a protective clear poly-carbonate panel.
 - .4 Each face plate shall come standard with two legend films for pictogram and directional indicators.

3 Execution

3.01 Installation

- .1 Install exit lights to manufacturer's recommendations, listing requirements, CSA standard and local regulatory requirements.
- .2 Ensure exit signs are not obscured. Where an exit sign is to be installed in an area with no ceiling, provide a suitable pendant mount.
- .3 Connect fixtures to exit light circuits normal power supply and emergency battery units specified in Section 26 52 13.13.

- .4 Ensure that emergency lighting circuit breaker is locked in ON position.
- .5 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.

3.02 Field Quality Control

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

3.03 Cleaning

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

3.04 Testing and Commissioning

- .1 When installation of emergency lighting equipment is complete, contractor shall commission and test the entire system and adjust if necessary.
- .2 The Contractor shall certify in writing to the consultant that the system is complete, installed per CSA C22.2 No. 141, has been tested, and operates for the specified battery run time.
- .3 The Contractor shall notify the Owner and the Consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the Owner.
- .4 Installation shall be in accordance with the electrical code and manufacturer's instructions.
- .5 Provide breaker lock on emergency lighting circuit at source panelboard.

3.05 Protection

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by exit sign installation.

End of Section

1 General

1.01 Conditions and Requirements

- .1 Refer to the General Conditions, Supplementary General Conditions, and General Requirements.
- .2 Provisions of this Section shall apply to all Sections of Division 27.
- .3 Refer to Consultant's drawings for exact location of electrical equipment and devices. Refer to Designer drawings for additional notes which complement these specifications.
- .4 The Division 26 specification documents shall be followed in conjunction with the specification in this section.

1.02 Related Requirements

- .1 Division 25 – Integrated Automation.
- .2 Division 26 – Electrical.
- .3 Division 28 – Electronic Safety and Security.

1.03 Intent

- .1 Include all material, labour, equipment, and plant construction as necessary to make a complete installation as shown and specified hereinafter. Sections of this specification are not intended to delegate functions nor to delegate work and supply to any specific trade. Ensure that the systems specified hereafter are complete and operative.

1.04 Specifications Language and Style

- .1 These specifications are written in the imperative mood and in streamlined form. The imperative language is directed to Contractor, unless stated otherwise.
- .2 Complete sentences by reading "shall", "Contractor shall", "shall be", and similar phrases by inference. Where a colon (:) is used within sentences and phrases, read the words "shall be" by inference.
- .3 Fulfill and perform all indicated requirements whether stated imperatively or otherwise.
- .4 When used in the context of a Product, read the word "provide" to mean "supply and install to result in a complete installation ready for its intended use."

1.05 Reference Standards

- .1 The equipment, material and installation shall conform to the latest version of the applicable codes, standards (including technical service bulletins and addenda), and regulations of authorities having jurisdiction.
- .2 BICSI
 - .1 Telecommunications Distribution Methods Manual.
 - .2 BICSI G1-17 – Outside Plant Manual.
- .3 CSA Group:
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.

- .2 Ontario Electrical Safety Code (29th edition/2024).
- .3 CSA T529 – Commercial Building Telecommunications Cabling Standard (ANSI/EIA/TIA-568-B).
- .4 CSA T530 – Commercial Building Standard For Telecommunications Pathways And Spaces (TIA/EIA 569-A).
- .5 CSA T528 – Administration Standard For The Telecommunications Infrastructure Of Commercial Buildings (ANSI/EIA/TIA-606).
- .6 CSA T527 – Commercial Building Grounding And Bonding Requirements For Telecommunications (ANSI/EIA/TIA-607).
- .7 CSA C22.2 No. 214 – Communications Cables.
- .8 CSA C22.2 No. 232-M – Fibre Optic Cables.
- .9 CSA C22.2 No. 182.4-M90 – Plugs, Receptacles, and Connectors for Communication Systems.
- .4 TIA
 - .1 TIA/EIA-568-B.1 – Commercial Building Telecommunications Cabling Standard
 - .2 TIA/EIA-568-B.2 – Balanced Twisted Pair Cabling Components
 - .3 TIA/EIA-568-B.3 – Optical Fibre Cabling Components Standard
- .5 ISO
 - .1 ISO/IEC IS 11801A – Generic Cabling for Customer Premises.
- .6 CENELEC EN 50173 – Performance Requirements for Generic Cabling Schemes.
- .7 IEC
 - .1 IEC 603-7, PART 7 – Detailed Specification For Connectors, 8-Way, Including Fixed And Free Connectors With Common Mating Features.
 - .2 IEC 807-8 – Rectangular Connectors For Frequencies Below 3 MHz, Part 8: Detailed Specification For Connectors, Four-Signal Contacts And Earthing Contacts For Cable Screens, First Edition.
- .8 FIPS PUB 174 – Commercial Building Telecommunications Wiring Standard. Federal Information Standard Publication.
- .9 UL 444 and 13 – Adopted Test and Follow-Up Service Requirements For the Optional Qualification of 100Ω Twisted-Pair (Cables).
- .10 NEMA WC 63 – Performance Standard For Field Testing Of Unshielded Twisted-Pair Cabling System.
- .11 ANSI/EIA/TIA
 - .1 ANSI/EIA/TIA-492AAAA – Detailed Specification For 62.5µm Core Diameter / 125µm Cladding Diameter Class 1a Multimode, Graded-Index Optical Waveguide fibres.
 - .2 ANSI/EIA/TIA-492BAAA – Detailed Specifications For Class Iva Dispersion-Unshifted Singlemode Optical Waveguide Fibres Used In Communication Systems.

- .3 ANSI/EIA/TIA-472CAAA – Detailed Specifications For All Dielectric (Construction 1) Fibre optic Communications Cable For Indoor Plenum Use, Containing Class 1a, 62.5µm Core Diameter / 125µm Cladding Diameter Fibre optic(s).
- .4 ANSI/EIA/TIA-472DAAA – Detailed Specifications For All Dielectric Fibre optic Communications Cable For Outdoor Plant Use, Containing Class 1, 62.5µm Core Diameter / 250µm Cladding Diameter Fibre optic(s).
- .5 ANSI/EIA/TIA-455 – Test Procedures For Fibre optics, Cables And Transistors.
- .6 ANSI/EIA/TIA-598 – Colour Coding of Fibre Optic Cables.
- .7 ANSI/EIA/TIA-604-3 – FOCIS 3 Fibre Optic Connector Intermateability Standard.
- .8 ANSI/EIA/TIA-606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
- .9 ANSI/EIA/TIA-607 – Commercial Building Grounding and Bonding Requirements for Telecommunications.
- .12 ANSI Z136.2 – American Standards For The Safe Operation of Fibre optic Communication Systems Utilizing Laser Diode And LED Sources.
- .13 ANSI/CEA
 - .1 ANSI/ICEA S-83-640 – Fibre Optic Outside Plant Communications Cable.
 - .2 ANSI/ICEA S-83-596 – Fibre Optic Premises Distribution Cable.

1.06 Submittals

- .1 Before delivery to site of any item of equipment, submit shop drawings c/w all data, pre-checked and stamped accordingly, for review to the Consultant. Indicate project name on each brochure or sheet. Submit shop drawings within 1 week after award of contract.

1.07 Record Documentation

- .1 To Section 01 78 00.
- .2 Red lines, mark-ups by this contractor.

1.08 Operation and Maintenance Manuals

- .1 Refer to Division 01.

1.09 Inspections

- .1 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

1.10 Drawings and Specifications

- .1 The drawings and specifications are complementary each to the other and what is called for by one to be binding as if called for by both. Should any discrepancy appear between the drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of plans and specifications, a ruling is to be obtained from the Engineer in writing before submitting Tender. If this is not done, the maximum, the most expensive alternate or option will be provided in base tender bid.

- .2 All drawings and all Divisions of these specifications shall be considered as a whole and work of this Division shown anywhere therein shall be furnished under this Division.
- .3 Drawings are diagrammatic and indicate the general arrangement of equipment and pathways. Most direct routing of cabling is not assured. Exact requirements shall be governed by architectural, structural, and mechanical conditions of the job. Consult all other drawings in preparation of the bid. Extra lengths of wiring or addition of pull and junction boxes, etc. necessitated by such conditions shall be included in the bid. Check all information and report and apparent discrepancies before submitting the bid.
- .4 Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pathways so as to best fit the layout of the job.
- .5 Scaling off the drawings will not be sufficient or accurate for determining these locations. Where job conditions require reasonable changes in indicated arrangement and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
- .6 Before ordering any conduit, cable tray, cables, fittings, etc., this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.11 Material

- .1 This contractor is responsible to ensure that all items submitted meet all requirements of the drawings and specification, and fits in the allocated space. The final determination of a product being acceptable shall be determined by the Engineer.

1.12 Testing Data

- .1 The contractor shall provide a complete testing report utilizing a testing device as specified in the applicable TIA/EIA standard with the correct adapter and test. All copper tests shall be compliant to the current TIA/EIA standards: Perm Link or Channel.
- .2 The Summary report shall provide be provided to the end user in a universal format so that there is no need to purchase any software to read and print the report.
 - .1 Utilizing Adobe Acrobat is an acceptable manner.

1.13 Painting and Finishes

- .1 Minor damages to finish on factory finished equipment shall be touched up to the Engineer's satisfaction. Items suffering major damage to finish shall be replaced at the direction of the Engineer. Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

1.14 Safety

- .1 The Contractor shall be responsible for the safety of his workmen and the equipment on the project in accordance with all applicable safety legislation passed by Federal, Provincial, and local authorities governing construction safety. The more stringent regulations shall prevail.

1.15 Warranty

- .1 Submit a written performance warranty to the Owner for one year for the complete installation for a period of no less than five years from the date of testing and acceptance. The system warranty shall be based on industry standards.
- .2 The contractor shall also provide a one year labour warranty on the installation.

2 Products

2.01 Material Approval

- .1 The design, manufacture and testing of electrical equipment and materials shall conform to or exceed the latest applicable CSA, IEEE, and ANSI standards.
- .2 All materials must be new and be ULC or CSA listed. Any materials not covered by the aforementioned listing standards shall be tested and approved by an independent testing laboratory, Technical Inspection Services, or other government agency.

3 Execution

3.01 Workmanship and Contractor's Qualifications

- .1 Only first class workmanship will be accepted, not only in regards to durability, efficiency and safety, but also in regards to neatness of detail. Present a neat and clean appearance on completion to the satisfaction of the Engineer. Any unsatisfactory workmanship will be replaced at no extra cost.
- .2 Conform to the best practices applicable to this type of work. Install all equipment and systems in accordance with the manufacturer's recommendations, but consistent with the General Requirements of this Specification. This Contractor will be held responsible for all damage to the work of his own or any other trade, resulting from the execution of his work. Store all equipment and materials in dry locations.
- .3 Provide foreman in charge of this work at all times.
- .4 The contractor shall be fully liable to provide and maintain in force during the life of this Contract, such insurance, including Public Liability Insurance, Product Liability Insurance, Auto Liability Insurance, Worker's Compensation, and Employer's Liability Insurance.

3.02 Work Sequence

- .1 Prior to start of each work period in occupied area, temporary protection shall be installed to prevent damage to any personal property or furnishing. Coordinate with Owner's representative if any furniture must be relocated to facilitate work.
- .2 Owner's representative shall approve temporary protection plan prior to use.
- .3 Necessary steps shall be taken by contractor to ensure that required fire fighting apparatus is accessible at all times. Flammable materials shall be kept in suitable places outside the building.

3.03 Coordination

- .1 Coordinate work with other trades.
- .2 Verify equipment dimensions and requirements with provision specified under this Section. Check actual job conditions before fabricating work. Report all necessary changes in time to prevent needless work. Changes or additions subject to additional compensation, which are made without written authorization and an agreed price, shall be at Contractor's risk and expense.
- .3 Read specifications and drawings of other trades and conform with their requirements before proceeding with any work specified in this Division related to other trades. Cooperate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other Trades.

3.04 Manufacturers' Instructions

- .1 Where the specifications call for an installation to be made in accordance with Manufacturer's recommendations, a copy of such recommendations shall be at all times be kept on the job site and be available to the Owner's Representative.
- .2 Follow manufacturer's instructions where they cover points now specifically indicated on the drawings and specifications. If they are in conflict with the drawings and specifications obtain clarification from the Consultant before starting work.

3.05 Quality Assurance

- .1 See General Provisions of the Contract.
- .2 The specifications contained herein are set forth as the minimum acceptable requirements. This does not relieve the Contractor from executing other quality assurance measures to obtain a complete operating system within the scope of this project.
- .3 The Contractor shall ensure that all workmanship, all materials employed, all required equipment and the manner and method of installation conforms to accepted construction and engineering practices, and that each piece of equipment is in satisfactory working condition to satisfactorily perform its functional operation.
- .4 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.

3.06 Labels and Signs

- .1 Labelling shall be as per TIA/EIA-606.

3.07 Adjust and Clean-Up

- .1 The Contractor and associated sub trades, at all times during construction, to keep the site free of all debris, boxes, packing, etc., resulting from work of this Trade. At the completion of this work, the installation is to be left in a clean and finished condition to the satisfaction of the Engineer.

3.08 Tests and Acceptance

- .1 The operation of the equipment does not constitute an acceptance of the work by the Owner. The final acceptance is to be made after the Contractor has adjusted his equipment and demonstrated that it fulfils the requirements of the drawings and the specifications.
- .2 Testing of all systems shall be performed in the presence of the Owner's designated representative. The contractor shall give 72 hours advance notice to the Owner before beginning the tests.
- .3 Upon completion of the installation, the Contractor shall furnish certificates of approval from all authorities having jurisdiction, as applicable. Contractor shall demonstrate that work is complete and in perfect operating condition. In the presence of the Owner, the Contractor shall demonstration the proper operation of all miscellaneous systems.

End of Section

1 General

1.01 Summary

- .1 Section Includes:
 - .1 Demolition and removal of selected portions of building or structure.
 - .2 Demolition and removal of selected site elements and/or Information Technology (IT), Security or other special systems or infrastructure.
 - .3 Salvage of existing items to be reused or recycled.
- .2 Contractor shall include in the Bid all labour, materials, tools, plant, transportation, storage costs, equipment, insurance, temporary protection, permits, inspections, taxes, and all necessary and related items required to provide complete demolition and cutover of existing telecommunication systems shown and described in the Specifications.
- .3 The Contractor is responsible for providing and coordinating phased activities and construction methods that minimize disruption to Terminal operations and provide complete and operational systems.
- .4 The Contractor shall coordinate interfaces to existing systems that are being demolished in order to minimize disruption to the existing systems operations. Any systems outages shall be approved in advance and scheduled with Owner.
- .5 The Contractor shall coordinate specialty electronic, IT data networks, common use, CCTV, public address, and any other IT infrastructure systems.

1.02 Related Requirements

- .1 Section 02 41 19 – Selective Demolition.

1.03 Definitions

- .1 Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- .2 Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.
- .3 Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- .4 Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.04 Administrative Requirements

- .1 Pre-Demolition Meeting
 - .1 Conduct a pre-demolition meeting at Project Site with Owner and all affected stakeholders.
 - .1 Inspect and discuss condition of construction to be selectively demolished.
 - .2 Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

- .3 Existing telecommunications rooms that have demolition work may involve electrical, mechanical, and architectural demolition. Review and coordinate requirements of work performed by other trades.
- .4 Review areas where existing construction is to remain and requires protection.
- .5 Review procedures to be followed when critical systems are inadvertently interrupted.

1.05 Submittals

- .1 Action Submittals
 - .1 Comply with all submittal procedures given in other Sections.
 - .2 Submit a Schedule of selective demolition and cutover activities which indicates the following as a minimum:
 - .1 Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's and tenants' on-site operations are uninterrupted.
 - .2 Duration of how long IT and security services will be interrupted and when systems cannot be disabled and temporary parallel service is required submit how this is proposed to be accomplished.
 - .3 The contractor's plan for coordination of shutoff, capping, and continuation of IT and all other utility services.
 - .4 Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
 - .3 Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
 - .4 Pre-demolition Photographs or Video: Submit before Work begins.
 - .5 Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.
- .2 Closeout Submittals
 - .1 Submit a list of items that have been removed and salvaged.
 - .2 Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
 - .3 Submit as-built documentation of all remaining IT and security systems conduit and cabling that remains.

1.06 Material Ownership

- .1 Unless otherwise indicated, demolition waste becomes property of Contractor.

1.07 Field/Site Conditions

- .1 Owner will occupy portions of building immediately adjacent to selective demolition area.
 - .1 Conduct selective demolition so Owner's operations will not be disrupted.

- .2 Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
 - .1 Before selective demolition, Owner will remove their equipment from the space.
- .3 Notify Consultant of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- .4 Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
 - .1 Hazardous materials will be removed by Owner before start of the Work.
 - .2 If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer. Hazardous materials will be removed by Owner under a separate contract.
- .5 Storage or sale of removed items or materials on-site is not permitted.
- .6 Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1.08 Warranty

- .1 Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

2 Products – Not Used

3 Execution

3.01 Examination

- .1 Verify that utilities have been disconnected and capped per Owner approved procedures before starting selective demolition operations.
- .2 Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- .3 Survey existing condition of all IT related conduits and cables from origin to destination and correlate with requirements indicated to determine extent of selective demolition required.
- .4 Label all conduits and cables with origin, destination and what system they serve.
- .5 Consult with Owner to determine whether systems can be disabled or whether a new parallel system needs to be installed.

3.02 Removal of Communications Cabling and Equipment

- .1 Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - .1 Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level. Remove all abandoned cables from origin to destination.
 - .2 Dispose of demolished items and materials promptly.

- .2 Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.
- .3 For existing equipment cabinets with active components in them, provide an airtight dust seal around the cabinet and circulate cooling air with a portable air conditioning unit or other means to ensure equipment does not overheat.
- .4 If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
- .5 When removing communications outlets, remove all conductors back to patch panel in communications closet or IT rack. Provide blank faceplates where outlets are removed from walls or partitions to remain.
- .6 Where communications cabling is to be re-used, coil the communications outlet cabling in the ceiling space for re-use.
- .7 Turn over wireless access points to Owner.

3.03 Disposal of Demolished Materials

- .1 General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in accordance with the requirements of the Authority Having Jurisdiction.
 - .1 Do not allow demolished materials to accumulate on-site.
 - .2 Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
 - .3 Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- .2 Burning: Do not burn demolished materials.
- .3 Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.04 Cleaning

- .1 Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

End of Section

1 General

1.01 Summary

- .1 This Section covers the Specification and requirements for the grounding and bonding of communications systems and structured cabling infrastructures.
- .2 Contractor shall provide all services, labor, materials, tools, and equipment required for the implementation of a complete and effective grounding and bonding System, as specified this Section.
- .3 Contractor shall comply with all the requirements of Specification, Design Drawings, and all applicable Telecommunications Standards and Electrical Codes.
- .4 Grounding and bonding System shall be designed, engineered, and installed to suit the Client's premises, communications systems, and cabling infrastructure.
- .5 Grounding electrode system refers to all electrodes required by Electrical Code, including, telecommunications system grounding electrodes.
- .6 The terms "connect" and "bond" are used interchangeably in this Specification and have the same meaning.

1.02 Definitions

- .1 AWG – American Wire Gauge – The standardized system for gauging the diameter of round, solid, non-ferrous, electrically-conducting wire.
- .2 BBC – Bonding Backbone Conductor – A telecommunications bonding connection which interconnects telecommunications bonding backbones. Formerly known as the grounding equalizer.
- .3 BN – Bonding Network – A set of interconnected conductive structures that provides a low impedance path for the associated telecommunications infrastructure.
- .4 EF – Entrance Facility – An entrance to a building for both public and private network service cables, including wireless, that includes the entrance point of the building and continues to the entrance room or space.
- .5 ESD – Electrostatic Discharge – The sudden flow of electricity between two electrically-charged objects caused by contact, an electrical short, or dielectric breakdown.
- .6 Mesh-BN – Mesh Bonding Network – A bonding network to which all associated equipment, such as cabinets, frames, racks, trays, and pathways, are connected using a bonding grid that is connected to multiple points on the common bonding network.
- .7 PBB – Primary Bonding Busbar – A busbar placed in a convenient and accessible location and bonded, by means of the Telecommunications Bonding Conductor (TBC), to the building's service equipment (power) ground. Formerly known as the Telecommunications Main Grounding Busbar (TMGB).
- .8 RBB – Rack Bonding Busbar – A busbar within a cabinet, frame, or rack.
- .9 RBC – Rack Bonding Conductor – A bonding conductor from the rack or Rack Bonding Busbar (RBB) to the Telecommunications Equipment Bonding Conductor (TEBC).
- .10 SBB – Secondary Bonding Busbar – A common point of connection for telecommunications system and equipment bonding to ground, located in the distributor room. Formerly known as the Telecommunications Grounding Busbar (TGB).

- .11 TBB – Telecommunications Bonding Backbone – The conductor that interconnects the Primary Bonding Busbar (PBB) to the Secondary Bonding Busbar (SBB).
- .12 TBC – Telecommunications Bonding Conductor – A conductor that interconnects the telecommunications bonding infrastructure to the building's service equipment (power) ground. Formerly known as the bonding conductor for telecommunications.
- .13 TEBC – Telecommunications Equipment Bonding Conductor – A conductor that connects the Primary Bonding Busbar (PBB) or Secondary Bonding Busbar (SBB) to equipment racks or cabinets.
- .14 TR – Telecommunications Room – An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling. It is the recognized location of the cross-connect between the backbone and horizontal facilities.
- .15 UBC – Unit Bonding Conductor – A bonding conductor from equipment or a patch panel to a Rack Bonding Conductor (RBB) or a Rack Bonding Busbar (RBB).

1.03 References

- .1 Publications listed below (including amendments, addenda, revisions, supplements, and errata) form a part of this Specification to the extent referenced. Publications are referenced in the text by the basic designation only.
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM-B1-13(2018) – Standard Specification for Hard-Drawn Copper Wire.
 - .2 ASTM B8-11(2017) – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- .3 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - .1 IEEE 81-2012 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
- .4 Canadian Standards Association (CSA):
 - .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (29th edition/2024).
- .5 Telecommunications Industry Association (TIA): Latest Revision of Standards
 - .1 TIA-606 – Administration Standard for Telecommunications Infrastructure
 - .2 TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- .6 BICSI:
 - .1 Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria – Latest Revision
 - .2 Telecommunications Distribution Methods Manual (TDMM) – Latest Revision
- .7 Underwriters Laboratories, Inc. (UL):
 - .1 UL 44 (19th Edition, 2018) – UL Standard for Safety Thermoset-Insulated Wires and Cables.

- .2 UL 83 (16th Edition, 2017) – UL Standard for Safety Thermoplastic-Insulated Wires and Cables.
- .3 UL 467 (11th Edition, 2022) – UL Standard for Safety Grounding and Bonding Equipment.
- .4 UL 486A-486B (3rd Edition, 2018) – UL Standard for Safety for Wire Connectors.
- .8 International Annealed Copper Standard (IACS)

1.04 Submittals

- .1 Submit in accordance with Section 01 33 00 and Section 27 05 00.
- .2 Action Submittals: Product Data for each type of product (PBB, SBB, RBB, 2-Hole Lugs, etc.)
- .3 Shop Drawings:
 - .1 Sufficient information, clearly presented, shall be included to determine compliance with latest TIA-607 Standard and this Specification.
 - .2 Include the location of system grounding electrode connections and the routing of aboveground and underground grounding electrode conductors.

1.05 Closeout Submittals

- .1 Submit closeout documents in accordance with Section 27 05 00.
- .2 As-Built Data: Submit plans showing as-built locations of grounding and bonding infrastructure, including the following: PBB, SBB, RBB and routing of their bonding conductors.
- .3 Test Reports: Provide test reports of ground resistance to each primary or secondary bonding busbar (PBB/SBB) located in each telecommunications space impacted by the work.

2 Products

2.01 Manufacturers

- .1 Hubbell.
- .2 nVent Erico.
- .3 Panduit.
- .4 Thomas & Betts.

2.02 General Requirements

- .1 Contractor shall provide a comprehensive and effective telecommunications grounding and bonding infrastructure for the protection of personnel and equipment, in compliance with the current Canadian Electrical Code, the latest TIA-607 Standard, and all applicable codes of Authority Having Jurisdiction (AHJ).
- .2 Grounding and bonding infrastructure shall follow the latest TIA-607 design methodology, whereby within a building the generic telecommunications bonding infrastructure originates at the facility's electrical entrance ground and extends throughout the building. The infrastructure shall comprise the following major components:
 - .1 Primary bonding busbar (PBB).

- .2 Telecommunications bonding conductor (TBC).
- .3 Telecommunications bonding backbone (TBB).
- .4 Secondary bonding busbar (SBB).
- .5 Backbone bonding conductor (BBC).
- .3 All cables shall be plenum rated FT6.
- .4 External Grounding Electrodes:
 - .1 The grounding electrode system shall be designed to have a resistance to earth of 25 ohms or less for a single grounding electrode.
 - .2 For sites that are critical in nature (e.g., public safety facilities, military installations, data centers, web hosting facilities, central offices) the grounding electrode system shall be designed to have a resistance of less than 10 ohms – ideally less than 5 ohms.

2.03 Bonding Busbars

- .1 Bonding busbars shall be provided in each telecommunications space (room/closet) and in each equipment rack/cabinet, as specified in this Section. Bonding busbars shall provide connection or termination points for the telecommunications space's bonding conductors.
- .2 The types of bonding busbars specified in the infrastructure comprise:
 - .1 Primary Bonding Busbar (PBB).
 - .2 Secondary Bonding Busbar (SBB).
 - .3 Rack Bonding Busbar (RBB).

2.04 Primary Bonding Busbar (PBB)

- .1 The PBB shall be placed in a convenient and accessible location in the telecommunications entrance room or space. Typically, there should be a single PBB per building.
- .2 The PBB shall be bonded, by means of the telecommunications bonding conductor (TBC), to the building's service equipment (electrical) ground.
- .3 The PBB serves as the dedicated extension of the building grounding electrode system for the telecommunications infrastructure. It also serves as the central attachment point for the Secondary Bonding Busbars (SBB) through the Telecommunications Bonding Backbone (TBB).
- .4 The PBB shall be:
 - .1 Pre-drilled with mounting holes to accommodate matched listed lugs and hardware.
 - .2 Made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 - .3 Of minimum dimensions of 6.35 mm (0.25 in) thick x 100 mm (4 in) wide and variable in length to accommodate design requirements.
 - .4 UL Listed.
 - .5 Cleaned with an antioxidant applied prior to fastening connectors to the busbar.

- .6 Insulated from its support using an insulator that is listed for the purpose by a nationally recognized testing laboratory (NRTL).
 - .7 Installed a minimum of 50 mm (2 in) from the finished wall to allow access to the rear of the busbar.
 - .8 Sized for current applications and future growth.
- .5 The primary protector grounding conductor shall be connected to the PBB. This conductor is intended to conduct lightning and AC fault currents from the telecommunication primary protectors.

2.05 Secondary Bonding Busbar (SBB)

- .1 The SBB shall be placed in a convenient location of the telecommunications room/closet. The SBB shall form a common bonding connection point for telecommunications systems and equipment in the area served by the telecommunications room/closet.
- .2 The SBB shall be:
 - .1 Pre-drilled with mounting holes to accommodate matched UL Listed lugs and hardware.
 - .2 Made of copper, or copper alloys having a minimum of 95% conductivity when annealed as specified by the International Annealed Copper Standard (IACS).
 - .3 Of minimum dimensions of 6.35 mm (0.25 in) thick x 50 mm (2 in) wide and variable in length.
 - .4 cUL Listed.
 - .5 Cleaned with an antioxidant applied prior to fastening connectors to the busbar.
 - .6 Insulated from its support using an insulator that is listed for the purpose by a nationally recognized testing laboratory (NRTL).
 - .7 Installed at a minimum of 50 mm (2 in) from the finished wall to allow access to the rear of the busbar.
 - .8 Sized for current applications and future growth.

2.06 Rack Bonding Busbar (RBB)

- .1 The RBB is a grounding busbar within a cabinet, rack, or frame.
- .2 The RBB shall be provided in cabinets and racks that support multiple equipment bonding conductors to serve as an extension of the PBB or SBB for the equipment in the cabinet.
- .3 The RBB shall meet the following requirements:
 - .1 Manufactured from copper alloy.
 - .2 cUL Listed.
 - .3 Horizontal Busbars shall be at least 19 mm (0.75 in) wide, 483 mm (19 in) long, and 5 mm (0.1875 in) thick.
 - .4 Have a minimum of 14, factory–provided #12–24 threaded holes.
 - .5 Have pre–punched EIA 310 D standard rack mounting holes.

- .6 Vertical Busbars shall be at least 17 mm (0.67 in) wide, 2 m (78.65 in) long, and 1.27 mm (0.05 in) thick, and shall come in threaded rail and cage nut versions.

2.07 Bonding Conductors

- .1 The following common requirements apply to all types of bonding conductors specified in this Section:
 - .1 All bonding conductors shall be made of stranded copper wire with a green jacket (or per CE Code depending on size), run as a continuous conductor.
 - .2 Bonding conductors may be insulated. If insulated they shall be cUL Listed for the application.
 - .3 Bonding conductors shall be protected from physical and mechanical damage.
 - .4 Bonding conductors shall be sized to meet the ANSI/TIA-607-D requirements.
- .2 Telecommunications Bonding Backbone (TBB)
 - .1 The TBB is a conductor that bonds the Secondary Bonding Busbars (SBB) to the Facility's Primary Bonding Busbar (PBB).
 - .2 The TBB shall meet the following requirements:
 - .1 The TBB shall be sized to meet the requirements of ANSI/TIA-607-D and shall be as straight as practicable avoiding bends. The TBB minimum conductor size shall be AWG 6.
 - .2 Bonding and grounding conductors may be insulated or un-insulated and shall not decrease in size as the grounding path moves closer to earth.
 - .3 Connections (bonds) between the telecommunications grounding network and associated electrical panels shall be done by a qualified electrician in accordance with guidelines in the latest TIA-607 and applicable electrical codes.
 - .4 Bonding Conductors should be continuous (splices not allowed) and routed in the shortest possible straight-line path, avoiding changes in elevation and sharp bends.
 - .5 TBB grounding conductors routing through ferrous metal conduit should be avoided, but if it is necessary due to building constraints, any grounding conductor running through ferrous conduit longer than 3 feet shall be bonded at the end using appropriately sized conduit grounding clamps as described TIA-607.
 - .6 Bonding the TBB to the PBB and each SBB shall be performed with a UL listed irreversible compression (crimp) dual-lug connector.
 - .7 Metallic cable shield(s) and cabling pathways, including metallic conduits, shall not be used as a TBB.
 - .8 Whenever two (2) or more TBBs are used within a multistory building, the TBBs shall be bonded together with a BBC at every third floor as a minimum, and at the top floor.

- .9 Conductor sizing depends upon the Project specification, and shall be determined based on the TBB length as stipulated in TIA-607. Contractor shall ensure TBB sizing complies with the TIA-607 guidelines outlined in the Table below:

Sizing of the TBB	
TBB Length in Linear Meters (Feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
20-26 (67-84)	3/0
26-32 (85-105)	4/0
32-38 (106-125)	250 kcmil
38-46 (126-150)	300 kcmil
46-53 (151-175)	350 kcmil
53-76 (176-250)	500 kcmil
76-91 (251-300)	600 kcmil
Greater than 91 (301)	750 kcmil

- .3 Telecommunications Bonding Conductor (TBC)
- .1 The TBC connects the telecommunications bonding infrastructure to the building's service equipment (power) ground (formerly known as the bonding conductor for telecommunications).
 - .2 The TBC shall have at a minimum the same size as the largest TBB.
 - .3 The TBC shall bond the PBB to the service equipment (power) ground.
- .4 Backbone Bonding Conductor (BBC)
- .1 The BBC (formerly known as the grounding equalizer) is a bonding conductor which interconnects telecommunications bonding backbones.
 - .2 The BBC shall have at a minimum the same size as the largest TBB to which it is bonded.
- .5 Telecommunications Equipment Bonding Conductor (TEBC)

- .1 The TEBC is a bonding conductor which connects the cabinets and racks in a telecommunications room/closet to the local primary or secondary bonding busbar (PBB or SBB).
 - .2 The TEBC shall have a minimum size of AWG 6.
 - .3 Metallic objects and pathways shall not be used as a replacement for the TEBC.
 - .4 The TEBC may be routed inside cable trays. It shall be secured at maximum intervals of 0.9 m (3 ft).
 - .5 The TEBC shall be separated a minimum of 50.8 mm (2 in) from other cable groups, such as power or telecommunications cables.
 - .6 The TEBC shall be connected to the cabinets/racks, to a Rack Bonding Conductor (RBC) or to a vertical/horizontal Rack Bonding Busbar (RBB).
 - .7 Connections to the TEBC shall be made with UL Listed irreversible compression connectors, suitable for multiple conductors, and with the rack bonding conductors (RBCs) routed toward the PBB/SBB.
- .6 Rack Bonding Conductor (RBC)
- .1 The RBC is a bonding conductor from the cabinet or Rack Bonding Busbar (RBB) to the Telecommunications Equipment Bonding Conductor (TEBC).
 - .1 The RBC shall have a minimum size of AWG 6.
 - .2 The RBC shall be bonded to the Telecommunications Equipment Bonding Conductor (TEBC) using UL Listed irreversible compression (crimp) connectors.
 - .1 Where connected to a server cabinet, the RBC extends to the bottom of the server cabinet allowing Equipment Bonding Conductors to be attached at any point in the cabinet.
 - .2 Where connected to a network rack/cabinet, the Rack Bonding Conductor (RBC) is bonded to the Rack Bonding Busbar (RBB) via a UL Listed two-hole compression lug.
 - .2 Unit Bonding Conductor (UBC)
 - .1 The Unit Bonding Conductor (UBC) connects individual equipment in a cabinet or rack to the Rack Bonding Conductor (RBC) or Rack Bonding Busbar (RBB).
 - .2 The UBC shall also be used for bonding cable tray sections to the Telecommunications Equipment Bonding Conductor (TEBC).
 - .3 The UBC shall have a minimum size of AWG 6.
 - .4 Bonding.
 - .1 Where used in a server cabinet, UBC shall be bonded to the Rack Bonding Connector (RBC) using UL Listed irreversible compression (crimp) connectors and to IT equipment via a UL Listed two-hole compression lug. (Some IT equipment may require one-hole lugs.)
 - .2 Where used in a network cabinet/rack, UBC shall be bonded to the Rack Bonding Busbar (RBB) via a UL Listed two-hole compression lug and to IT

equipment via a UL Listed two-hole compression lug. (Some IT equipment may require one-hole lugs.)

- .3 Where used as a cable tray bonding conductor connecting cable tray sections, UBC shall be bonded to each adjoining section of the cable tray using UL Listed two-hole compression lugs.
- .4 Where used as a cable tray bonding conductor connecting cable tray sections to the Telecommunications Equipment Bonding Conductor (TEBC), UBC shall be bonded to the TEBC using UL Listed irreversible compression (crimp) connectors and to the cable tray via a UL Listed two-hole compression lug.

3 Execution

3.01 General

- .1 Ground in compliance with the CE Code, the latest TIA-607 Standard, and as specified in this Section and the Drawings.
- .2 Components of the telecommunications bonding system shall be installed and connected using materials and techniques as specified in the latest TIA-607 Standard.
- .3 Follow equipment manufacturer's grounding instructions.

3.02 Examination

- .1 Contractor shall check the AC grounding electrode system and equipment grounding for compliance with the requirements for maximum ground-resistance level, and other conditions affecting performance of grounding and bonding of the telecommunications system.
- .2 Inspect the test results of the AC grounding system.
- .3 Prepare written report listing all conditions detrimental to the performance of the Work.
- .4 Proceed with Work only after unsatisfactory conditions have been corrected.

3.03 Corrosion Inhibitors

- .1 When making ground and bonding connections, apply a corrosion inhibitor to all contact surfaces. Use corrosion inhibitor appropriate for protecting a connection between the metals used.
- .2 PBB and SBB shall always have tinned surfaces to restrain oxidation and shall be cleaned and have an antioxidant paste applied to both bonding surfaces prior to fastening conductors.

3.04 Telecommunications System Grounding

- .1 Bond the telecommunications grounding system to the electrical grounding electrode system.
- .2 Provide dedicated telecommunications grounding busbars for the following locations/spaces:
 - .1 Telecom entrance facility rooms
 - .2 Server rooms
 - .3 IT rooms/closets
- .3 Provide bonding to all telecom cabinets, racks, metallic cable shields, junction/pull boxes, enclosures, and communications/security equipment, as required by Standards and Code.

- .4 Provide bonding to all metallic cable trays and conduits to building ground.
- .5 Bond incoming carrier armor sheath to building ground.
- .6 Furnish and install all busbars and bonding conductors required to properly ground and bond all communications raceways, cable trays, metallic cable shields, and equipment, in compliance with design, Codes and Standards.
- .7 Bonding jumpers/conductors shall be continuous with no splices. Use the shortest possible length of bonding jumper.
- .8 Provide ground paths that are permanent and continuous with a resistance of 1 ohm or less from raceway, cable tray, and equipment connections to the building grounding electrode. The resistance across individual bonding connections shall be 10 milliohms or less.
- .9 Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding conductors, remove paint to expose the entire contact surface by grinding where necessary; thoroughly clean all connector, plate and other contact surfaces; and apply an appropriate corrosion inhibitor to all surfaces before joining.
- .10 Bonding Conductors:
 - .1 Use insulated ground wire of the size and type shown on the Drawings or use a minimum of #6 AWG insulated copper wire.
 - .2 Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
 - .3 Use compression connectors of proper size for the specified conductors. Use connector manufacturer's compression tool.
- .11 Bonding Jumper Fasteners:
 - .1 Conduit: Fasten bonding jumpers using screw lugs on grounding bushings or conduit strut clamps, or the clamp pads on push-type conduit fasteners. When screw lug connection to a conduit strut clamp is not possible, fasten the plain end of a bonding jumper wire by slipping the plain end under the conduit strut clamp pad; tighten the clamp screw firmly. Where appropriate, use zinc-plated external tooth lockwashers.
 - .2 Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, e.g., zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
 - .3 Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Use tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
 - .4 Strut Channel and Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers.

3.05 Raceway Grounding

- .1 Conduit: Use insulated #6 AWG bonding jumpers to ground metallic conduit at each end and to bond at all intermediate metallic enclosures.
- .2 Cable Tray: Use insulated #6 AWG bonding jumpers to ground metallic cable tray at:
 - .1 Each end
 - .2 All intermediate metallic enclosures/boxes

- .3 All cable tray section junctions

3.06 Identification and Administration

- .1 Provide complete grounding system labeling in accordance with the requirements of:
 - .1 ANSI/TIA–606, Latest Revision.
 - .2 Section 27 05 53 – Identification for Communications Systems.
- .2 Primary Bonding Busbar (PBB): Label with “PBB”.
- .3 Secondary Bonding Busbar (SBB): Label with “SBB”.
- .4 Telecommunications Bonding Backbone (TBB): Label with “WARNING! TELECOMMUNICATIONS BONDING BACKBONE. DO NOT REMOVE OR DISCONNECT” Labels shall be affixed at both ends and at accessible intermediate points.

3.07 Testing

- .1 Perform tests as specified in BICSI Information Technology Systems Installation Methods Manual (ITSIMM), Recommended Testing Procedures and Criteria.
- .2 Perform two-point bond testing to be performed by qualified technicians.
- .3 Conduct continuity tests to verify that all metallic pathways and pathway sections are bonded to PBB or SBB.
- .4 Conduct electrical continuity test to verify that PBB is effectively bonded to the facility grounding electrode conductor.
- .5 Perform resistance tests to ensure rack and cabinet bonding connection resistance measures less than 4 Ω to PBB or SBB.
- .6 Provide a complete test report to Consultant and Owner.

End of Section

1 General

1.01 Summary

- .1 Provide a complete system of empty conduit, pull boxes, outlets, and sleeves for enclosure of communications cabling.

1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

1.03 References

- .1 BICSI Telecommunications Distribution Methods Manual, 14th Edition.

1.04 Closeout Submittals

- .1 Record documentation:
 - .1 Records of underground utility locates.
 - .2 Record as-constructed location of all underground conduits and telecommunications pathways on as-built drawings regardless of conduit size.

2 Products

2.01 Outlets

- .1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.
- .2 Provide 53 mm conduit through walls as noted.

2.02 Conduits

- .1 Conduit size shall be in accordance with recommended standard for conduits in Building as published by BICSI.
- .2 Minimum conduit size shall be 21 mm diameter.
- .3 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .4 Plenum cables are permitted in accessible ceilings. Provide 'J' hooks in these locations for later cable installation by others.
- .5 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.
- .6 Provide a minimum of two 5-15R duplex receptacles on separate circuits at each backboard.

3 Execution

3.01 Installation

- .1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.
- .2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 3.2 mm (1/8") nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.
- .3 Conduit shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.
- .4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 m in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by future installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.01 Section Includes

- .1 Provide a complete system of empty conduits, pull boxes, outlets, and sleeves for enclosure of wiring under cash allowance. Refer to General Requirements.

1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.
- .3 Section 28 46 13 – Fire-Alarm Systems.

1.03 References

- .1 BISCI Telecommunications Distribution Methods Manual, 13th Edition (2014).

2 Products

2.01 Outlets

- .1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.

2.02 Conduits

- .1 Conduit size shall be in accordance with recommended standard for conduits in Building as published by BICSI.
- .2 Minimum conduit size shall be 21 mm diameter.
- .3 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .4 Plywood backboards shall be minimum 1200 mm by 2400 mm, 19 mm thick, painted with two coats of fire retardant light grey enamel.
- .5 Provide a minimum of two duplex receptacles on separate circuits at each backboard.
- .6 Provide fire alarm over-ride feature at fire alarm control panel (FACP) to deactivate public address system when Fire Alarm System is in alarm.

3 Execution

3.01 Installation

- .1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.
- .2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 3.2 mm (1/8") nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.
- .3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.
- .4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 000 mm in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.01 Summary

- .1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlets for enclosure of wiring by Security Contractor/Installer under cash allowance.

1.02 Related Requirements

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
- .2 Section 26 05 33.16 – Boxes for Electrical Systems.

2 Products

2.01 Outlets

- .1 Wall and door outlets shall be single boxes, or 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.

2.02 Conduits

- .1 Provide conduit in all walls, exposed areas, and inaccessible ceilings. All conduit work shall be concealed.
- .2 Minimum conduit size shall be 21 mm diameter.
- .3 Provide J hooks in accessible ceilings for plenum rated wiring.
- .4 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Plywood backboards shall be minimum 1200 x 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.
- .6 Provide a minimum of 2 duplex receptacles on separate circuits at each backboard.

3 Execution

3.01 Installation

- .1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.

- .2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 3.2 mm (1/8”) nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.
- .3 Conduit bonds shall have a bending radius of not less than nine times conduit diameter. Ream out conduit and identify ends with green paint.
- .4 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 m in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease. Minimum space requirements in pull boxes having one conduit each in opposite ends of the box, shall be as follows:

Maximum conduit size	Size of pull boxes in millimetres			For each additional conduit size increase width by:
	Width	Length	Depth	
21 mm	150 mm	300 mm	100 mm	50 mm
27 mm	200 mm	400 mm	150 mm	75 mm
35 mm	250 mm	450 mm	200 mm	75 mm
41 mm	300 mm	600 mm	250 mm	100 mm
53 mm	350 mm	750 mm	300 mm	125 mm

- .5 Show as-installed conduit routing and location of all pull boxes on the record drawings, prior to project completion, for use by Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.01 Summary

- .1 The work covered under this section consists of the furnishing of all necessary labour, supervision, materials, equipment, and services to completely execute the system of non-continuous cable supports (“J-Hooks”) as described in this specification.

1.02 Scope

- .1 Non-continuous cable supports.
- .2 Adjustable non-continuous cable support sling.
- .3 Multi-tiered non-continuous cable support assemblies.
- .4 Non-continuous cable support assemblies from tee bar.
- .5 Non-continuous cable support assemblies from drop wire/ceiling.
- .6 Non-continuous cable support assemblies from beam, flange.
- .7 Non-continuous cable support assemblies from C & Z Purlin.
- .8 Non-continuous cable support assemblies from wall, concrete, or joist.
- .9 Non-continuous cable support assemblies from threaded rod.
- .10 Raised floor non-continuous cable support assemblies.
- .11 Cantilever-Mounted Option for non-continuous cable supports.
- .12 Installation accessories for non-continuous cable supports.

1.03 Definitions

- .1 UTP: Unshielded twisted pair.
- .2 ANSI: American National Standards Institute.
- .3 ASTM: American Society for Testing and Materials.
- .4 EIA: Electronic Industries Alliance.
- .5 TIA: Telecommunications Industry Association.
- .6 cULus: Listed by Underwriters Laboratories based on both Canadian and US (United States) standards requirements.

1.04 Submittals

- .1 Submit product data on non-continuous cable support devices, including attachment methods. Product data to include, but not limited to materials, finishes, approvals, load ratings, and dimensional information.

1.05 Quality Assurance

- .1 Non-continuous cable supports and cable support assemblies shall be listed by Underwriters Laboratories for both Canadian and US standards (cULus).

- .2 Non-continuous cable supports shall have the manufacturers name and part number stamped on the part for identification.
- .3 Manufacturer: Company specializing in manufacturing products specified in this section with a minimum of five years documented experience in the industry, and certified ISO 9000.

2 Products

2.01 Manufacturers

- .1 ERICO, Inc.
- .2 Approved equal.

2.02 References

- .1 ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel
- .2 ASTM B 695-90 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
- .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .4 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- .5 ASTM A109 Standard Specification for Steel, Strip, Carbon, Cold-Rolled
- .6 ASTM A167 Standard Specification for Stainless and heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- .7 ASTM A480/A480M Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- .8 ASTM A568 Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy Hot-Rolled and Cold-Rolled
- .9 A653 G60-Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-coated (Galvannealed) by the Hot-Dip process
- .10 ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar
- .11 ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled, Spring Quality
- .12 ASTM A879 Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface
- .13 ASTM B117 Standard Method of Salt Spray (Fog) Testing
- .14 ASTM D610 Standard test Method for Evaluating Degree of Rusting on Painted Steel Surfaces UL 2043 - Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces.
- .15 ANSI/ TIA/ EIA 568 Commercial Building Telecommunications Cabling Standard, current revision level.
- .16 ANSI/ TIA/ EIA 569 Commercial Building Standard for Telecommunications Pathways and Spaces, current revision level.

- .17 NFPA 70 National Electrical Code.

2.03 Non-Continuous Cable Support Systems

- .1 Non-continuous cable supports
 - .1 Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
 - .2 Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 - .3 Non-continuous cable supports sized 1 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 - .4 Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 - .5 Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
 - .6 Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J-Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.
- .2 Adjustable non-continuous cable support sling
 - .1 Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support Category 5 and higher cable, or optical fiber cable; cULus Listed.
 - .2 Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
 - .3 Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
 - .4 If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
 - .5 Acceptable products: ERICO CADDY CableCat™ CAT425; or approved equal.
- .3 Multi-tiered non-continuous cable support assemblies
 - .1 Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.
 - .3 The multi-tiered support bracket shall consist of ERICO CADDY CATHBA and CableCat™ J-Hooks with screws; or approved equal.
- .4 Non-continuous cable support assemblies from tee bar
 - .1 Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.

- .2 Acceptable products: ERICO CADDY CAT12TS, CAT21528, CAT32528; or approved equal.
- .5 Non-continuous cable support assemblies from drop wire/ceiling
 - .1 Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.
- .6 Non-continuous cable support assemblies from beam, flange
 - .1 Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.
- .7 Non-continuous cable support assemblies from C & Z Purlin
 - .1 Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
 - .2 Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.
- .8 Non-continuous cable support assemblies from wall, concrete, or joist
 - .1 Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus Listed.
 - .2 Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.
- .9 Non-continuous cable support assemblies from threaded rod
 - .1 Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, cULus Listed.
 - .2 The multi-tiered support bracket shall have a static load limit of 300 lbs.
 - .3 U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
 - .4 Acceptable products: ERICO CableCat™ J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CMTM Double J-hook CAT100CM, CAT-CMTM Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.
- .10 Raised floor non-continuous cable support assemblies
 - .1 Fastener to raised (access) floor pedestal with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments; cULus Listed.
 - .2 Acceptable products: ERICO CADDY CAT12CD1B, CAT21CD1B or CAT32CD1B; CAT64CD1B; or approved equal.
- .11 Cantilever-Mounted cable supports
 - .1 U-hook shall be able to be assembled to a wide variety of wall mount brackets.

- .2 Spacing of individual U-hooks as needed, max of 4' to 5' apart.
 - .3 U-hooks may have the optional attachment of a cable roller for ease in pulling cables.
 - .4 Acceptable products: ERICO CAT-CMTM U-hooks CAT200CMLN, CAT300CMLN; CAT-CM roller assemblies CATRL200CM, CATRL300CM; CATWMCM bracket; or approved equal.
- .12 Installation accessories for non-continuous cable supports
- .1 Cable Pulley
 - .1 Non-continuous cable supports may be used as an installation tool when a removable pulley assembly is included. The pulley shall be made of plastic and be without sharp edges. The pin and bail assembly must be able to be secured to the J-Hook during cable installation. The pulley must remain secured while cables are being pulled.
 - .2 The pin and roller assembly must be removed after cables are installed.
 - .3 Acceptable products: ERICO CADDY CAT32PLR, CAT64PLR, or approved equal.
 - .2 Cable Protector
 - .1 The protective steel tube shall fit over threaded rod and be at least 4" in length.
 - .2 The tube shall prevent damage to cables placed in or pulled through CAT-CMTM U-hooks. The tube shall not inhibit the pulling of cables.
 - .3 Acceptable products: ERICO CAT-CMTM CATTBCM, or approved equal.

2.04 Finishes

- .1 ASTM B633 Standard Specification for Electro-deposited Coatings of Zinc on Iron and Steel
- .2 ASTM B 695 Standard Specification for coatings of Zinc Mechanically Deposited on Iron and Steel
- .3 ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- .4 ASTM A924/A924M Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
- .5 Non-continuous cable supports used where only mildly corrosive conditions apply shall be stainless steel, AISI type 304.

3 Execution

3.01 Installation

- .1 Installation and configuration shall conform to the requirements of the current revision levels of ANSI/EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- .2 Install cables using techniques, practices, and methods that are consistent with Category 5 or higher requirements and that supports Category 5 or higher performance of completed and linked signal paths, end to end.
- .3 Install cables without damaging conductors, shield, or jacket.

- .4 Do not bend cables, in handling or in installing, to smaller radii than minimums recommended by manufacturer.
- .5 Pull cables without exceeding cable manufacturer's recommended pulling tensions. Use pulling means that will not damage media.
- .6 Do not exceed load ratings specified by manufacturer.
- .7 Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- .8 Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.

End of Section

1 General

1.01 Section Includes

- .1 Cable trays, including ladder rack, wire mesh, optical fibre trough, and accessories.

1.02 Related Requirements

- .1 Section 26 05 26 – Grounding and Bonding for Electrical Systems.
- .2 Section 26 05 29 – Hangers and Supports for Electrical Systems.

1.03 References

- .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (29th edition/2024).
- .3 CSA C22.2 No. 126.1-17 (CSA/NEMA) - Metal Cable Tray Systems (Binational standard with NEMA VE 1-2017).

1.04 Action Submittals

- .1 Product Data: Provide data for fittings and accessories.
- .2 Shop Drawings: Indicate tray type, dimensions, support points, and finishes.

1.05 Informational Submittals

- .1 Manufacturer's Instructions:
 - .1 Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements.
 - .2 Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 Closeout Submittals

- .1 Project Record Documents: Record actual routing of cable tray and locations of supports.

1.07 Regulatory Requirements

- .1 Products: Listed and classified by CSA (Canadian Standards Association as suitable for the purpose specified and indicated.

2 Products

2.01 Ladder Rack-Type Cable Tray

- .1 Description: CSA C22.2 No. 126.1, Class ladder type tray.
- .2 Material: Aluminum.
- .3 Inside width: As indicated.
- .4 Inside depth: As indicated.

- .5 Straight section rung spacing: 152 mm (6 in) on centre.
- .6 Inside Radius of Fittings: As indicated.
- .7 Unless otherwise noted, provide manufacturer's standard clamps, hangers, brackets, splice plates, reducer plates, blind ends, barrier strips, connectors, and grounding straps.
- .8 Refer to drawings for details.
- .9 Manufacturers:
 - .1 Hubbell Nextframe Ladder Rack.
 - .2 Canadian Electrical Raceways "Telecom Cable Rack".
 - .3 Approved equal.

2.02 Optical Fibre Routing System (Fibre Tray)

- .1 The optical fiber routing system shall be used to route, segregate, and protect fiber optic communication cabling.
- .2 ULC Listed (UL2024A)
- .3 Size:
 - .1 100 mm x 100 mm (4 in x 4 in).
 - .2 As otherwise indicated on drawings.
- .4 50 mm (2") minimum bend radius through-out pathway.
- .5 Impact resistant and flame-retardant material (UL94-V0 Flammability).
- .6 Color: Black.
- .7 Will include all mounting hardware, waterfalls, directional fittings, and other accessories required for installation.
- .8 Manufacturers:
 - .1 Panduit Fiberrunner series.
 - .2 ADC FiberGuide series.
 - .3 Commscope SpeedPRO series.

3 Execution

3.01 Installation

- .1 Trays to be sized to 40 per cent maximum capacity.
- .2 Install metallic cable tray to CSA C22.1 SB-02 and C22.2 No. 126.1.
- .3 Install fibreglass cable tray to CSA C22.1 SB-02 and C22.2 No. 126.2.
- .4 Support trays to Section 26 05 29. Provide supports at each connection point, at the end of each run, and at other points to maintain spacing between supports.

- .5 Use expansion connectors where required.

End of Section

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1 General

1.01 Section Includes

- .1 Firestopping through penetrations in fire rated assemblies.

1.02 Related Requirements

- .1 Section 07 84 00 – Firestopping.

1.03 References

- .1 ASTM E 84, “Surface Burning Characteristics of Building Materials”.
- .2 ASTM E 119, “Fire Tests of Building Construction and Materials”.
- .3 ASTM E 814, “Fire Tests of Penetration Firestop Systems”.
- .4 ANSI/UL263, “Fire Tests of Building Construction and Materials”.
- .5 ANSI/UL723, “Surface Burning Characteristics of Building Materials”.
- .6 ANSI/UL1479, “Fire Tests of Through Penetration Firestops”.
- .7 Underwriters Laboratories Inc. (UL) – Fire Resistance Directory

1.04 Performance Requirements

- .1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur, such devices shall:
 - .1 Meet the hourly rating of the floor or wall penetrated.
 - .2 Permit the allowable cable load to range from 0% to 100% visual fill thereby eliminating the need to calculate allowable fill ratios.
 - .3 Not require any additional action on the part of the installer to open or close the pathway device or activate the internal smoke and fire seal, such as, but not limited to:
 - .1 Opening or closing of doors.
 - .2 Twisting an inner liner.
 - .3 Removal or replacement of any material such as, but not limited to, sealant, caulk, putty, pillows, bags, foam plugs, foam blocks, or any other material.
 - .4 Permit multiple devices to be ganged together to increase overall cable capacity.
 - .5 Allow for retrofit to install around existing cables.
 - .6 Include an optional means to lengthen the device to facilitate installation in thicker barriers without degrading fire or smoke sealing properties or inhibiting ability of device to permit cable moves, add-ons, or changes.
- .2 Where single cables (up to 7 mm (0.27 in) diameter) penetrate gypsum board/stud wall assemblies, a fire-rated cable grommet may be substituted. Acceptable products shall be molded from plenum-grade polymer and conform to the outer diameter of the cable forming a tight seal for fire and smoke. Additionally, acceptable products shall lock into the barrier to secure cable penetration.

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- .3 Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water, or other forms of moisture characteristic during or after construction.
- .4 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
- .5 Cable trays shall terminate at each barrier and resume on the opposite side such that cables pass independently through fire-rated pathway devices. Cable tray shall be rigidly supported independent from fire-rated pathway devices on each side of barrier.

1.05 Submittals

- .1 Submit under provisions of Section 01 30 00.
- .2 Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
- .3 Shop Drawings: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .4 Certificates: Product certificates signed by firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.
- .5 Installation Instructions: Submit manufacturer's printed installation instructions.

1.06 Quality Assurance

- .1 Products/Systems: Provide firestopping systems that comply with the following requirements:
 - .1 Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
 - .2 Firestopping products bear the classification marking of qualified testing and inspection agency.
- .2 Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

1.07 Delivery, Storage, and Handling

- .1 Delivery:
 - .1 Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multicomponent products.
 - .2 Handle and store products according to manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
- .2 Storage and Protection:

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- .1 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

1.08 Project Conditions

- .1 Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- .2 Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- .4 Do not use materials that contain flammable solvents.
- .5 Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- .7 Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

2 Products

2.01 Manufacturers

- .1 Specified Technologies Inc.
200 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: specseal@stifirestop.com, Website: www.stifirestop.com.
- .2 Substitutions: as approved by the Consultant prior to tender closing.
- .3 Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.02 Materials

- .1 General: Use only firestopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

2.03 Fire Rated Cable Pathways

- .1 Steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
 - .1 Specified Technologies Inc. (STI) EZ-PATH Fire Rated Pathway.

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3 Execution

3.01 Examination

- .1 Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
- .2 Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- .3 Provide masking and temporary covering to protect adjacent surfaces.
- .4 Do not proceed until unsatisfactory conditions have been corrected.

3.02 Installation

- .1 General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.03 Field Quality Control

- .1 Inspections: Engage qualified independent inspection agency to inspect through-penetration firestop systems.
- .2 Keep areas of work accessible until inspection by authorities having jurisdiction.
- .3 Where deficiencies are found, repair firestopping products so they comply with requirements.

3.04 Adjusting and Cleaning

- .1 Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- .2 Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

End of Section

1 General

1.01 Section Includes

- .1 Labelling and identification requirements for communications systems.

1.02 References

- .1 ANSI/TIA/EIA-606-A – Administration Standard for Commercial Telecommunications Infrastructure.
- .2 UL 969 – Marking and Labeling Systems.

2 Products

2.01 Summary

- .1 Adhesive cable labels to meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in UL 969 for indoor use.
- .2 Self-laminating vinyl construction cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
- .3 ANSI/EIA/TIA-606 for colour codes shall be followed. Labels are to be mechanically printed using a laser printer. Hand written labels will not be acceptable.

2.02 Label Printer

- .1 Thermal Transfer Printer shall print high quality, industrial labels on a wide variety of materials for electrical and network applications such as wire/cable, components, safety, and facility identification.
- .2 Laminated Adhesive Label Cassettes:
 - .1 For flat label applications.
 - .2 Polyester material.
- .3 Non-Laminated Adhesive Label Cassettes:
 - .1 For marking wire and cable and flat label applications.
 - .2 Polyester material
- .4 Example Products:
 - .1 Panduit LS7 series hand-held printer.
 - .2 Panduit LS8 series hand-held printer.

2.03 Nameplates

- .1 Engraved three-layer laminated plastic, letters on contrasting background:
- .2 Rack and Cabinet ID labels: 25 mm (1") high White Text on Black Background

3 Execution

3.01 Installation

- .1 Cable identification labels should appear at the following locations with the numbers indicated on the cable schedule and drawings:
 - .1 300 mm (12 inches) from each end of the cable – after termination.
 - .2 Front of patch panels.
 - .3 Front of IDC termination blocks.
 - .4 Front of workstation/communications outlet faceplates.
 - .5 Each end of each Telecommunications Conduit.
- .2 Fibre Optic safety labels shall appear at the following locations:
 - .1 Along the length of the conduit or innerduct at 3 m (10 foot) intervals.
 - .2 At all junction boxes
 - .3 At all pull boxes.
 - .4 On all fibre optic patch panels.
- .3 Provide 25 per cent additional labels to be left in each telecommunications room on site for future growth.
- .4 Provide two Rack/Cabinet nameplates. Mount one on the front, and one on the rear of the rack.

3.02 Identification Conventions

- .1 All cabling will be labelled with the closet letter, followed by a dash and the wire number (i.e. A-001 would be the first wire in closet A).
- .2 Labelling for backbone wiring will be preceded with BB followed by the wire number (i.e. BB-001 would be the first backbone).

End of Section

1 General

1.01 Section Includes

- .1 Commissioning Requirements.

1.02 References

- .1 Refer to Section 27 05 00 for references.

1.03 Closeout Submittals

- .1 The Telecommunications Cabling Contractor is required to submit test results in native tester format or a format which can be read with a text reader (i.e. “.txt” extension). Paper results shall not be submitted for projects with 100 or more horizontal cable drops and/or fibre cables.
- .2 The Telecommunications Cabling Contractor is required to provide the software required to view the results.
- .3 The report should be divided into sections by Telecommunications Room.
- .4 The report should indicate for each cable when it was tested successfully, the result, and the length.
- .5 The Telecommunications Cabling Contractor shall sign off on the entire test report prior to submitting to the Consultant.
- .6 The test result documentation is to be submitted to the Consultant for review no later than 10 working days following the completion of the installation.
- .7 All deficiencies must be corrected before the Consultant will provide a certificate to release the Holdback on the project.

2 Products – Not Used

3 Execution

3.01 Installation

- .1 Testing of all horizontal copper cables are to be completed in accordance with the follow test criteria:
 - .1 Basic Link
 - .2 Grounds
 - .3 NEXT
 - .4 ELFEXT
 - .5 Continuity
 - .6 correct polarity
 - .7 PSNEXT
 - .8 PSELFEXT
 - .9 Shorts

- .10 Length
- .11 ACR
- .12 Return Loss
- .13 Opens
- .14 Attenuation
- .15 PSACR
- .16 Resistance
- .2 Fibre strands in excess of 122 m (400 ft) shall be tested with an Optical Time Domain Reflectometer for length and attenuation.
- .3 Test each stand of fibre, bi-directionally, with a Power Meter / Light Source combination operating at wavelengths of 850 nm and 1300 nm for multimode fibres.
- .4 Maximum multi-mode passive link loss (including patch cords) is not to exceed -2.35 dB.
- .5 Maximum single-mode passive link loss (including patch cords) is not to exceed -1.0 dB.

3.02 Record Drawings

- .1 The Telecommunications Cabling Contractor is required to maintain one set of correct and accurate record drawings on-site at all times. These drawings are to be made available to the General Contractor/Construction Manager or the Consultant for review during the project.
- .2 The Telecommunications Cabling Contractor is required to provide record drawings of the telecommunication cabling installation in relation to the drawings provided in this specification.
- .3 The record drawings shall be updated electronically and include, but are not limited to;
 - .1 Horizontal cable numbers on the floor plans
 - .2 Horizontal Cable Routing on the floor plans
 - .3 Changes on the floor plans
 - .4 Backbone cable Routing between Telecommunications Rooms
 - .5 Paging Speaker Locations including daisy chain cable run
 - .6 Wireless Access Points and Cell coverage
 - .7 Cabinet/Rack Elevation drawings
 - .8 Backboard Elevation Drawing
- .4 The Telecommunications Cabling Contractor shall provide one soft copy in AutoCAD 2007 and one plotted copy for the Consultant to review prior to complete substantial performance and close-out documentation submission.
- .5 After approval, the Telecommunications Cabling Contractor shall submit one plotted copy of the drawings for;
 - .1 The Main Computer Room

- .2 Each Telecommunications Room
- .6 All close-out documentation must be submitted to the General Contractor/Construction Manager or The Consultant within 10 working days of the completion of the project before the documentation holdback will be released.

End of Section

1 General

1.01 Summary

- .1 Supply, install and test complete data cabling system and accessories, based on physical star wiring topology, and as specified herein and indicated on drawings [for the new addition].
- .2 Include data cabling system the following sub-systems:
 - .1 Backbone Terminal Systems, located in Communications Closets, to serve as connection points between backbone cables and horizontal distribution cables.
 - .2 Horizontal distribution system links backbone terminal system to telecommunications outlets.
 - .3 Contractor is to submit details on equipment types and locations for review and approval prior to installation.

1.02 Related Requirements

- .1 Active electronics, including servers, hubs, routers, switchers, and, PCs are by Owner and are not part of this contract.

1.03 Abbreviations and Acronyms

- .1 MTER Main Telecommunication Equipment Room.
- .2 TC Telecommunications Closet.
- .3 TCs Telecommunications Closets.
- .4 RCDD Registered Communications Distribution Designer.
- .5 BICSI Building Industry Consulting Service International.
- .6 MDTS Main Distribution Terminal System.
- .7 IDC Insulation Displacement Connection.
- .8 OTDR Optical Time-Domain Reflectometer.
- .9 BCS Backbone Cabling System.
- .10 IDT Intermediate Distribution Terminal.
- .11 BTS Backbone Terminal System.

1.04 Reference Standards

- .1 Conform to CAN/CSA-T530 for new buildings and areas of substantial renovations of telecommunications, spaces, and pathways.
- .2 Ensure that cabling system shall conform to current issue of industry standard CAN/CSA-T529. This standard is currently being revised and is available as document EIA/TIA SP-2840A (future CAN/CSA-T529). All requirements of this new document must be followed including: Structural Return Loss (section 10.2.4.5), Power Sum Testing (section 10.3.4.7) and End to End Link Performance and continuity, attenuation, cable open and shorts, NEXT; mutual capacitance, pair polarity and cable impedance, S/N ratio, and Pass/Fail status. Tests are to be conducted and recorded using a Penta Scanner. Fibre optic cables shall be tested in conformance to ISO/IEC IS 11801 standards using an EXFO Optical Time

Domain Reflectometer. Test results such as; dB loss, cable length and fibre deficiencies (if any) shall be conducted. Verification, documentation, and warranty shall be provided.

- .3 Where applicable, have performance of Category 5e cabling components used, verified by nationally recognized testing laboratory. Submit test results upon request.
- .4 Conform to applicable Building and Electrical Safety Codes.

1.05 Submittals

- .1 Shop Drawings
 - .1 Provide submittals in accordance with Section 01 33 00 prior to commencing installation.
 - .2 Submit complete cabling system layout for Consultant review for data, cable routing summary and cable outlet designation. Have cabling system layout performed by accredited RCDD (Registered Communications Distribution Designer) as defined by BICSI (Building Industry Consulting Service International). The Data Cabling system will not be accepted without this submission.
 - .3 Documentation proving compliance to End-to-End Link Performance test, as specified in Annex E of EIA/TIA SP-2840A shall be provided prior to structured cabling being installed.
 - .4 Submit detailed layout drawings, including termination racks prior to commencing this installation.
 - .5 Manufacturer's product information documents on all components of the cabling system, including horizontal and vertical cable management systems and all auxiliary components/devices and equipment prior to commencing this installation.
 - .6 The following documentation shall be submitted with a following cover letter listing attachments prior to commencement of work.
 - .1 A list of personnel for the project that will include the name of the Project Manager, Site Manager(s), Lead Hands, and Installers.
 - .2 Permits and notifications as may be required for the project.

1.06 Closeout Submittals

- .1 Provide manufacturer's certificate at completion of installation certifying the installation.
- .2 Prepare and submit "As-built" drawings reviewed by an RCDD.
- .3 "As-built" drawings are to detail the exact location of equipment indicating wiring runs and raceways, pull, junction and terminal boxes. Also to include outlet locations, cable numbers and equipment rack profiles.
- .4 Upon completion of work and prior to final acceptance, the contractor will submit to the Owner the required copies of Network Certification and Documentation in the form of manuals that will include the following:
 - .1 Detailed information on types of materials and equipment used and their locations including: distribution frame equipment (rack), equipment types and locations; a detailed listing of cable and outlet types and locations.
 - .2 Accurately and neatly recorded test results.
 - .3 Accurately and neatly record locations including room numbers, of all network components in list form for easy reference.

- .4 Identify drawings as 'Project Record Copy' and maintain in new condition making available for inspection by Owner.
- .5 Bind all items listed above in a 3-ring hard covered binder suitably labelled with the names of each site/project.

1.07 Quality Assurance

- .1 Qualifications of Manufacturer
 - .1 Supply equipment manufactured by experienced reputable manufacturer, whose installations have rendered satisfactory service for at least 2 years and who would provide factory trained technicians fully experienced in telecommunications wiring. Submit information regarding number of employees, and proof of VAR/CSV certification, including length of time Contractor or employee(s) have been certified to install Cable systems.
 - .2 Provide certification that cabling solution offered will perform as a system as is defined in standards documents such as EIA-TIA SP-2840A and T568A configuration for Category 5E system standards. Provide certification supported by manufacturer of cabling components used.
 - .3 In addition to certificate of assurance, evidence of support by manufacturer for above items shall be provided upon request in writing with bidding response.
 - .4 Use components sourced completely from single manufacturer.
- .2 Qualifications of Installer
 - .1 Provide installation and supervision work supervised by telecommunications technicians qualified to install voice and data cabling system and to perform related tests as required by manufacturer. Installers/company must have valid certification.
 - .2 Provide fully qualified telecommunications technicians, trained and certified by manufacturer in installation and testing of equipment specified. Provide evidence upon request in writing prior to work commencement of manufacturer's certification of supplier's ability to properly install structured cabling for building.
 - .3 Submit proven track record in cabling projects of similar size. Include details of minimum 3 projects of similar size involving category 5E cabling, Multimode and Single-mode fibre optic cabling which have been completed in last 2 years. Include names, addresses, and phone numbers of references for 3 projects.
- .3 Certifications
 - .1 UTP network wiring shall conform to T568A configuration, Category 5e system standards. All UTP cables shall provide minimum signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination at each end. The following tests will be conducted and recorded using a Penta Scanner:
 - .2 End to end continuity, attenuation, cable open and shorts; NEXT; mutual capacitance; pair polarity and cable impedance; S/N ratio and pass/fail status.

1.08 Warranty

- .1 The structured cabling systems shall be warranted for 25 years, covering all system products manufactured and provided by the single source supplier. The warrantor shall guarantee the following:
 - .1 All passive system components, e.g. patch panels, UTP cable and outlet jacks are free from manufacturing defects in material or workmanship

- .2 Approved cabling systems exceed the specifications of the T1A-568A standards and ISO/IEC IS 11801, if applicable.
- .3 The installation exceeds attenuation and near end cross talk, loss and bandwidth requirements TIA Bulletin TIA TSB-67 and ISO/EIC IS 11801.
- .2 General workmanship and apparatus installed under this contract shall be warranted against defects of workmanship and material for a period of one year after final acceptance of work by the Owner, unless otherwise specified. The contractor will make good any defects developed as a result of their work during such time without expense to the Owner.

2 Products

2.01 Manufacturers

- .1 Manufacturer List
 - .1 Belden.
 - .2 Commscope.
 - .3 Panduit.
 - .4 TE.
 - .5 Wirewerks.
 - .6 Approved equal.
- .2 Substitution Limitations
 - .1 Copper cabling installation shall be of one manufacturer.

2.02 UTP Cabling

- .1 100 ohm 4 pair UTP, compliant with TIA/EIA-568-C.2
- .2 Category 6A cabling for telephone/VOIP communication.
- .3 Category 6A for data communication, security cameras.
 - .1 Unshielded twisted pair, 4 pair twisted, #24AWG, FT-6/CMP plenum rated, blue outer insulation,
- .4 CMP (FT6) Plenum rated.
- .5 No splicing of any data network cabling will be permitted.

2.03 Data Outlets

- .1 All data jacks must meet specifications.
- .2 Computer outlets complete with termination jacks shall be single, duplex or quad flush faceplates complete with Category 5e, 8-position jacks.
- .3 Supply and install one – 4 pair cable to the single outlet, two – 4 pair cables to the duplex outlet, and three – 4 pair cables to quad outlet.

2.04 Patch Panels/Equipment Racks

- .1 All data UTP, 4 pair, Category 6A horizontal cables are to be terminated on cabinet or rack mounted 24/48 port panels wired.
 - .1 PS5 HD-BIX Patch panel, 1U, 24 Port (Belden AX100465 or equal)
 - .2 PS5 HD-BIX Patch panel, 2U, 48 Port (Belden AX100473 or equal)
- .2 Network rack must have the following features:
 - .1 Free standing.
 - .2 Standard 19" module compatible.
 - .3 Lockable door.
 - .4 Maximum dimensions of 22"w x 36"d x 85" h.
 - .5 Acceptable products:
 - .1 RF Mote Cat. #RFM-1944-RHD c/w hinged lockable door.
 - .2 Anixter Cat. #175419 c/w hinged lockable door.
- .3 Distribution panels must be category 6A rated BIX punchdown style with capacities as follows;
 - .1 24 port Belden AX100465
 - .2 48 port Belden AX100473
 - .3 96 port Belden AX100485
- .4 In addition to the above, provide all necessary ancillary equipment such as cable management, label holders, and patch cords.

2.05 Patch Cords

- .1 Provide Category 6A patch cords, consisting of 4 pair stranded cable rated FT4 or higher and stamped accordingly. They must conform to EIA/TIA 568A and meet or exceed the EIA/TIA TSB-36 specifications for cordage.
- .2 Patch cords at the workstation end shall be 3050 mm in length, one per data cable.
- .3 Patch cords at the TC end shall be 2133 mm in length, one per data cable.

3 Execution

3.01 Pathways for Communications

- .1 Conduit to Section 26 05 33.13. J-Hooks: as described in Section 27 05 29.
- .2 Cabling between cable tray/j-hooks and data outlets to be enclosed in EMT conduit.
- .3 Cables/data outlets may be enclosed in pre-finished non-metallic raceways computer labs, classrooms, etc. where indicated.

- .4 Data network cables shall be installed in cable tray. Data network cables shall not be tie-wrapped to electrical conduits, mechanical piping, etc. and shall be run as far as possible from fluorescent lighting fixtures, transformers and electrical power service conduits.

3.02 Installation

- .1 Each equipment rack shall be anchored securely to the floor and grounded to the building ground with a #6 AWG Insulated Ground Wire in accordance with applicable code requirements (refer to CAN/CSA T5238).
- .2 Ground all data cables shields and associated equipment in Telecommunications rooms to meet applicable code requirements.
- .3 Supply vertical cables and backbone cabling using cable clamps or wiring harnesses.
- .4 Conform to Telecommunications Industry Standards (refer to EIA/TIA 568A) for all cable termination and pinning assignments.
- .5 Utilize cable trays in MTER and TCs to manage cable in orderly fashion.
- .6 All sleeves containing cable or unused shall be fire sealed. Coordinate with Section 07 84 00 for provision and installation of fire barriers.
- .7 Cabling is to be run at 90 degrees to the building grid except where the distance would exceed 90m in length if installed in this manner.
- .8 The maximum horizontal run length is not to exceed 90 metres. If the 90 metre constraint cannot be met, the Cabling Contractor is to notify the Owners Designee of any cables that exceed 90 metres, prior to the installation.
- .9 Ensure all grounding conductors are rated FT-6. Tie into bundles and support using j-hooks outside of tray or conduit and fasten to under-slab at intervals not to exceed 1500 mm.
- .10 Route all cable in such a way as to ensure minimum separations are maintained from sources of EMI as defined in EIA/TIA SP-2840A.
- .11 Place all exposed cabling in TC in neat and professional manner and route as per specifications and drawings. Cables are to be combed, bundled, and routed in a neat and organized manner. Tie-wrap all exposed cable bundles at maximum of every 200 mm using black 'hook-and-loop- fastening ties.
- .12 Securely mount voice outlets at all work area locations and locate so that cable required to reach work area equipment will be no more than 3 m long.
- .13 Ensure that optical fibre splices, fusion or mechanical, do not exceed maximum optical attenuation of 0.3 dB when measured in accordance with EIA/TIA 455-34 and CSA Standard C22.2 No. 232.
- .14 All cables must be properly handled and installed in accordance with the manufacturer's specification. Undue pulling tension, abrasion or rough handling must be avoided to ensure that the cables will permit transmission of the intended information with no impairment or degradation of signal quality. Cable runs between the wiring closets and wall plates must be performed with no splices or cuts to ensure the elimination of reflections, discontinuities, impedance, mismatches, and egress/ingress of undesired signals. Cables must be installed at a specified distance (shown below) from any electrical equipment such as radios, televisions, fluorescent lights or fixtures, motors, transformers, or other significant sources of RFI/EMI interference
- .15 Label all cables in accordance with Industry Standards and CAN/CSA T528 specifications. Number cables as per drawings.

- .16 In cases where the routing may bring the cable in close proximity to the above mentioned sources of disruption, the following minimum distances must be maintained:
 - .1 125 mm (5 inches) from power lines of 2 kVA or less.
 - .2 305 mm (12 inches) from lighting (including fluorescent).
 - .3 914 mm (36 inches) from power lines of 5 kVA or greater
 - .4 40 inches from transformers and motors
- .17 As well, cables must be routed to avoid direct contact with steam pipes or other heat sources so as to avoid thermal degradation of the cable insulation or other undesired effects.
- .18 Cables shall be located in ceiling spaces neatly, tied in bundles and installed in cable management “trays”, J-hooks, and conduit as indicated on the drawings.
- .19 All cables entering the wiring closets must be neatly dressed in bundles and run to the appropriate terminating location.
- .20 Each cable sheath must be clearly and permanently identified with a labelling scheme acceptable to the owner. Each patch panel port a must be clearly and indelibly marked with a structured, user friendly numbering scheme. This numbering scheme must be capable of accepting cable additions so as not to disrupt the logical flow of the scheme. All testing documentation is to reference this numbering scheme.
- .21 NOTE: The faceplate identification numbers/tags MUST be added to the electronic versions of the floor plans. This will be considered part of the As Built contract closeout submittals. The electronic version of the floor plan will be provided in ACAD 14 format by the consultant.
- .22 The wiring closets shall be labelled C1 etc.
- .23 Fibre optic cable installation procedures shall be as follows:
 - .1 All cables must be properly handled and installed in accordance with the manufacturer's specification. Undue pulling tension, abrasion or rough handling must be avoided to ensure that the cables will permit transmission of the intended information with no impairment or degradation of signal quality. Cable runs between the wiring closets and must be performed with no splices or cuts to ensure the elimination of reflections, discontinuities, excess signal loss, or other undesirable problems.
 - .2 All fibre cables shall be installed in conduits from end-to-end.
 - .3 If, during the course of cable installation, it is necessary to bore holes through a firewall, the holes must be sealed with an acceptable sealing material of compound once the cables are in place.
 - .4 All cables entering the computer room must be neatly dressed in bundles and run to the appropriate terminating location.
 - .5 Cable runs shall be free of tension at both ends as well as over the length of the run.
 - .6 Each cable sheath must be clearly and permanently identified at each end using an appropriate labelling scheme accepted by the Owner.

3.03 Cable Identification and Labels

- .1 To Section 27 05 53.

- .2 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition the labels shall meet the general exposure requirements in UL 969 for indoor use.
- .3 Cable labels shall be of self-laminating vinyl construction with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
- .4 All labels must be mechanically printed using a laser printer. Hand written labels are not permitted.
- .5 Labels are to be attached to:
 - .1 front of the IDC connector or communication outlet faceplate
 - .2 each patch panel jack
 - .3 each end of the horizontal cable at maximum distance of 50mm from the end of the sheath
- .6 Affix faceplate label printed with Workstation Identification number to faceplate cover of in-tile service box.

3.04 Site Tests and Inspections

- .1 All UTP distribution cabling must be tested with a specialized UTP cable tester to measure the following characteristics:
 - .1 DC Resistance
 - .2 Characteristic Impedance
 - .3 Cable Length
 - .4 Pair Sequence Testing
 - .5 Hardcopy checklists indicating room number and faceplate ID, should be prepared, These results should be documented and form part of the Certification Report, Any documentation supplied in hardcopy form should also be supplied in electronic format (suitable word processing file, spread sheet, graphics file (e.g. AutoCAD, etc.).
 - .6 In addition to the above UTP testing, each cable and termination must be tested to 100 MBS standards.
 - .7 The specific tests to be performed, after all jack plates are mounted on boxes and labelled, are as follows,
 - .1 Mutual Capacitance
 - .2 Attenuation
 - .3 Near End Cross Talk
- .2 Fibre Optic Cable Testing Procedure
 - .1 System acceptance tests must be performed to verify that the cable plant can be certified fully operational. All optical fibre strands must be properly measured with approved optical fibre test equipment for the following characteristics:
 - .1 End to end attenuation loss in dB as measured by a calibrated optical power meter.
 - .2 Splice loss (if any)

- .3 Cable length
- .2 The above results are to be obtained by the following test procedures:
 - .1 Power meter and light source.
 - .2 OTDR - provide hard copy of signature trace in report.
 - .3 Detailed results of these tests must be included as part of a Certification Report.
 - .4 No connector should exceed 0.5 dB loss. Splices shall not exceed 0-3 dB loss. Total attenuation of link including fibre cable, connectors and splices shall not exceed 5 dB.
- .3 These test results must be documented and form part of the Certification Report.

End of Section

1 General

1.01 Submittals For Review

- .1 Product Data: Provide manufacturers catalogue information.

2 Products

2.01 Facility Network Cabling

- .1 Minimum plenum rated (CMP) Category 6 UTP.
- .2 Panduit TX6000 series.

2.02 Jacks and Modules

- .1 Panduit Mini-Com TX6 series

3 Execution

3.01 Installation

- .1 Install backbone cables in accordance with manufacturer's specifications ensuring that proper installation techniques are used and that the cable's maximum pull-force and maximum bend radii specifications are adhered to.
- .2 Backbone cable/cable bundles shall be secured properly when fastened to backboards or termination cabinets/racks.
- .3 For UTP cabling, maintain a minimum of four (4) times cable diameter as a bend radius if no bend radius is specified.
- .4 The Contractor shall notify The Consultant immediately if UTP backbone cable run exceeds 90 m (295'-0").
- .5 The Manufacturer and the Electrical Contractor shall ensure the maximum length of any zone cabling does not exceed the manufacturer's specifications.

End of Section

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1 General

1.01 Section Includes

- .1 Communications conductors and cables for fire detection, suppression, and alarm systems.
- .2 Conduit for fire detection, suppression, and alarm systems.

1.02 Related Requirements

- .1 Section 28 46 13 – Fire-Alarm Systems.
- .2 Section 28 46 31 – Fire-Alarm Initiating Devices.

1.03 Definitions

- .1 ULC-S524: CLASS A CIRCUIT (Return Loop Circuit) – A circuit having one continuous path connecting all components on the circuit and terminating through an alternate connection path in the source enclosure.
- .2 ULC-S524: CLASS B CIRCUIT (Terminated Circuit) – A circuit having one continuous path connecting all devices on the circuit and terminating at an end-of-line device.

1.04 References

- .1 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (29th edition/2024).
- .3 CSA C22.2 No. 208-14 – Fire Alarm and Signal Cable.
- .4 CAN/ULC-S139:2017 – Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.
- .5 CAN/ULC-S524:2019 – Standard for the Installation of Fire Alarm Systems.

1.05 Delivery, Storage, and Handling

- .1 In accordance with Section 01 61 00.

1.06 Warranty

- .1 All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one year from the date of acceptance.

2 Products

2.01 Conduit and Wire for Fire Alarm System

- .1 Conduit:
 - .1 In accordance with Section 26 05 33.13.
 - .2 All wiring shall be installed in conduit or raceway.
- .2 Terminal Boxes, Junction Boxes and Cabinets:

- .1 All boxes and cabinets shall be listed for their purpose and use.

2.02 Fire Alarm Cable

- .1 Wiring shall be in accordance with local, provincial, and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as outlined in the Ontario Electrical Safety Code, and as recommended by the fire alarm system manufacturer.
- .2 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system, as outlined in the Ontario Electrical Safety Code.
- .3 Certified by CSA as fire alarm and signal cable type FAS 105 to CSA C22.2 No. 208.
- .4 Conductors:
 - .1 300 V rated multiconductor, insulated, colour coded, copper conductor.
 - .1 Use solid conductors unless noted otherwise.
 - .2 Use stranded conductors for connections between closest junction box and vibrating equipment i.e. generator set supervisory connection.
 - .2 Minimum 16 AWG for initiation circuits.
 - .3 Minimum 12 AWG for strobe signal circuits.
 - .4 Minimum 14 AWG for horn signal circuits.
 - .5 Minimum 12 AWG for bell signal circuits.
- .5 Non-Fire resistive cable:
 - .1 Insulation: 105°C flame retardant PVC.
 - .2 Outer Jacket: 105°C flame retardant PVC Red.
 - .3 Armour: Interlocking aluminum without overall Jacket. For drops to devices in suspended ceilings from conduit system.
- .6 Fire resistive fire alarm cable:
 - .1 Pentair Pyrotenax 1850 series mineral insulated (MI) cable with 2 hour fire rating to ULC-S139 and to meet Ontario Building Code Rule 3.2.7.10.
 - .2 Substitution: VITALink CIC Type FAS105, manufactured by Comtran (listed by ULC under ULC category code 'FHIT7' and 'FHJR7', dated 19 May 2015), installed in EMT conduit.
 - .3 Substitutions such as "Lifeline" installed in conduit may only be considered if listed by ULC under ULC Category Code 'FHIT7'.

3 Execution

3.01 Installation

- .1 All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

- .2 The entire system shall be installed in accordance with the latest edition of CAN/ULC-S524 and the approved manufacturer's manuals and wiring diagrams.
- .3 The contractor shall furnish all labour, conduit, wiring, outlet boxes, junction boxes, cabinets, and similar devices necessary for installation of system devices.
- .4 Provide all necessary power supply, interconnecting and remote signal wire in dedicated conduit throughout and installed in accordance with the manufacturer's wiring diagrams and the requirements of the Ontario Electrical Safety Code and the Inspection Authority.
- .5 All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.
- .6 Install all wiring in metal raceways.
- .7 Provide wiring suitable for fire alarm circuits.
 - .1 Class A wiring for initiating circuits.
 - .2 Class B wiring for signalling circuits.
- .8 Fire resistive conductors:
 - .1 Install fire resistive conductors in accordance with the manufacturer's installation guidelines.
 - .2 Install 2 hour fire resistive cables for fire alarm circuits as required by the building code where transponders (data gathering panels) or annunciators are installed in a separate fire compartment from the main FACP CPU.
 - .3 Install 2 hour fire resistive cables for fire alarm system branch circuits where the transponder or DGP is not within the same storey as the first initiation, signalling, or voice communication device in the loop for that storey.
 - .4 In lieu of fire resistive cables for the above noted cases, Contractor may, when reviewed beforehand by the Consultant, install non rated conductors in be located in a service space that is separated from the remainder of the building by a fire separation that has a fire resistance rating of not less than 2 hours.

3.02 Site Tests and Inspections

- .1 The manufacturer's representative shall perform an inspection of the fire alarm equipment. The inspection shall comprise an examination and test of such equipment for the following:
 - .1 That the type of conductors and cables installed are that designated by the specifications.
 - .2 That the specified equipment has been installed in accordance with the manufacturer's recommendations.
 - .3 That the supervisory wiring of all devices connected to a supervised circuit is operating and that the wiring has been met to the satisfaction of the inspecting officials.
- .2 Testing to be done in the presence of the local building inspector, and the local fire inspector.

End of Section

1 General

1.01 Summary

- .1 This Section covers the supply and installation of a complete Communications Copper Horizontal Cabling system. The scope of work includes, but is not limited to, the following tasks, as well as all tasks specified by the Consultant or the Owner, stipulated in the Contract Documents, or required for proper completion and commissioning of the system.
 - .1 Supply, delivery, supervision, coordination, installation, testing and commissioning of a complete horizontal copper cabling system, as specified in the present document, the Contract Documents, and the Drawings.
 - .2 Submittal of complete documentation, including, certifications, test reports, progress reports, warranty certificates, manuals, as-built drawings, as specified in the present document and the Contract Documents, and as requested by the Consultant and the Owner for the purpose of proper completion of the project.
- .2 Contractor shall examine, and is responsible for complying with, the Contract Documents in their entirety, including all relevant Drawings and Specification presented in other Sections and Divisions, regardless of whether such Drawings and Specification are referenced in this Section.
- .3 Contractor shall provide, install and test a complete Communications Copper Horizontal Cabling system as follows.
 - .1 Contractor shall furnish and install all horizontal cabling system equipment, including:
 - .1 Horizontal Cables (Permanent links, patch cords and equipment cables).
 - .2 Termination Hardware.
 - .3 Telecom Outlets.
 - .4 Patch Panels.
 - .5 Device Connection.
 - .6 Testing (Including cable and channel verification, qualification and certification).
 - .7 Administration and Identification.
 - .2 Contractor shall furnish and install all miscellaneous items, accessories, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation, without claim for additional payment, even if such work or components are not specifically mentioned in the Specification or the Drawings.
 - .3 Contractor shall provide system testing and demonstration, proper commissioning, system documentation, as-built drawings, training and installation manuals, and adequate training for the Owner's personnel, without claim for additional payment.
- .4 Errors, Omissions and Conflicts:
 - .1 Contractor shall notify the Consultant no later than ten (10) days prior to submitting the bid of any errors or omissions encountered in the Drawings, Specification, or other Contract Documents.
 - .2 Contractor shall use the more expensive material or method whenever a conflict is encountered between or within Drawings and Specification, unless Contractor has requested received a written response (addendum) as to which material or method is suitable.

- .5 Related Requirements:
 - .1 Section 07 84 00 – Firestopping.
 - .2 Section 26 05 26 – Grounding and Bonding for Electrical Systems.
 - .3 Section 27 08 11 – Testing of Structured Cabling Systems.
 - .4 Section 27 11 16 – Communications Cabinets, Racks, Frames, and Enclosures.
 - .5 Section 27 11 19 – Communications Termination Blocks and Patch Panels.
 - .6 Section 27 11 23.13 – Communications Cable Management.
 - .7 Section 27 11 26 – Communications Rack Mounted Power Protection and Power Strips.
 - .8 Section 27 15 43 – Communications Faceplates and Connectors.

1.02 Acronyms and Abbreviations

- .1 ANSI - American Northern Standards Institute.
- .2 AWG - American Wire Gauge.
- .3 BICSI - Building Industry Consulting Service International.
- .4 TDMM - Telecommunications Distribution Methods Manual (BICSI).
- .5 EIA - Electronics Industry Alliance.
- .6 IEEE - Institute of Electrical and Electronics Engineers.
- .7 ISO - International Standards Organization.
- .8 OESC – Ontario Electrical Safety Code.
- .9 NFPA - National Fire Protection Agency.
- .10 NRTL - Nationally Recognized Testing Laboratory.
- .11 TIA - Telecommunications Industry Association.
- .12 UL - Underwriters Laboratories.

1.03 References

- .1 Most recent editions and addenda of the following documents:
 - .1 ANSI/TIA-568 - Commercial Building Telecommunications Cabling Standard Set
 - .2 ANSI/TIA-569 - Telecommunications Pathways and Spaces
 - .3 ANSI/TIA-606 - Administration Standard for Telecommunications Infrastructure
 - .4 ANSI/TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - .5 ANSI/TIA-862 - Structured Cabling Infrastructure Standard for Intelligent Building Systems
 - .6 ANSI/TIA-942 - Telecommunications Infrastructure Standard for Data Centers.

- .7 ANSI/TIA-1179 - Healthcare Facility Telecommunications Infrastructure Standard.
- .8 ANSI/TIA-4966 - Telecommunications Infrastructure Standard for Educational Facilities.
- .9 BICSI/TDMM - Telecommunications Distribution Methods Manual.
- .10 TIA-TSB-162 - Telecommunications Cabling Guidelines for Wireless Access Points.
- .11 CSA C22.1 - Canadian Electrical Code Part 1.
- .12 UL 444 - Standard for Safety of Communications Cable.
- .13 UL 1666 - Standard for Safety of Flame Propagation Height.
- .14 Local Authority Having Jurisdiction (AHJ).
- .15 Anywhere cabling standards conflict with one another or with electrical or safety codes, Contractor shall defer to the OESC and any applicable local codes or ordinances, or default to the most stringent requirements listed by either.

1.04 System Description

- .1 The Contractor shall provide, install, test, label and document a complete horizontal structured cabling system, spanning from a centralized telecom room(s) (TR) to the telecom outlets (TO), in a star network topology. The main components of the system are specified below.
- .2 Horizontal Cabling
 - .1 The horizontal cabling system extends from the telecom room (TR) or telecom enclosure (TE) to the work area telecom outlet (TO). It includes horizontal cable, hardware terminations, jumpers, patch cords, and may incorporate multiuser telecommunications outlet assemblies (MUTOAs) and consolidation points (CPs).
 - .2 Maximum horizontal cable length shall be 90 m (295 ft.), independently of media type. Where an MUTOA is deployed, the maximum horizontal copper cable length shall be adjusted accordingly.
- .3 Telecom Room / Enclosure (TR / TE)
 - .1 Telecom Room (TR) is a dedicated and controlled space on each building floor, used for housing telecommunications equipment, cable terminations, and cross-connect hardware serving that particular floor. TR constitutes the recognized connection point between horizontal and backbone cabling systems. The telecom standards (ANSI/TIA, BICSI TDMM, etc.) require a minimum of one telecom room, closet, or enclosure per floor.
 - .2 Telecom Enclosure (TE) usage is project-specific rather than a standard requirement. TE is intended to serve relatively smaller floor area, and is often used to extend the space and reach of a TR.
- .4 Pathways and Raceways
 - .1 Pathways and raceways are conveyance and routing systems for distributing, supporting and protecting telecom infrastructure cabling systems. Pathway system type and installation method shall be suitable for the media being supported and the environment being traversed.
 - .2 Pathway and raceway systems shall conform to the standards specified and referenced in Section 27 05 28 and Section 27 05 36.

- .3 Pathway design shall combine continuous cable trays and non-continuous cable supports. Cable trays should, nonetheless, form the main horizontal cabling pathway, and should be located over the main corridors, to facilitate access and maintenance tasks.
- .4 In low cable density areas, non-continuous supports shall be used in lieu of a cable tray system, unless otherwise specified in the design documents.
- .5 In open-ceiling spaces where the cable is exposed, a conduit or a surface raceway shall be used in lieu of non-continuous supports, to enhance cable protection and aesthetic appearance.

1.05 Submittals

- .1 Provide submittals in accordance with Division 01.
- .2 Shop Drawings
 - .1 Contractor shall submit shop drawings for all components and equipment used in the project, including, the items listed below.
 - .1 Modular Connectors.
 - .2 Telecom Outlet Faceplates.
 - .3 Horizontal Cable.
 - .4 Patch Panels.
 - .5 Patch Cables and Equipment Cords.
 - .6 Telecommunications Enclosures and Racks.
 - .7 Cable Management Components.
 - .8 Pathways and Raceways (Cable Trays, Cable Supports, Conduits, etc.).
 - .9 Firestopping Material.
- .3 General Component Data
 - .1 Contractor shall submit the information and documents outlined below, with respect to all components and products covered under this Section or installed as part of communications copper horizontal cabling:
 - .1 Product Name, Manufacturer Name, Model Number and Part Number.
 - .2 Product Datasheets and Specifications.
 - .1 Complete specification, including but not limited to, standards compliance, Category type, fire rating, environmental rating, number and color code of pairs, conductor size and material, insulation type and material, performance and attenuation parameters, near-end cross talk (NEXT), cable diameter and weight, jacket type and material, cable color, etc.
 - .3 Product Manuals (Installation Instructions, User Manuals, Maintenance Manuals).
- .4 Deviations

- .1 Contractor shall be responsible for any deviation from Contract Documents, regardless of whether such deviation or associated drawings and samples have been reviewed by the Consultant, unless deviation has been approved in writing by the Consultant and the Owner.
- .2 Contractor shall submit an indexed sheet detailing all deviations from Contract Documents, and shall be responsible for all such deviations, unless these have been expressly approved in writing by the Consultant and the Owner.
- .3 Contractor shall not assume that an approval of an item's shop drawing or sample is equivalent to an approval of the item itself. Deviations shall be treated specifically, and shall be approved separately as such, in writing by the Consultant and the Owner.
- .4 Contractor shall be responsible for all deviations, errors and omissions in the submittal documents and process, regardless of whether such deviations, errors and omissions have been reviewed by the Consultant or the Owner.

1.06 Closeout Submittals

- .1 Testing and Test Results
 - .1 Refer to Section 27 08 11.
 - .2 Specification and calibration sheets for all test equipment.
 - .3 Contracting firm qualifications and certifications.
 - .4 Installation team qualifications (by person).
 - .5 Test results (Intermediate and final test results, as specified in Part 3 - Execution).
- .2 Contractor shall submit final closeout documents as required by the Consultant and the Owner. These shall include, but are not limited to, the following items.
 - .1 Test results covering all cable segments and links, in native tester and PDF formats, or as otherwise specified by the Consultant.
 - .2 Manufacturer and contractor warranties.
 - .3 Complete project manual set, including, product datasheets, material submittals, training manuals, user manuals, maintenance manuals and preventive maintenance plan.
 - .4 Spare parts recommendation list.
- .3 Contractor shall submit a complete set of as-built drawings in an accessible AutoCAD format, as specified by the Consultant and the Owner. As-built drawings shall cover the following.
 - .1 Precise location and identification (labels) of all equipment, including, all data outlets, cables, cable trays, patch panels, racks, telecom rooms and enclosures, and all other equipment which is part of the horizontal cabling system.
 - .2 Detailed floor plans of all telecom rooms and spaces.
 - .3 Detailed layout of all racks, patch panels, cable trays, pathways, conduits.
 - .4 Detailed layout of all pathways, cable trays, and cable routes.
- .4 Contractor shall submit and mount on the wall of each telecom space or room, detailed as-built drawings depicting the floorplan, floor area, TO points, and cabling layout, for that space or room. Drawings shall

be printed on ANSI C paper size or larger, shall be laminated, and shall be approved and wall-mounted in coordination with the Consultant and the Owner.

1.07 Quality Assurance

- .1 Standards for Materials and Equipment
 - .1 Contractor shall provide all materials, equipment, and installations, in compliance with the latest applicable standards.
- .2 Installer Qualifications
 - .1 Refer to Section 27 05 00 – Common Work Results for Communications.

1.08 Warranty

- .1 Contractor shall ensure each piece of equipment installed including wiring is warranted by the manufacturer to be free of defects in operation, material, and workmanship for a period of 15 years from date of Substantial Completion.

2 Products

2.01 Manufacturers

- .1 Manufacturers listed in 27 10 00.

2.02 Category 6A Data Communications Horizontal Cable

- .1 Category 6A (Class EA) cable shall meet ANSI/TIA-568.2-D Category 6A component standard. Cable conductors shall consist of 23 AWG copper wires and shall be twisted in pairs. In addition, Category 6A cable shall comply with the following specifications and standards:
- .2 General Requirements
 - .1 Cable shall consist of 4 unshielded twisted pairs with no outer shielding (Cat 6A U/UTP), unless otherwise specified in the design and expressly approved by the Owner.
 - .2 Cable used in data networking systems shall have a blue color jacket.
 - .3 Cable conductor insulations shall be color coded in compliance with the TIA-568 standard.
 - .4 Cable individual conductors shall be 23 AWG copper wires. Special applications requiring the use of the thinner 24 AWG conductor in patch cords (short length, max 2 m) shall be specified and expressly approved by the Owner. Note: Only Category 6A cable with 23 AWG solid conductors is permitted in Permanent Link.
 - .5 Cable deployed as horizontal permanent link extending from the telecom enclosure/room to the telecom outlet shall have solid conductors.
 - .6 Equipment cable and patch cords shall have stranded conductors.
 - .7 Cable shall be properly rated for its use application and its installation environment (Outdoor/OSP, Plenum/CMP, Riser/CMR, LSZH, Industrial/Armored, Direct Burial, etc.), as required by the local and national codes.
 - .8 Cable weight shall not to exceed 30 lbs./1000 ft.
- .3 Standards Compliance and Technical Specification

- .1 Category 6A cable shall satisfy the following compliance and technical specification.
 - .2 Cable shall exceed requirements of ANSI/TIA-568.2-D Category 6A and ISO 11801 2nd Edition Class EA channels standard.
 - .3 Cable shall exceed requirements of ANSI/TIA-568.2-D and IEC 61156-5 Category 6A components standard.
 - .4 Cable shall meet requirements of IEEE 802.3af, IEEE 802.3at and IEEE 802.3bt for Power over Ethernet (PoE) applications up to 100 watts (IEEE 802.3bt Type 4, 4PPoE).
 - .5 Cable shall meet TIA TSB-184-A / IEEE 802.3bt cable requirements, and UL listed CMP-LP (0.7A).
 - .6 Cable shall be characterized up to 500 MHz or higher, as specified in the ANSI/TIA-568.2-D, Category 6A standard.
 - .7 Cable shall be third-party tested and verified for compliance with ANSI/TIA-568.2-D, Category 6A.
 - .8 Cable shall support IEEE 802.3 for 10GBASE-T (10 Gigabit Ethernet), 1000BASE-T (Gigabit Ethernet), 100BASE-T (Fast Ethernet), and 10BASE-T applications up to 100 metres.
- 4 Safety Standards
- .1 Category 6A cable shall strictly meet the following specification in order to achieve compliance with the local and national (CSA) safety codes and standards.
 - .2 Cable deployed in the plenum and/or raised floor space (whether partly or entirely) shall be plenum CMP rated and shall comply with the CSA FT6 or NFPA 262 (UL-910) fire test standards.
 - .3 Cable running between floors in non-plenum area shall be riser CMR rated and shall comply with the CSA FT4 and UL-1666 fire test standards.
 - .4 Plenum CMP rated cable (CSA FT6 or NFPA 262) may be used in riser applications, if needed. Riser CMR rated cable, however, is not approved for use in plenum space and shall not be deployed therein.
- .5 Temperature Rating
- .1 Installation Temperature Range: 32°F to 122°F (0°C to 50°C)
 - .2 Operating Temperature Range: -4°F to 167°F (- 20°C to 75°C)

3 Execution

3.01 General

- .1 Comply with the design requirements and industry standards, and with the applicable local and national codes.
- .2 Follow best practices guidelines and applicable industry standards for the installation of the cable and all horizontal channel components.
- .3 Ensure that patch panels, connectors, and all structured cabling components are compatible with the Category rating of the cable. For example, if Category 6A cable is used; then, all structured cabling components shall be Category 6A compatible.

- .4 Ensure that all materials, components and equipment being installed are properly rated (Plenum or Riser), as required by local and national codes.
- .5 Install all cables and horizontal channel components (connectors, outlets, faceplates, jacks, etc.) as instructed in the manuals and specified in the Drawings.
- .6 Provide all installation and mounting accessories and components, such as, screws, anchors, clamps, hooks and loops, grounding and support hardware, etc., as required to carry out the installation of the cabling system.
- .7 Furnish all special installation equipment or tools, as needed to properly complete the installation.
- .8 Provide appropriate underlay for storage of cable reels. Rolling of cable reels is not permitted.
- .9 Provide all additional material and labour required to rectify a situation arising from their failure to comply with applicable standards and best practices guidelines. This equally applies to all damage inflicted to cables by Contractor during the installation process.
- .10 Provide fire blocking material at all fire rated penetrations, as required by design, standards, and codes.
- .11 Seal all conduits where cabling has been installed with re-enterable duct sealing system, as required by design, standards, and code.
- .12 Provide and install bushings on all conduit ends.
- .13 Ensure means and methods promote ease of access to cables for maintenance and testing purposes.
- .14 The pathways shown on the Drawings are an approximate representation, and should not be interpreted as an absolute and accurate layout. Conduct site surveys, and coordinate with other trades, as required, in order to determine the exact final pathway layout.

3.02 Horizontal Cabling Guidelines

- .1 Comply with best practices guidelines for horizontal cabling systems.
- .2 Install horizontal cabling in a continuous run, from the TR patch panel to the peripheral telecom outlet. Spliced copper cable is not permitted.
- .3 Group and bundle all cables by power level and cable type. Use “hook and loop” fasteners for bundling cables.
- .4 Do not exceed the maximum cable pulling tension specified by the manufacturer.
- .5 Terminate and test all cables.
- .6 Install all patch panels inside the data racks, at the specified telecom spaces. Coordinate with the Owner for installation of network switches.
- .7 Perform all cabling tasks in compliance with best practices guidelines, and applicable industry standards, particularly, BICSI’S TDMM and ANSI/TIA-568.
- .8 Ensure that all horizontal cables, including any required service loops, do not extend beyond 90 m (295 feet). Identify any areas that cannot be reached within the 90 metre constraint, and report them to the Consultant. Contractor shall strictly adhere to this rule, unless a written approval has been issued by the Consultant.
- .9 Provide cable slack (service loop) at both ends of the cable for maintenance or future cabling system changes. The recommended lengths (BICSI TDMM) are:

- .1 Minimum of 3 metres in the telecommunications closet for both twisted-pair and fiber cable
- .2 Minimum 1 metre for fiber at the outlet.
- .3 Minimum 30 cm for twisted-pair cable at the outlet.
- .10 Ensure that all equipment installed in the horizontal channel including but not limited to, cable, pathways, conduits, connectors, is properly rated in compliance with local and national codes. All cables and components installed partly or entirely in the plenum space shall be plenum rated. All cables or components installed partly or entirely in the riser space shall be riser rated. All cables or components installed partly or entirely outdoors shall be weatherproof and OSP (outside plant) rated.
- .11 Install all cable pathways and conduits perpendicular or parallel to the ceiling structure, unless otherwise specified in the Drawings.
- .12 Exercise care and follow proper guidelines during cable installation in order to prevent damage to cable and equipment. Use grommets to protect cable where conduit or chase nipples are not installed around cut-outs or knockouts.
- .13 Contractor shall not expose cable to water, paint overspray, paint removal products, water-based pulling lubricants, or any other substances or environments which can damage or compromise the integrity of the cable.
- .14 Provide metallic isolation barriers to isolate different wiring groups, where cables with different classifications share a common box or enclosure.
- .15 Coordinate as needed with the electrical and mechanical trades in order to implement a proper earthing and bonding system, and an effective Electromagnetic Compatibility (EMC) scheme.
- .16 Mitigate electromagnetic interference (EMI) by maintaining the recommended separation between telecom and power (EMI) sources, as specified by ANSI/TIA-569 and shown in the table below.

Minimum Separation Distance Between Power and Data Cables (ANSI/TIA-569)			
	Minimum Separation Distance		
Condition	< 2 kVA in (mm)	2 - 5 kVA in (mm)	> 5 kVA in (mm)
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways	5 (127)	12 (305)	24 (610)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway	2.5 (64)	6 (152)	12 (305)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway		3 (76)	6 (152)
Electrical motors and transformers			48 (1,220)

- .17 Do not install telecom cables and power cables in the same pathways, cable trays, or conduits.
- .18 Provide vertical cable support for all cables installed in vertical cable trays, using properly sized vertical cable supports on every third floor. Use of nylon cable ties is not permitted.

3.03 Cable Installation in Conduit and Duct

- .1 Apply best practices when pulling cable inside conduits and ducts.
- .2 Ensure that pulling tension never exceeds the manufacturer's specification.
- .3 Ensure that cable bending during installation conforms to the manufacturer's specifications.
- .4 Use a pull mandrel one size smaller than the conduit.
- .5 Use cable pulling lubricant to reduce friction and tension during cable pulling.
- .6 Use a dynamometer to measure pulling tension in the case of long or difficult installations.
- .7 Use pulling grips suitable for copper cable installations. Contractor shall consult the cable manufacturer to determine the suitable pulling grip and method of attachment.
- .8 Seal loose cable ends using cable caps (heat-shrinking type) to protect them until they are terminated.
- .9 Use corner blocks to facilitate the bending of cable. Contractor should use 45° cable block for bends between 5° and 45°, and 90° corner block for bends between 45° and 90°.

3.04 Cable Bundling Material

- .1 Contractor shall use the appropriate cable bundling and securing material, in line with industry and best practices standards, to ensure cable runs are securely held in place, both vertically and horizontally.
- .2 Contractor shall not tighten bundling and securing ties and straps around cables, to avoid deforming cable geometry, and as a result, cable performance.
- .3 Contractor shall only use safe and soft cable fasteners to bundle or secure cable, such as, "hook and loop" cable fasteners. The use of regular plastic cable ties is strictly forbidden.
- .4 Contractor shall not attach or secure cable runs to other building systems (such as, electrical or mechanical conduits, HVAC ducts, sprinkler pipes, ceiling suspension members, etc.).
- .5 Contractor shall strictly use plenum rated cable bundling components inside suspended ceilings, raised floors, and air-handling spaces.

3.05 System Administration

- .1 Refer to Section 27 05 53 – Identification for Communications Systems.
- .2 Conform to the system administration guidelines of ANSI/TIA-606, Administration Standard for Telecommunications Infrastructure.
- .3 Propose a consistent and comprehensive system administration scheme in coordination with the Consultant, the Owner and all stakeholders. Contractor shall seek the Consultant's or the Owner's written approval of the proposed scheme ahead of implementation.
- .4 Uniquely identify all components of the installed system by location, function, unit, and sub-unit.
- .5 Identify each location, telecom space, telecom room or enclosure in the building with a unique alphanumeric identifier.
- .6 Identify each system component, including but not limited to, adapter modules, connectors, cables, patch panels, patch and equipment cords, cable management devices, grounding system components, power cords, faceplates, outlets, cable trays and pathways, racks, enclosures, etc. with a unique alphanumeric identifier.

- .7 Contractor shall supply all the required records and documentation in compliance with ANSI/TIA 606.
- .8 Contractor shall provide an ODBC-compliant database (Open Database Connectivity), for administration of the cabling system described in this Section.

3.06 Identification

- .1 Contractor shall seek the Consultant's and the Owner's approval of the project's labeling plan, ahead of cable installation.
- .2 Labeling Cables
 - .1 Mark each cable at each endpoint and at all intermediate pull and access points, and junction boxes with labels that indicate the origin and destination identifiers, the sheath identifier, and the strand or pair range.
 - .2 Contractor shall mark each horizontal cable on the sheath at each end with the TR, patch panel, and panel port where cable is terminated.
- .3 Labeling Conduits and Pathways
 - .1 Contractor shall label conduits and pathways within 0.5 m (18 inches) of each end, on an exposed and accessible spot.
 - .2 Contractor should apply additional labeling, where possible, at every 3 m (10 feet) of exposed length.

3.07 Cable Testing

- .1 Refer to Section 27 08 11 for cable testing procedures.
- .2 Ensure all testing procedures and field-test instruments comply with the requirements of:
 - .1 ANSI/TIA-1152-A, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - .2 ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises
 - .3 ANSI/TIA-568.1-D, Commercial Building Telecommunications Cabling Standard
 - .4 ANSI/TIA 568.2-D, Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- .3 Provide all labor, materials, tools, field-test instruments and equipment required for the complete testing of the work.
- .4 Test all horizontal UTP cables as instructed below.
- .5 Perform tests using a level IV accuracy cable tester, updated with latest firmware.
- .6 Provide all test records in both "native" and pdf formats, as part of the as-built package.
- .7 Unless otherwise specified by the Consultant or the Owner, all horizontal links and channels shall be tested for the following:
 - .1 Wire Map.
 - .2 Length.

- .3 Propagation Delay.
 - .4 Delay Skew.
 - .5 DC Loop Resistance.
 - .6 Insertion Loss.
 - .7 NEXT (Near-End Crosstalk).
 - .8 PS NEXT (Power Sum Near-End Crosstalk).
 - .9 ACR-N (Attenuation to Crosstalk Ratio Near-End).
 - .10 PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End).
 - .11 ACR-F (Attenuation to Crosstalk Ratio Far-End).
 - .12 PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End).
 - .13 Return Loss.
- .8 All horizontal links and channels shall pass the test requirements for respective cable Category, as specified in ANSI/TIA-568.2-D. Category 6 and 6A cables shall be tested up to 250 MHz and 500 MHz, respectively.
- .9 Any cable or link that fails the requirements shall be identified and corrected.

3.08 Firestopping

- .1 Comply with the requirements of Section 07 84 00 – Firestopping.
- .2 Comply with the requirements of the latest TIA/EIA-569, Annex A, Firestopping.
- .3 Comply with the requirements of the latest BICSI TDMM, Chapter 7, Firestop Systems.
- .4 Firestop systems shall meet the requirements of ULC Standard CAN/ULC-S115.

End of Section

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1 General

1.01 Section Includes

- .1 Twisted Pair Patch Cords.
 - .1 Schedule of copper patch cords to be supplied.
- .2 Fibre Optic Patch Cords.
- .3 Related Cross-connect components.
- .4 Cross-connection and patching.

1.02 Related Requirements

- .1 Section 27 13 23 – Communications Optical Fiber Backbone Cabling.
- .2 Section 27 13 13 – Communications Copper Backbone Cabling.
- .3 Section 27 11 19 – Communications Termination Blocks and Patch Panels.

1.03 Submittals

- .1 Product Data: For each type of product indicated.
 - .1 For Category-6 patch cords, include the following installation data for each type used:
 - .1 Nominal OD.
 - .2 Minimum bending radius.
 - .3 Maximum pulling tension.
 - .2 For Fiber Optic patch cords, include the following installation data for each type used:
 - .1 Nominal OD.
 - .2 Minimum bending radius.
 - .3 Maximum pulling tension.
- .2 Source quality-control reports.
- .3 Field quality-control reports.

1.04 Quality Assurance

- .1 Electrical Components, Devices, and Accessories: Listed and labeled by a qualified testing agency, and marked for intended location and application.
- .2 Warranty: see Section 27 05 00.

1.05 Delivery, Storage, and Handling

- .1 Test cables upon receipt at Project site.
 - .1 Test optical fiber cables to determine the continuity of the strand end to end. Use optical loss test set.

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- .2 Test each pair of UTP cable for open and short circuits.

1.06 Project Conditions

- .1 Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2 Products

2.01 Manufacturers

- .1 Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - .1 Panduit (selection based on Owner's standard).
 - .2 No alternative will be accepted.

2.02 Patch Cables

- .1 General Requirements: Comply with TIA/EIA-569-C.
- .2 Category 6A Copper Patch Cords:
 - .1 Factory-made, four-pair cables terminated with eight-position modular plug at each end in lengths as indicated in pricing sheet.
 - .2 Patch cords shall have bend-relief-compliant boots to ensure Category 6 performance.
 - .3 UTP Patch Cords will be supplied in the following lengths:

Quantity	Length	Colour	Use	Panduit Part Number
450	5'	White	Desks	UTP28SP5
150	7'	White	Cabinet	UTP28SP7
150	10'	White	Cabinet	UTP28SP10
75	7'	Yellow	Internet	UTP28SP7YL
75	10'	Yellow	Internet	UTP28SP10YL

- .3 Fibre Optic Patch Cords: Factor-made, dual-fibre cables with LC duplex connectors.
 - .1 Fibre patch cords will be available in the following lengths.
- .4 Estimated Quantities
 - .1 The estimate of cable counts and lengths is given for bid purposed only; the final count and lengths will be provided in the integration phase of the project.
 - .2 Pricing should include single cable pricing and quantity discount pricing.
- .5 Cable Connecting Hardware:

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- .1 Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA568-C.3.
- .2 Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB.

2.03 Identification Products

- .1 Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, and inks used by label printers.
- .2 Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

2.04 Source Quality Control

- .1 Factory test UTP cables according to TIA/EIA-568-C.2.
- .2 Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-C.3.
- .3 Provide test and inspection reports.

3 Execution

3.01 Field Quality Control

- .1 Perform tests and inspections.
 - .1 Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling connections for compliance with TIA/EIA-568-C.1.
 - .2 Visually confirm Category 6a, marking of patch cables.
 - .3 Visually confirm Fiber patch cable marking.
 - .4 Visually inspect cable placement, and patch cords, and labeling of all components

3.02 Supply of Patch Cords

- .1 Patch cords included in contract; all patch cords to be supply only, installation by the Owner.
 - .1 Supply two (2) copper patch cords per each telecom field outlet.
 - .1 7'-0" length at telecom room.
 - .2 10'-0" length at workstation.
 - .2 Supply one (1) duplex Fiber patch cord for every 12 strand fiber backbone cable.
 - .3 Supply one (1) duplex Fiber patch cord for every 2 strand fiber horizontal distribution cable.
- .2 Patch cord colour to match colour of system cabling.

End of Section

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1 General

1.01 Section Includes

- .1 Wireless Access Points (WAPs) for WiFi network communications.

2 Products

2.01 Owner-Supplied Products

- .1 WAP (Wireless Access Points).
 - .1 Issued by Owner to this Contractor for installation at locations as indicated on the drawings.
 - .2 Power Over Ethernet (PoE) powered.

3 Execution

3.01 Installation

- .1 Refer to drawings for WAP locations and provide CAT 6 cabling for each WAP unit.
- .2 Allow for site wireless survey for the final locations of WAPs.
- .3 Allow for 5 m cable slack at WAP outlets end for final location adjustment.
- .4 Wireless access points shall be installed as follows:
 - .1 Wherever possible mount APs in middle of room on dropped ceiling.
 - .2 APs are not to be mounted greater than 4.5m (15ft) AFF, whether ceiling or wall mounted. Purpose is to allow for easy maintenance and optimal RF performance.
 - .3 When installing APs in a dropped ceiling, cut discrete hole for the data cable to come through, allowing the ceiling tile to lay flat.

End of Section

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1 General

1.01 Section Includes

- .1 Modifications to existing fire alarm system, including provision of new zones as indicated, new fire alarm devices as indicated on the drawings, and system verification. Complete systems shall be left ready for continuous and efficient satisfactory operation.
- .2 Update annunciators / passive / active graphic to include additions and renovated areas, as applicable.
- .3 New devices connected directly to the existing fire alarm system shall be of the manufacturer's current product selection, and to match the existing system.

1.02 Related Requirements

- .1 Section 21 12 00 – Fire-Suppression Standpipes.
- .2 Section 21 13 00 – Fire-Suppression Sprinkler Systems.
- .3 Section 26 05 33.13 – Conduit for Electrical Systems.
- .4 Section 26 05 33.16 – Boxes for Electrical Systems.
- .5 Section 26 05 33.23 – Surface Raceways for Electrical Systems.
- .6 Latest fire alarm verification or annual inspection report.

1.03 Unit Prices

- .1 Refer to Document 00 43 00.26.
- .2 Submit with Tender unit prices to provide the following:
 - .1 Provide manual station complete with wiring and conduit based on 10 metre distance.
 - .2 Provide fire alarm horn/strobe complete with wiring and conduit, based on 10 metre distance.
 - .3 Provide smoke detector complete with wiring and conduit, based on 10 metre distance.
 - .4 Provide duct type smoke detector complete with wiring and conduit on a separate zone, based on 30 metre distance.
 - .5 Provide unit rate cost of new conduit and wire for initiation or signal circuits based on 10 metre length.
 - .6 Provide unit rate cost to replace existing heat detector.
 - .7 Provide unit rate cost to replace existing manual station.
 - .8 Provide unit rate cost to replace existing end of line resistors.

1.04 Alternates

- .1 Refer to Document 00 43 00.26.
- .2 Base bid design entails the provision of new fire alarm initiation and signal circuit wiring, unless noted otherwise on plans.

- .3 Submit with Tender as an alternate (separate) price to delete the removal of all existing fire alarm wiring, and delete the replacement of same with new wiring in existing conduits. This price will be actioned as a Change Order if it is determined during construction that the existing wiring can be re-used.

1.05 References

- .1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. Comply with latest edition/amendment referenced Code/Publication.
 - .1 2024 Ontario Building Code.
 - .2 2007 Ontario Fire Code.
 - .3 CAN/ULC-S524:2019, Standard for Installation of Fire Alarm Systems.
 - .4 CAN/ULC-S537:2019, Standard for Verification of Fire Alarm Systems.
 - .5 CAN/ULC-S1001-11, Integrated Systems Testing of Fire Protection and Life Safety Systems.
 - .6 CSA C22.1:24, Canadian Electrical Code, Part 1 (26th Edition), Safety Standard for Electrical Installations.
 - .7 Ontario Electrical Safety Code (29th edition/2024).
 - .8 All requirements of the Authority Having Jurisdiction (AHJ).

1.06 Submittals

- .1 Provide submittals to the Consultant for review in accordance with Section 01 33 00.
- .2 Submit to the Fire Department, drawings showing bells, manual stations, complete wiring diagrams and annunciator details and obtain their approval.
- .3 Shop Drawings
 - .1 Include sufficient information, clearly presented, to determine compliance with drawings and specifications.
 - .2 Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, and device arrangement.
 - .3 Show annunciator layout and main control panel module layout, configurations and terminations.
 - .4 Show device layout, complete riser diagram, and auxiliary functions.
 - .5 The supplier of the system shall prepare a complete zoning schedule and artwork layout for active graphic to be included with submittal package.
- .4 Manuals
 - .1 Submit complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets (with model numbers to be used indicated).
 - .2 Wiring diagrams indicating terminals and the interconnections between the items of equipment.
 - .3 Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment.

1.07 Closeout Submittals

- .1 Fire Alarm Verification Report.
- .2 Operation and Maintenance Manual.
- .3 Training session attendance list.

1.08 Quality Assurance

- .1 Approvals
 - .1 The system shall have proper listing and/or approval from the following nationally recognized agencies:
 - .1 ULC Underwriters Laboratories Canada.
 - .2 The fire alarm control, panel shall meet the modular listing requirements of ULC. Each subassembly of the FACP, including all printed circuit boards, shall include the appropriate ULC modular label.
 - .2 All devices/components shall be suitable for the locations, environment, temperatures in which they are to be installed.

1.09 Warranty

- .1 All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

2 Products

2.01 Existing System

- .1 The existing Fire Alarm System is as indicated on drawings alarm system.
 - .1 The location of the Fire Alarm Control Panel is as indicated on the drawings.
 - .2 There is passive graphic annunciators to be updated, location as indicated on the drawings.

2.02 Manufacturers

- .1 The system components shall be selected so as to match and be compatible with the existing Fire Alarm system.

2.03 Equipment and Material, General

- .1 Review latest verification report, and review existing system during tender walkthrough and note all required modifications.
- .2 All equipment and components shall be new, and the manufacturer's current model.
- .3 All equipment and components shall be installed in strict compliance with manufacturers' recommendations.
- .4 All Equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.04 Conduit and Wire

- .1 Existing conventional zone wiring is existing to remain.
- .2 New conduit and wire for new zones and new devices to Section 27 15 01.19.
- .3 Conduit
 - .1 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.
 - .2 All wiring shall be installed in conduit or raceway to Section 26 05 33.13 and Section 26 05 33.23.
- .4 Wire
 - .1 All fire alarm system wiring to suit new devices shall be new.
 - .2 Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as outlined in the Ontario Electrical Safety Code and as recommended by the fire alarm system manufacturer.
 - .3 All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system, as outlined in the Ontario Electrical Safety Code.
- .5 Terminal Boxes, Junction Boxes and Cabinets:
 - .1 All boxes and cabinets shall be listed for their purpose and use.

2.05 Main Fire Alarm Control Panel

- .1 Add new zones, zone modules, etc., for new work as required, and connect all new devices to Fire Alarm Control Panel.
- .2 Remote Annunciator and Passive Graphic
 - .1 Connect all new zones for the new work to annunciators.
 - .2 Provide new passive graphic, multicolour, under plexiglass with anodized frame and concealed tamperproof mounting.

2.06 Components

- .1 Programmable Electronic Sounders:
 - .1 Electronic sounders shall match existing system.
 - .2 Shall be flush mounted as required.
 - .3 Mini horns shall be provided in all classroom areas etc. and where shown.
- .2 Audible/Visual Combination Devices:
 - .1 Shall meet the applicable requirements of sounders listed above for audibility.
 - .2 Shall have a built-in strobe, 15 candela.
- .3 Strobe Synchronizing Modules:
 - .1 Synchronize strobes at 1 Hz and horns at temporal over single wire pan.

- .4 Manual Fire Alarm Stations
 - .1 Manual fire alarm stations shall be non-coded, non-breakable glass type.
 - .2 Stations must be designed such that after an actual activation, they cannot be restored to normal without the use of a special tool.
 - .3 An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 30.5 m (100 ft) front or side.
 - .4 Manual stations constructed of metal, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters 12.7 mm (1/2 in) in size or larger.
 - .5 Manual stations shall be c/w polycarbonate vandal covers.
- .5 Conventional Photoelectric Area Smoke Detectors
 - .1 Photoelectric smoke detectors shall be two wire, ceiling-mounted, light scattering type using an LED light source.
 - .2 Each detector shall contain a remote LED output and a built-in test switch.
 - .3 Detector shall be provided on a twist-lock base.
 - .4 It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
 - .5 A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall flash every 10 seconds, indicating that power is applied to the detector.
 - .6 The detector shall not go into alarm when exposed to air velocities of up to 914.4 m (3000 ft) per minute.
 - .7 The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
 - .8 All field wire connections shall be made to the base through the use of a clamping plate and screw.
- .6 Duct Smoke Detectors
 - .1 Duct smoke detectors shall be complete with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the with properly sized air sampling tubes.
- .7 Automatic Conventional Heat Detectors
 - .1 Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees F (57.2 degrees C) for areas where ambient temperatures do not exceed 100 degrees F (37.7 degrees C), and 200 degrees F (93.33 degrees C) for areas where the temperature does not exceed 150 degrees F (65.5 degrees C).
 - .2 Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
 - .3 The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.

- .4 The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
- .5 Automatic heat detectors shall have a smooth ceiling rating of 2 500 square feet (762 square metres).

2.07 Operation Sequences

- .1 The fire alarm system shall be a Zoned Single Stage Non-Coded System as defined in the Ontario Building Code.
- .2 Basic Performance:
 - .1 Initiation Device Circuits (IDC) shall be wired Class A.
 - .2 Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y).
 - .3 Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
- .3 Basic System Functional Operation:
 - .1 An alarm is caused by actuation of any one of the following devices:
 - .1 Actuation of a manual station.
 - .2 Operation of an automatic fire alarm detector.
 - .3 Operation of a sprinkler flow switch.
 - .4 Operation of a smoke detector.
 - .2 If, in any area of the building, an alarm is caused by actuation of the aforementioned devices, the following shall occur:
 - .1 Signals in the building shall sound.
 - .2 Annunciators shall indicate exact zone where alarm originated
 - .3 Fans shall be automatically turned off.
 - .3 Central station shall be automatically alerted via telephone lines connected for fire alarm system.
 - .4 If, in any area of the building, supervised valves of the sprinkler, systems are operated or exhibit short or open circuits, the following shall occur:
 - .1 The annunciator shall identify, as a separate zone, the item causing the trouble signal.
 - .2 The trouble buzzer on the annunciator(s) shall sound.
 - .3 The signals in the building shall not be sounded.

3 Execution

3.01 Examination

- .1 Do not disturb any existing devices unless absolutely necessary to facilitate installation of a new device. No existing devices are to be disturbed without specific authorization by the Project Manager.

- .2 Conduct an impedance test of initiation and signal circuits, and submit report to the Consultant. Report any discrepancies in circuit loading.

3.02 Installation

- .1 Maintain continuity of the existing fire alarm system at all times. In the event that a shutdown is required of the fire alarm system, provide a fire watch.
- .2 Install fire alarm system devices in accordance with applicable codes, and manufacturer's instructions.
- .3 Entire installation shall be done under supervision of manufacturer. Upon completion of installation, check entire system to approval and correct any malfunction immediately.
- .4 Standpipe System Connections.
 - .1 Refer to Section 21 12 00.
 - .2 Connect contact of supervisory switches to fire alarm zones indicated.
- .5 Sprinkler System Connections.
 - .1 Refer to Section 21 13 00.
 - .2 Connect contact of sprinkler flow switches and supervisory switches to fire alarm zones indicated.
- .6 Align alarm devices and signals, where grouped together, one above the other.
- .7 Mount devices at the following heights unless otherwise shown:
 - .1 Signal devices:
 - .1 300 mm below finished ceiling
 - .2 2050 mm above floor in unfinished areas.
 - .2 Manual stations:
 - .1 1200 mm above finished floor level.
 - .3 In areas with separate signal devices for fire suppression and/or pre-action, provide a lamacoid nameplate for base building signalling devices.
- .8 Manufacturer shall examine Drawings and Specifications prior to award of Contract to ensure that detectors, control panels and miscellaneous devices being supplied will provide a satisfactory working installation.

3.03 Field Quality Control

- .1 Testing and Verification
 - .1 Test each automatic detector to ensure correct wiring and zoning by setting off its rate of rise component and sounding the bells or by ringing it out. Test each smoke detector, sprinkler system and standpipe valves to ensure correct wiring.
 - .2 Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with CAN/ULC-S537.
 - .3 Check for correct connections and test for short circuits, ground faults, continuity, and insulation.

- .4 Perform audibility test of space and provide annunciation devices to suit ambient sound levels. Ensure coverage for fire alarm signalling devices on base building fire alarm system. Provide audible test of signaling devices after other systems have been commissioned to verify operation at computer room ambient sound level.
 - .5 Verify activation of all relocated devices, including flow switches, trouble, and supervisory signals from the relocated pre-action assembly.
 - .6 Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.
 - .7 All initial testing shall be in accordance with CAN/ULC-S537. A representative of the electrical contractor shall be present to participate and assist the manufacturer representative during the course of the verification. The electrical contractor shall make good any deficiencies discovered during the verification. All devices, new and existing, shall be verified. The electrical contractor shall provide one person for assistance with the verification.
 - .8 Include associated costs in Tender Price.
 - .9 Carry out a complete audibility test and submit report.
 - .10 On completion of the verification the manufacturer shall supply a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed, supervised and operational.
 - .11 Provide functional testing of interconnected systems in accordance with CAN/ULC-S1001.
- .2 Manufacturer Services
- .1 The manufacturer(s) of the fire alarm shall make a complete inspection of all existing and new components installed for system(s), such as manual stations, horns, and annunciators and sprinkler and standpipe valves and smoke detectors to ensure the following:
 - .1 That the system is complete in accordance with Specifications.
 - .2 That the system is connected according to ULC requirements.
 - .3 That the system is connected in accordance with the Manufacturer's recommendations.
 - .4 That the regulations concerning the supervision of components have been adhered to (e.g. stations, detectors, supervised valves, bells), and are properly wired and supervised.
 - .5 That all valves are properly connected and displayed correctly on each annunciator.
 - .6 That any subsequent changes necessary to conform to the above will be carried out with technical advice supplied by the manufacturer.
 - .7 That all thermal detectors, smoke detectors and manual stations have been operated and are in good working order.
 - .8 That all sprinkler system and standpipe system valves have been operated and are in good working order.
 - .9 That all annunciators correctly pinpoint the origin of any fire alarm.

- .10 That actual smoke concentration of sufficient density, have been applied to each smoke detector to cause the detector to be set off and that the sensitivity of each smoke detector has been set.
- .11 That all existing devices are in good working order. Include for replacement of any defective/damaged devices at no extra cost to Owner.
- .12 That signal audibility is acceptable in all areas. Submit audibility readings for every room.
- .13 If existing audible signal devices have been discontinued by the manufacturer (for example mechanical horns), allow for replacement of all audible devices so that all devices generate similar sounds and sound patterns when activated.

3.04 Closeout Activities

- .1 At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.
- .2 Provide instruction as required to the building personnel and fire and safety personnel. "Hands-on" demonstrations of the operation of the system shall be provided.

End of Section