

1 General

1.1 SECTION INCLUDES

- .1 Common requirements for electrical work.
- .2 Mounting heights for electrical equipment and devices.

1.2 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 Section 07 60 00 – Flashing and Sheet Metal.
- .3 Section 07 84 00 – Firestopping.
- .4 Section 08 31 00 – Access Doors and Panels.
- .5 Section 09 91 00 – Painting.
- .6 This section is to be read in conjunction with Division 00 documents, and Division 01 specification sections, which take precedence as described in CCDC 2-2008.
 - .1 General Conditions.
 - .2 Supplementary General Conditions.
 - .3 General Requirements.

1.3 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 2-2008 GC 1.1.7: 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.

1.4 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.
- .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 at no additional cost to the Owner.
- .6 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.
- .7 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.
- .8 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.
- .9 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.
- .10 Provide any fitting, offset, transformation, etc., required to suit architectural and structural details but not shown.

1.5 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.

1.6 SUBSTITUTION PROCEDURES

- .1 Refer to Division 01 and General Provisions of the Contract.
- .2 Additionally, "Approved Equal" shall be defined as an alternate approved by the Consultant.
- .3 Requests for alternates are not accepted during the bidding period.
- .4 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.
- .5 This contractor, at his option, may use equipment as manufactured by the other manufacturers if listed. 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.
- .6 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 manufacture at time of shop drawing submittal.

1.7 CONTRACT MODIFICATION PROCEDURES

- .1 When submitting quotations in response to changes in the contract, quotations for electrical work are to include a breakdown of all material, including material unit rates, and labour units as indicated in the NECA Manual of Labor Units (MLU).

1.8 COORDINATION

- .1 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.
- .2 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.
- .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. 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.
- .4 Coordinate utility service outages with the owner. Obtain permission from Owner at least 24 hours before partially or completely disabling system. Minimize outage duration.
- .5 Co-ordinate work with all trades to ensure a proper and complete installation. Notify all trades concerned of the requirement for openings, sleeves, insets 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.
- .6 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.

1.9 SUBMITTAL PROCEDURES

- .1 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).
- .2 Verify field measurements and affected adjacent Work are coordinated, including passageway clearances for movement of equipment into location.
- .3 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.
- .4 Submit a schedule of shop drawings within one week after award of contract. Group submittals by specification division as appropriate.

.5 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.

1.10 SAFETY REQUIREMENTS

- .1 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.

1.11 REGULATORY REQUIREMENTS

- .1 Codes and Standards
 - .1 Ontario Electrical Safety Code c/w 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.
- .2 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.

.3 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.

1.12 REFERENCES

- .1 Canadian Standards Association
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th 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 (OESC) 27th Edition, 2018, 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 SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
- .6 2012 Ontario Building Code.

1.13 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.14 QUALITY ASSURANCE

- .1 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.
- .2 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.
- .3 Provide quality assurance tests and operational check on all components of the electrical distribution system, all lighting fixtures, and communication systems.
- .4 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.
- .5 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.

- .6 Provide foreman in charge of this work at all times.
- .7 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.
- .8 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.
- .9 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.
- .10 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.

1.15 QUALITY CONTROL

- .1 Provide a full time Superintendent to oversee and coordinate all sub-trades in these divisions.

1.16 TEMPORARY UTILITIES

- .1 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.
- .2 The use of permanent facilities for temporary construction service will not affect in any way the commencement day of the warranty period.
- .3 Temporary heating during the construction period will be provided as described in Division 01.

1.17 TEMPORARY FACILITIES AND CONTROLS

- .1 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.
- .2 Submit temporary protection plan to Owner's Representative for approval prior to use.
- .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.

1.18 PRODUCT REQUIREMENTS

- .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 Materials and equipment are specifically described and named in this Specification in order to establish a standard of material and workmanship.
- .4 Materials required for performance of work shall be new and the best of their respective kinds and of uniform pattern throughout work.
- .5 Materials shall be of Canadian manufacture where obtainable. Materials of foreign manufacture, unless specified, shall be approved before being used.
- .6 Equipment items shall be standard products of approved manufacture. Identical units of equipment shall be of same manufacture. In any unit of equipment, identical component parts shall be of same manufacture, but the various component parts comprising the unit need not be of one manufacture.

- .7 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.
- .8 Materials shall bear approval labels as required by Code and/or Inspection Authorities.
- .9 Install materials in strict accordance with manufacturer's recommendations.
- .10 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.
- .11 Remove materials, condemned as not approved for use, from job site and deliver and install suitable approved materials in their place.
- .12 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.
- .13 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.
- .14 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.
- .15 If materials or equipment manufactured and/or supplied by a manufacturer named as acceptable are used in lieu of products of the manufacturer specified, 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 Contractor.
- .16 In addition to the manufacturers specified or named as acceptable, the Contractor may propose alternative manufacturers of equipment and/or apparatus to the Consultant for acceptance, listing in each case a corresponding credit for each alternative 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 alternative 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 alternatives, will be borne by the party making the proposal. Alternative equipment requiring greater than specified energy requirements or unduly limiting service space requirements will not be accepted.
- .17 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.

1.19 EXAMINATION AND PREPARATION

- .1 Examine 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.
- .2 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.
- .3 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.

- .4 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.

1.20 CUTTING AND PATCHING

- .1 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.
- .2 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.
- .3 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 Consultant's presence to determine if concealed services exist.
- .4 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.

1.21 CLEANING AND WASTE MANAGEMENT

- .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 electrical installation is to be left in a clean and finished condition to the satisfaction of the Consultant.
- .2 Assume responsibility for removing tools and waste materials on completion of Work, and leave Work in clean and perfect condition.

1.22 STARTING AND ADJUSTING

- .1 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.
- .2 Make tests of equipment and wiring at times requested.
- .3 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.
- .4 Supply meters, materials and personnel as required to carry out these tests.
- .5 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.
- .6 Connect single phase loads so that there is the least possible unbalance of the supply phases.
- .7 Submit all test results in report format.
- .8 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.

1.23 CLOSEOUT PROCEDURES

- .1 The Consultant will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.
- .2 Furnish a Certificate of Acceptance from Inspection Department on completion of work.

1.24 CLOSEOUT SUBMITTALS

- .1 Project Record Documents
 - .1 Extra sets of white prints will be provided on which to make, as the job progresses, all approved changes and deviations from the original drawings. Complete Record Drawings accurately marked up in red ink must be submitted for approval 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 Request CAD release form from Consultant, and submit back to Consultant.
 - .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 record drawings. Provide drawings in Adobe Acrobat 6.0, and AutoCAD release 2010.
 - .4 Submit three (3) CD's of 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 1/4 inch foam board.
 - .2 As-built Single Line Diagram to indicate manufacturer name and catalogue numbers of as-installed products.
- .2 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 Warranties

- .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.

1.25 DEMONSTRATION AND TRAINING

- .1 In the presence of the Owner, demonstrate the proper operation of all systems.
- .2 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.
- .3 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.

2 Products – Not Used

3 Execution

3.1 CONCRETE WORK

- .1 Refer to Division 03 – Concrete.
- .2 Provide all concrete work required for the electrical work. Reinstall surfacing as per architectural requirements.
- .3 Provide a 100 mm (4 inch) 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.

3.2 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.

3.3 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.

3.4 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.

3.5 FIRESTOPPING

- .1 Ensure that fire ratings of floors and walls are maintained.
- .2 Provide ULC classified firestopping products by 3M or Hilti which have been tested in accordance with CAN4-S115.
- .3 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.
- .4 Install firestopping systems using personnel trained or instructed by the product manufacturer.

3.6 ACCESS DOORS

- .1 Group conduit work to ensure the minimum number of access doors is required.
- .2 Access doors are to be installed by the trade responsible for the particular type of construction in which the doors are required.

3.7 PAINTING AND FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .2 Repair and finish factory finished equipment, damaged or scratched during installation, in an approved manner.
- .3 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.
- .4 Primary and final painting for Work, other than items specified as factory primed or finished, will be performed as described in Division 09 – Finishes.
- .5 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.
- .6 All panelboards, motor starters etc., to be factory finished with baked on enamel. All enamel to be baked on gloss over corrosion resistant primer.
- .7 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.
- .8 Protect work so that finishes will not be damaged or marred during construction. Maintain the necessary protection until completion of the work.

- .9 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.
- .10 For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.8 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.

3.9 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.
 - .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 feet).
- .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 pull stations: 1200 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 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.

3.11 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 for any physical defects.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Building wire and cable.
 - .1 Armoured cable.
 - .2 Metal clad cable.
 - .3 Wiring connectors and connections.
- .2 Permitted voltage drop for feeder and branch circuits.

1.2 REFERENCES

- .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code.
- .3 CSA C22.2 No. 0.3 - Test Methods for Electrical Wires and Cables.
- .4 CSA C22.2 No. 48-M90 (R2000) - Non-metallic Sheathed Cable.
- .5 CSA C22.2 No. 51 Armoured Cables.
- .6 CSA C22.2 No. 52-96 (R2000) - Underground Service-Entrance Cables.
- .7 CAN/CSA C22.2 No. 65-03 (CSA/UL/ANCE) – Wire Connectors.
- .8 CSA C22.2 No. 75-03 (CSA/UL/ANCE) - Thermoplastic-Insulated Wires and Cables.
- .9 CSA C22.2 No. 123 Aluminum Sheathed Cables.
- .10 CSA C22.2 No. 131 Type TECK 90 Cable.
- .11 NECA (National Electrical Contractors Association) - Standard of Installation.
- .12 NETA (International Electrical Testing Association) - ATS-2003 - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .13 CAN/ULC-S139-12 – Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data and Optical Fibre Cables.

1.3 COORDINATION

- .1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

1.4 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.5 REGULATORY REQUIREMENTS

- .1 Conform to CSA C22.1.
- .2 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

1.6 SITE CONDITIONS

- .1 Verify that field measurements are as indicated.
- .2 Conductor sizes are based on copper unless indicated as aluminum or "AL".
- .3 Wire and cable routing indicated is approximate unless dimensioned.

2 Products

2.1 MANUFACTURERS

- .1 BICC Phillips.
- .2 General Cable.
- .3 Nexans.
- .4 Prysmian.
- .5 Southwire.

2.2 BUILDING WIRE

- .1 RW90:
 - .1 Single copper conductor.
 - .2 Minimum #12 AWG for branch circuit wiring.
 - .3 Minimum #14 AWG for 120V control wiring.
 - .4 Chemically cross-linked polyethylene insulation.
 - .5 Rated for 90 degrees C, 600V
 - .6 Suitable for handling to minus 40 degrees 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 degrees C, 600 V
 - .6 Suitable for handling to minus 4 degrees C.
 - .7 For exterior installations in conduit.
- .3 T90 Nylon:
 - .1 Single copper conductor.
 - .2 Thin wall PVC insulation with nylon covering.
 - .3 Rated for 90 degrees C, 600V.
 - .4 May be used up to size 10 AWG for interior installations.
 - .5 Base conduit fill on RW90 cable diameters.

2.3 ARMoured CABLE

- .1 Description: Type AC.
- .2 Two, three or four copper conductors rated RW90, 1000 V.
- .3 Bare copper ground wire.
- .4 Insulation Voltage Rating: 600 volts.
- .5 Insulation Temperature Rating: 90 degrees C (194 degrees F).

- .6 Insulation Material: Thermoplastic.
- .7 Runs to be limited to fixture drops and in walls, maximum exposed run 1.5 m.
- .8 Do not daisy chain (leap frog) luminaires with armoured cable.

2.4 FIRE RATED CABLES

- .1 General:
 - .1 2 hour fire rating to ULC S139 and to meet 2020 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 Basis of Design: nVent Pyrotenax 1850 series.
 - .2 Alternates such as "Lifeline" installed in conduit may only be considered if listed by ULC under ULC Category Code 'FHJRC' after October 2014.
 - .3 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code 'FHJRC', dated 19 May 2015).
 - .1 Request quotation from Bhavik Jain at Cerco Cable (905.670.3777) for field certification of installed Vitalink cables prior to requesting Engineer's construction field review.
 - .2 2-Hour rated Vitalink RC90 power cable must be installed according to UL protocol FHIT7.120 – Electrical circuit integrity systems certified in Canada.

2.5 TECK90 CABLE

- .1 Single, three, or four conductors as indicated on drawings.
- .2 Cable to CAN/CSA-C22.2 No. 131.
- .3 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
 - .3 Aluminum alloy conductors (NUAL) permitted for feeders above 400 amps where 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.

2.6 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 No. 6 gauge, 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

2.7 CONDUCTORS, WIRES, AND CABLES

- .1 Indoor wiring installed in conduit, unless otherwise noted: 600 volt "RW90 XLPE".
- .2 Wiring in channel back of fluorescent lighting fixtures: 600 volt type GTF or TEW.
- .3 Lighting and power branch circuit wiring:
 - .1 Copper, minimum No. 12 gauge.
 - .2 Home runs to lighting and receptacle panels, which exceed 22 m (75 feet) in length: minimum No. 10 gauge.
- .4 Size wires for 2 per cent maximum voltage drop to farthest outlet on a maximum 80 per cent loaded circuit.
- .5 Outdoor wiring: "RWU90 XLPE".
- .6 Conductors shall be colour coded. Conductors No. 10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No. 8 gauge 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.
- .7 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
- .8 Neatly train circuit wiring in cabinets, panels, pull boxes and junction boxes and hold with nylon cable ties.

3 Execution

3.1 EXAMINATION

- .1 Voltage Drop
 - .1 Ensure voltage drop in power and control conductors is in accordance with the requirements of the Electrical Code.
 - .2 Size conductors accordingly when sizes are not identified.
 - .1 Feeder conductors: maximum voltage drop of 2 per cent.
 - .2 Branch circuit conductors: maximum voltage drop of 3 per cent.
- .2 Verify that mechanical work likely to damage wire and cable has been completed.
- .3 Verify that raceway installation is complete and supported.

3.2 PREPARATION

- .1 Completely and thoroughly swab raceway before installing wire.

3.3 INSTALLATION

- .1 Route wire and cable as required to meet project conditions.
 - .2 Install cable to CSA C22.1.
 - .3 Conduit and cable 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 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 Armoured cable (commonly referred to as BX) is only to be used for light fixture connections and limited to maximum 1830 mm in length.
 - .7 Use 10 AWG conductors for 20 ampere, 120 volt 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.
- ### 3.4 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 inches) 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.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Low-voltage control cabling.
- .2 Control-circuit conductors.

1.2 REFERENCES

- .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations
- .2 Ontario Electrical Safety Code.
- .3 CSA C22.2 No. 0.3 - Test Methods for Electrical Wires and Cables.
- .4 CSA C22.2 No. 48-M90 (R2000) - Non-metallic Sheathed Cable.
- .5 CSA C22.2 No. 51 Armoured Cables.
- .6 CAN/CSA C22.2 No. 65-03 (CSA/UL/ANCE) – Wire Connectors.
- .7 CSA C22.2 No. 75-03 (CSA/UL/ANCE) - Thermoplastic-Insulated Wires and Cables.
- .8 CSA C22.2 No. 208 - Fire Alarm and Signal Cable.
- .9 NECA (National Electrical Contractors Association) - Standard of Installation.

1.3 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.

1.4 REGULATORY REQUIREMENTS

- .1 Conform to CSA C22.1.
- .2 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

1.5 PROJECT CONDITIONS

- .1 Verify that field measurements are as indicated.
- .2 Wire and cable routing indicated is approximate unless dimensioned.

1.6 COORDINATION

- .1 Where wire and cable destination is indicated and routing is not shown, determine exact routing and lengths required.

2 Products

2.1 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 6 Network Cabling.

- .1 CMP (FT6) rated if cable is exposed.
- .2 CMR (FT4) rated if cable is installed in conduit.

2.2 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 No. 10 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 No. 8 or three No. 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

3.1 EXAMINATION

- .1 Verify that mechanical work likely to damage wire and cable has been completed.
- .2 Verify that raceway installation is complete and supported.

3.2 PREPARATION

- .1 Completely and thoroughly swab raceway before installing wire.

3.3 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 inches) at terminations, junction and pull boxes and conduit fittings. Do not paint conductors under any condition.

End of Section

1 General

1.1 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.

1.2 RELATED REQUIREMENTS

- .1 Section 27 05 26 – Grounding and Bonding for Communications Systems.

1.3 REFERENCES

- .1 Canadian Standards Association
 - .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No.0.4 - Bonding of Electrical Equipment.
 - .3 CSA C22.2 No. 41 - Grounding and Bonding Equipment.
- .2 Ontario Electrical Safety Code.
- .3 ANSI/TIA/EIA J-STD-607-A - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .4 Institute of Electrical and Electronics Engineers, Inc.: IEEE 81-1983 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.4 PERFORMANCE REQUIREMENTS

- .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.

1.5 ACTION SUBMITTALS

- .1 Product Data: Provide for grounding electrodes and connections.

1.6 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.

1.7 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.

1.8 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years' experience.

1.9 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

2.1 MANUFACTURERS

- .1 B-Line by Eaton.
- .2 Hubbell (Burndy).
- .3 Panduit.
- .4 Thomas & Betts.

2.2 GROUNDING AND BONDING CONDUCTORS

- .1 Electrical grounding conductors shall be UL 83 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.

2.3 ROD ELECTRODES

- .1 Material: Copper-clad steel.
- .2 Diameter: 19 mm.
- .3 Length: 3000 mm.

2.4 GROUND RODS

- .1 Copper clad steel, 19 mm (3/4 inch) diameter by 3000 mm (10 feet) long, conforming to UL 467.
- .2 Quantity of rods shall be as required to obtain the specified ground resistance.

2.5 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).

2.6 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.

2.7 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.

2.8 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.

2.9 MECHANICAL CONNECTORS

- .1 Material: Bronze.

2.10 WIRE

- .1 Material: Stranded copper.
- .2 Foundation Electrodes: 2/0 AWG.

- .3 Grounding Electrode Conductor: Size to meet Ontario Electrical Safety Code requirements.

2.11 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

3.1 EXAMINATION

- .1 Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 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 feet) 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.
- .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.

3.3 FIELD QUALITY CONTROL

- .1 Perform inspections and tests listed in NETA ATS, Section 7.13.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Conduit and equipment supports.
- .2 Anchors and fasteners.

1.2 REFERENCES

- .1 CSA C22.1 - Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code.
- .3 CECA - Canadian Electrical Contractors Association.

1.3 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.

1.4 REGULATORY REQUIREMENTS

- .1 Provide products listed and classified by Canadian Standards as suitable for purpose specified and shown.

2 Products

2.1 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.
- .8 Alternates as considered by the Consultant.

2.2 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.

2.3 ANCHORS AND HANGERS

- .1 Hangers for electrical conduit shall be galvanized after fabrication.
- .2 Perforated strapping: not permitted.

2.4 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.

2.5 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 inches) above finished floors, and cut flush with underside of floor.

2.6 STEEL CHANNEL

- .1 Description: Painted steel.

2.7 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 inch) diameter steel threaded rod. Use clevis type attachment.
- .4 Provide minimum 100 mm (4 inch) high concrete bases for all floor mounted equipment.

2.8 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 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.

2.9 THREADED ROD COVERS

- .1 Protect cable from abrasion caused by contact with threaded rod.
- .2 To meet UL 94V-0 specifications.
- .3 Colour: Black.
- .4 Example product: Panduit TRC18FR-X20Y.

3 Execution

3.1 INSTALLATION

- .1 Obtain permission from 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 inch) off wall.
- .5 Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- .6 Where threaded rod is exposed in data centre, provide threaded rod cover.
- .7 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.
- .8 Provide insets, holes, anchor bolts and sleeves in time when walls, floors, and roof are erected.
- .9 Provide sleeves at each place where electrical devices pass through a wall, floor or roof.
- .10 Size sleeves to provide 13 mm (1/2 inches) clearance all round.
- .11 Sleeves are not required in interior walls and dry area floors where conduit is installed ahead of floor construction.
- .12 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.
- .13 Provide all flashing and waterproofing for sleeves through roof and exterior walls to the requirements of Division 07.
- .14 Place insets only in structural members and not in the finishing material.
- .15 Secure all supports and hangers to the structure unless noted otherwise.
- .16 Suspend hanger rods from approved concrete inserts and from beam clamps. Obtain Consultant's approval before welding to steel structural members.
- .17 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.
- .18 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.
- .19 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

1.1 SECTION INCLUDES

- .1 Metal conduit.
- .2 Flexible metal conduit.
- .3 Liquid tight flexible metal conduit.
- .4 Electrical metallic tubing.
- .5 Fittings and conduit bodies.

1.2 REFERENCES

- .1 Canadian Standards Association
 - .1 CSA C22.1 – Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code.
 - .3 CAN/CSA-C22.2 No. 18 – Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .4 CSA C22.2 No. 45 – Rigid Metal Conduit.
 - .5 CSA C22.2 No. 45.1 – Rigid Metal Conduit - Steel.
 - .6 CSA C22.2 No. 56 – Flexible Metal Conduit and Liquid - Tight Flexible Metal Conduit.
 - .7 CSA C22.2 No. 83.1 – Electrical Metallic Tubing - Steel.
 - .8 CSA C22.2 No. 211.1 – Rigid Types EB1 and DB2/ES2 PVC Conduit.
 - .9 CSA C22.2 No.211.2 – Rigid PVC (Unplasticized) Conduit.
 - .10 CSA C22.2 No. 211.3 – Reinforced Thermosetting Resin Conduit (RTRC) on Fittings.
 - .11 CSA C22.2 No. 227.1 – Electrical Nonmetallic Tubing.
 - .12 CSA C22.2 No. 227.2.1 – Liquid-Tight Flexible Nonmetallic Conduit.

1.3 PROJECT RECORD DOCUMENTS

- .1 Accurately record actual routing of conduits larger than 51 mm.
- .2 Accurately record actual routing of all conduits installed below grade, regardless of size, including whether direct buried or installed in concrete duct bank.

1.4 REGULATORY REQUIREMENTS

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and shown.

1.5 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.

1.6 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 is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

2 Products

2.1 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.

2.2 CONDUIT REQUIREMENTS

- .1 Minimum size: 21 mm (3/4 inch) unless otherwise specified.
- .2 Outdoor locations, above grade: use rigid steel.
- .3 Wet and damp locations: use rigid and non-metallic tubing.
- .4 Dry locations:
 - .1 Concealed: Use electrical metallic tubing
 - .2 Exposed: Use electrical metallic tubing.

2.3 METAL CONDUIT

- .1 Rigid Steel Conduit: C22.2 No. 45.1.
- .2 Rigid Aluminum Conduit: C22.2 No. 45.
- .3 Intermediate Metal Conduit (IMC): Rigid steel.
- .4 Fittings and Conduit Bodies: Material to match conduit.

2.4 FLEXIBLE METAL CONDUIT

- .1 Description: Interlocked steel construction.
- .2 Fittings: CSA C22.2 No. 56.

2.5 LIQUID TIGHT FLEXIBLE METAL CONDUIT

- .1 Description: Interlocked steel aluminum construction with PVC jacket.
- .2 Fittings: CSA C22.2 No. 56.

2.6 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.

2.7 ELECTRICAL NONMETALLIC TUBING (ENT)

- .1 Not permitted.

2.8 CONDUIT, FITTINGS, AND ACCESSORIES

- .1 Conduit accessories, conduits and fittings conforming to CSA Standard C22.2 No. 18-1972.
- .2 Rigid conduit bushings:
 - .1 Thomas & Betts Ltd. - Series 5031.

- .3 EMT Connectors:
 - .1 Thomas & Betts Ltd. - Steel City TC 121E Series.
- .4 Ground Bushings:
 - .1 Thomas & Betts – Blackjack or 1220 Series.
- .5 Flexible conduit connectors:
 - .1 Thomas & Betts Ltd. - Series 3110.
 - .2 EMT couplings: steel concrete tight to match connectors.
- .6 Terminate rigid conduit entering boxes or enclosures with nylon insulated steel threaded bushings.
 - .1 Thomas & Betts – 8125 Series.
- .7 Terminate EMT entering boxes or enclosures with nylon insulated steel concrete tight connectors.
- .8 Terminate flexible conduit entering boxes or enclosures with nylon insulated steel connectors.
 - .1 Thomas & Betts – 5332 Series.

3 Execution

3.1 INSTALLATION

- .1 Install conduit to CSA C22.1.
- .2 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. Remove wire used for temporary supports
 - .8 Do not attach conduit to ceiling support wires.
 - .9 Route exposed conduit parallel and perpendicular to walls.
 - .10 Route conduit installed above accessible ceilings parallel and perpendicular to walls.
 - .11 Route conduit in and under slab from point-to-point.
 - .12 Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
 - .13 Provide suitable fittings to accommodate expansion and deflection where conduit crosses expansion joints.
- .3 Clearances
 - .1 Maintain adequate clearance between conduit and piping.
 - .2 Maintain 300 mm (12 inch) clearance between conduit and surfaces with temperatures exceeding 40 degrees C.
- .4 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.
- .5 Install wall entrance seals where conduits pass through exterior walls below grade.
- .6 Provide expansion coupling in conduit runs at building expansion joints and in long runs subject to thermal expansion, all in accordance with manufacturer recommendations.
- .7 Cut conduit square using saw or pipe cutter; de-burr cut ends.
- .8 Bring conduit to shoulder of fittings; fasten securely.
- .9 Use suitable caps to protect installed conduit against entrance of dirt and moisture.
- .10 Use conduit hubs or sealing locknuts to fasten conduit and to cast boxes.
- .11 Provide suitable pull string in each empty conduit except sleeves and nipples.
- .12 Ground and bond conduit to Section 26 05 26.
- .13 Identify conduit to Section 26 05 53.
- .14 Wiring Methods
 - .1 Install wiring in conduit unless otherwise specified.
 - .2 Install wiring and conduit work in a concealed manner. Surface conduit work is not permitted unless specifically noted.
 - .3 Use thin wall conduit, up to and including 53 mm (2 inch) conduit size, for branch circuit and feeder wiring in ceilings, furred spaces, and in hollow walls and partitions. Use rigid galvanized steel conduit for wiring in poured concrete, where exposed, and for conduit 65 mm or larger. Use rigid PVC conduit for wiring in slabs on grade and wiring below grade.
 - .4 Aluminium conduit may be used, in lieu of rigid steel conduit, in clean and dry locations, but shall not be used in poured concrete, or for signal and intercommunication systems wiring.
 - .5 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.
 - .6 Conduit manufacturer's touch-up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Wall and ceiling outlet boxes.
- .2 Pull and junction boxes.

1.2 RELATED REQUIREMENTS

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 27 26 – Wiring Devices: Wall plates in finished areas and fire-rated poke-through fittings.

1.3 REFERENCES

- .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations
- .2 Ontario Electrical Safety Code.
- .3 CAN/CSA-C22.2 No. 18 - Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
- .4 CSA C22.2 No. 18.1 (CSA/UL/ANCE) - Metallic Outlet Boxes.
- .5 CSA C22.2 No. 40 - Cutout, Junction and Pull Boxes.
- .6 CAN/CSA-C22.2 No. 85 - Rigid PVC Boxes and Fittings.

1.4 CLOSEOUT SUBMITTALS

- .1 Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.5 REGULATORY REQUIREMENTS

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 OUTLET BOXES

- .1 Sheet Metal Outlet Boxes: CSA C22.2 No. 18, 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.
- .3 Cast Boxes: CSA C22.2 No. 18, 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.

2.2 PULL BOXES AND JUNCTION BOXES

- .1 Sheet Metal Boxes: CSA C22.2 No. 18, galvanized steel.
- .2 Hinged Enclosures: As specified in Section 26 27 16.
- .3 Surface Mounted Cast Metal Box: CSA C22.2 No. 18, 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.

2.3 OUTLET BOXES

- .1 Conform to CSA C22.2 No. 18.

- .2 Where 103 mm (4 inch) 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 inch) octagon or square, complete with fittings, where required to support fixtures.
- .4 Switch and receptacle boxes:
 - .1 103 mm (4 inch) square with plaster ring, where flush mounted in plaster walls.
 - .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 particular 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 inch) 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 inch) 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

3.1 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 feet) 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 inch) 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 separation. Provide minimum 600 mm 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 Large pull boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.2 ADJUSTING

- .1 Adjust flush-mounting outlets to make front flush with finished wall material.
- .2 Install knockout closures in unused box openings.

3.3 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

1.1 SECTION INCLUDES

- .1 Cables installed in ducts.
- .2 Direct buried cables.

1.2 RELATED REQUIREMENTS

- .1 Section 31 23 00 – Excavation and Fill.

1.3 REFERENCES

- .1 Canadian Standards Association, (CSA International).
- .2 Insulated Cable Engineers Association, Inc. (ICEA).

1.4 SUBMITTALS

- .1 Submit records of underground utility locates, indicating location plan of existing utilities as found in field and clearance record from utility authority and location plan of relocated and abandoned services, as required.

1.5 CLOSEOUT SUBMITTALS

- .1 Record documentation:
 - .1 Records of underground utility locates.
 - .2 Record as-constructed location of all underground conduits and feeders on as-built drawings regardless of conduit size.

2 Products

2.1 FILL MATERIALS

- .1 Sand fill: clean, natural sand and gravel material, free from silt, clay, loam, friable or soluble materials and vegetable matter.
- .2 Backfill material: Selected material from excavation or other sources, reviewed by Consultant, unfrozen and free from rocks larger than 75 mm (3 inch), rock with sharp angular surfaces, cinders, ashes, sods, refuse, or other deleterious materials.

3 Execution

3.1 EXCAVATION AND FILL

- .1 In accordance with Section 31 23 00.
- .2 Trenching:
 - .1 Excavate to dimensions indicated. Ensure trench width is sufficient to accommodate mechanical vibratory compactor.
 - .2 Do not leave open trench at end of day's operation.
- .3 Backfilling
 - .1 Do not proceed with backfilling operations until Electrical Inspection Authority has inspected and approved installation.
- .4 Restoration
 - .1 Restore surface of work area to conditions existing prior to execution of work.
 - .2 After backfilling trench, provide new topsoil as required to follow minimum depths after settlement of 100 mm (4 inches) for grass seeded areas.

- .3 Restore surface of paved areas to match existing.

3.2 CABLE INSTALLATION IN DUCTS

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

3.3 DIRECT BURIAL OF CABLE

- .1 Provide sand bed as indicated.
- .2 Lay cables maintaining 75 mm (3 inch) clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .3 Provide offsets for thermal action and minor earth movements. Offset cable 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .4 Install treated planks on cables for mechanical protection. Install above cables and below markers.
- .5 Cable separation:
 - .1 Maintain 75 mm (3 inch) minimum separation between cables of different circuits.
 - .2 Maintain 300 mm (12 inch) horizontal separation between low and high voltage cables.
 - .3 When low voltage cables cross high voltage cables maintain 300 mm (12 inch) vertical separation with low voltage cables in upper position.
 - .4 At crossover, maintain 75 mm (3 inch) minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

3.4 MARKERS

- .1 Mark cable every 150 m along duct runs and changes in direction.
- .2 Mark underground splices.
- .3 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .4 Install cedar post type markers.
- .5 Lay concrete markers flat and centred over cable with top flush with finish grade.
- .1 Where warning tape is used to comply with OESC Rule 12-012(11), bury the tape approximately halfway between the installation and grade level, covering the width of the raceways or cables installed, in accordance with OESC Bulletin 12-2-(latest version).

3.5 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.

-
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
 - .5 Pre-acceptance tests:
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
 - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
 - .6 Acceptance Tests:
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.
 - .3 High Potential (Hipot) Testing.
 - .1 Conduct hipot testing in accordance with [manufacturer's] [ICEA] recommendations.
 - .7 Provide Owner with list of test results showing location at which each test was made, circuit tested and result of each test.
 - .8 Non-Conforming Work: Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.6 WASTE MANAGEMENT

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .3 Do not dispose of unused [sealant] material into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .4 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Do not dispose of preservative treated wood through incineration.
- .6 Do not dispose of preservative treated wood with other materials destined for recycling or reuse.
- .7 Dispose of treated wood, end pieces, wood scraps and sawdust at sanitary landfill approved by Departmental Representative.
- .8 Fold up metal banding, flatten and place in designated area for recycling.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 This section provides minimum acceptance requirements for vibration isolation and seismic restraints for all electrical equipment, conduit as required by codes.

1.2 RELATED REQUIREMENTS

- .1 Division 03 – Concrete.
- .2 Provide design, selection and provision of materials, installation instructions, installation and inspection of vibration isolation equipment and systems.
- .3 Select vibration isolation equipment to maintain noise levels below the NC levels in the following schedule.

AREA	NOISE CRITERIA (NC level)
Offices - private	32 to 34
-open plan	36 to 38
-business machine areas	40 to 42
-conference/boardrooms	30 to 32
Dorms	26 to 28
Public Areas	38 to 40

The requirements under this Section are in addition to the requirements for supports and vibration isolation specified in other Sections.

1.3 REFERENCE STANDARDS

- .1 Unless otherwise directed by the local authority having jurisdiction, the following codes and standards will apply:
- .1 Ontario Building Code – Latest Edition.
- .2 The following guides may be used for supplemental information on typical seismic installation practices. Where a conflict exists between the guides and these construction documents, the construction documents will preside.
- .1 Federal Emergency Management Agency (FEMA) manual 413, Installing Seismic Restraints for Electrical Equipment, January 2014.

1.4 COORDINATION

- .1 Trades shall supply necessary information to the Vibration Isolation Manufacturer regarding equipment to be isolated.
- .2 Provide shop drawings to other trades for setting anchor bolts and other appurtenances necessary for the proper installation of this equipment.

1.5 MANUFACTURER RESPONSIBILITIES

- .1 Manufacturer of vibration isolation components to:
- .1 Determine vibration isolation sizes and locations.
- .2 Supply suitable vibration isolation as required.
- .3 Supply installation instructions and drawings.
- .4 Provide trained field supervision personnel on site to insure proper installation.

- .5 Conduct site inspections of the Work in progress.
- .6 Conduct a final inspection of the Work.
- .7 Prepare a final inspection report of the installation.

1.6 SUBMITTALS

- .1 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.
- .2 Submit drawings for review showing complete details of foundations including necessary concrete and steel work, vibration isolation devices and reinforcing steel.
- .3 Provide data sheets for isolation components
- .4 Provide calculations for selection of seismic/wind restraints, certified by a qualified professional engineer, licensed in the province of Ontario.
- .5 Provide Finite Element Analysis (FEA) of all customized restraints, snubbers, and support structures such as equipment concrete housekeeping pad bases. A summary report from the analyses shall be made available to the Consultant and shall indicate compliance with the design forces for the project – including all gravity, wind and seismic loads. The report shall show locations of maximum stress and explain any allowances given for localized yielding along with safety factors.

2 Products

2.1 MANUFACTURERS

- .1 Vibration and sound control materials shall be manufactured by:
 - .1 Vibro-Acoustics.
 - .2 Kinetics Noise Control.
 - .3 Mason Industries.
 - .4 Tecoustics.
- .2 All vibration isolation and seismic/wind restraint systems shall be by one manufacturer.

2.2 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 color-coded to indicate capacity – color striping is not considered adequate.
- .2 Corrosion Protection: All springs shall be powder-coated enamel. Housings shall be galvanized, powder-coated enamel, or painted with rust-resistant paint. Hot-dipped galvanized housings shall be provided as indicated on the Schedule.
- .3 Steel Equipment Base: Bases shall be of welded construction with cross members to form an integral support platform. Structural steel members shall be designed to match supported equipment.
 - .1 Bases for exterior use shall be painted or hot-dipped galvanized for complete corrosion resistance.
 - .2 Minimum clearance under steel equipment bases shall be 25 mm (1").
- .4 Concrete Inertia Base: Inertia bases shall be of welded steel construction with concrete in-fill supplied by the installing contractor on site and shall incorporate 15M (No.4) reinforcing bars, welded 300 mm (12") maximum on centers each way.

- .1 The weight of each inertia base shall be at least equal to the weight of the equipment mounted thereon or sufficient to lower the center of gravity to or below the isolator support plane.
- .2 Inertia bases shall be a minimum of 100 mm (4") thick. (See Isolation Schedule).
- .3 Height-saving brackets or welded steel pockets shall be incorporated to ensure a 50 mm (2") minimum clearance under each inertia base.
- .5 Isolators:
 - .1 Free Spring Floor Mounted Isolators: Type FS – Free-standing, laterally stable, unhooused spring isolators with components for leveling and securing equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a ribbed neoprene pad, minimum 6 mm (0.25") thick, bonded to the base plate. Type FST – same as Type FS with the addition of an equipment support top plate.
 - .2 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 (0.25") 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 (0.5"). 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.
 - .3 Closed Mount Spring Isolators: Type CM – Floor mounted spring isolators with telescoping housings and bolts for leveling and securing equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 6 mm (0.25") thick, bonded to the base plate. Housings shall be fabricated or welded steel telescoping housings that incorporate neoprene stabilizers to minimize short circuiting and provide vertical damping.
 - .4 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.
 - .5 Spring Hangers: Vibration isolator hanger supports with steel springs and welded steel housings. Hangers shall be designed for a minimum of 15 degree angular misalignment from vertical before support rod contacts housing; hangers serving lightweight loads 0.90 kN (200 lbs) and less may be exempt from this requirement. Provide a vertical uplift stopwasher on spring hangers for seismically restrained equipment, duct or piping.
 - .1 Type SH – spring hanger isolators complete with spring, compression cup, and neoprene acoustic washer.
 - .2 Type SHR – spring hanger with neoprene isolators complete with spring, compression cup, and neoprene "double-deflection" element at top of hanger.
 - .3 Type SHB – spring hanger with bottom cup isolators complete with spring, compression cup, and neoprene cup under spring.
 - .4 Type SHRB – spring hanger with neoprene and bottom cup isolators complete with spring, compression cup, neoprene "double-deflection" element at top of hanger, and neoprene cup under the spring.
 - .5 Type PSH – precompressed spring hanger isolators complete with spring, compression cup, neoprene acoustic washer, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.
 - .6 Type PSHR – precompressed spring hanger with neoprene isolators complete with spring, compression cup, neoprene "double-deflection" element at top of hanger, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.
 - .7 Type PSHB – precompressed spring hanger with bottom cup isolators complete with spring, compression cup, neoprene cup under spring, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.

- .8 Type PSHRB – precompressed spring hanger with neoprene and bottom cup isolators complete with spring, compression cup, neoprene “double-deflection” element at top of hanger, neoprene cup under the spring, and hardware to compress spring. Springs shall be precompressed to 2/3 rated load.
- .6 Neoprene Hangers: Type NH – “Double-deflection” neoprene hanger isolators, each with an integral neoprene sleeve between hanger rod and housing. The neoprene element shall include an internal metal washer as a fail safe to prevent pull-out failure. Provide vertical uplift stopwasher on neoprene hangers for seismically restrained equipment, duct or piping.
- .7 Vibration Isolation Pads: Type N – Neoprene pad type isolators, 10 mm (0.375") minimum thick, ribbed on both sides. Type NSN – Sandwich neoprene pad type isolators, with 10 mm (0.375") 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.
- .8 Curb-mounted Spring Rail: Type RTR – Full-perimeter rail type isolator, minimum 1.6 mm (16ga) formed galvanized steel construction with integral spring isolators designed to fit over a roof curb and under the isolated equipment. Wind resistance shall be provided by means of resilient snubbers with a minimum clearance of 6 mm (0.25") so as not to interfere with the spring action except in high winds. The weather seal shall consist of continuous closed cell sponge materials both above and below the base and a waterproof, flexible EPDM connection joining the outside perimeter of the upper and lower members. The rail shall be manufactured, shipped and installed as a single piece unless its size exceeds standard shipping dimensions. Shipping splits and lifting points shall be coordinated with the installing contractor. An optional acoustic barrier system shall be provided as scheduled.

2.3 SEISMIC AND WIND RESTRAINTS

- .1 General:
 - .1 Provide positive seismic and wind restraints on those systems and components required by the applicable building code and by the local authority having jurisdiction.
 - .2 Provide restraint devices as required, specified, and as scheduled for isolated and non-isolated systems and equipment. Provide calculations to determine restraint loadings for all restrained systems and equipment resulting from seismic forces.
 - .3 See the vibration isolation and seismic restraint schedule on the drawings for equipment specific values to be used in calculating the seismic restraint forces, including component importance factor, I_p .
- .2 Vibration isolators with integral seismic restraint: Isolator housings shall be capable of withstanding the applicable design forces for the specific installation.
 - .1 Seismic Spring Floor Mounts: Type SFS – Laterally stable, restrained spring type with support for bolting to the equipment. Springs shall be supported either with a neoprene cup or a metal base plate complete with a neoprene noise isolation pad, minimum 6 mm (0.25") thick, bonded to the base plate. Mount shall include integral all-directional limit stops with elastomeric grommets preventing metal-to-metal contact and with minimum 1/4" clearance under normal operation.
 - .2 Seismic Restrained Spring Isolator: Type SCSR – Laterally stable, restrained spring type with housings and heavy top plates for supporting the equipment and resisting seismic and wind loading. Housings shall be of welded steel construction and include vertically restraining limit stops. Maximum clearance around the restraining bolts shall be 6 mm (0.25"). 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.
 - .3 Seismic Restrained Curb-mounted Spring Rail: Type RTR w/ seismic restraint – Full-perimeter rail type, minimum 16 ga formed galvanized steel construction with integral spring isolators designed to fit over a roof curb and under the isolated equipment. Seismic and wind resistance shall be provided by means of wire rope assemblies and resilient snubbers with a minimum clearance of 3 mm (0.125") so as not to interfere with the spring action under normal operation. The weather seal shall consist of continuous

closed cell sponge materials both above and below the base and a waterproof, flexible neoprene connection joining the outside perimeter of the upper and lower members. The rail shall be manufactured, shipped and installed as a single piece unless its size exceeds standard shipping dimensions. Shipping splits and lifting points shall be coordinated with the installing contractor. An optional acoustic barrier package shall be provided as required and scheduled.

- .4 Seismic Cable Restraints: Type SRK – Seismic cable sway bracing restraints shall consist of 7x19 galvanized steel aircraft cable sized to resist seismic loads with a safety factor of five (5). Cable end connections shall use heavy brackets, thimbles, and wire rope clips or compression sleeves.
- .5 Hanger Rod Stiffener: Structural steel angle attached with a formed steel clamp (Type VAC) to threaded rod support. Steel angle to be provided by contractor; steel clamp to be provided by seismic restraint manufacturer.
- .6 Seismic Restraint Brackets: Type SRB – Formed steel brackets for securing floor-mounted equipment complete with pre-drilled holes. Brackets shall be galvanized or powder coated enamel for corrosion protection.
- .7 Seismic Snubber: Structural steel angle(s) with surfaces covered with ribbed neoprene pads to cushion contact with snubber. Customized snubber designs may use other structural shapes and configurations as required. Snubbers shall be designed to limit equipment motion to no more than 6 mm (¼") in any direction.
- .8 Concrete Anchor Bolts: Post-installed anchors in concrete shall be qualified for seismic restraint application in accordance with ACI 355.2.
 - .1 Mechanical anchor bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications.
 - .2 Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications.
- .9 Grommet Washers: Type GW neoprene grommet washers, 70 durometer, of sufficient size to accommodate USS standard washers, long enough to sleeve through 6 mm (¼") plate material, and with at least 3 mm (1/8") thick material around the bolt hole.

3 Execution

3.1 INSTALLATION

- .1 Install all vibration isolation equipment in accordance with the manufacturer's instruction. Where conflict occurs between the requirements of this Section and the manufacturer's instructions, apply the most stringent requirements.
- .2 Coordinate size, doweling, and reinforcing of concrete equipment housekeeping pads and piers with vibration isolation and seismic restraint device manufacturer to ensure adequate space and prevent edge breakout failures. Pads and piers must be adequately doweled in to structural slab.
- .3 Coordinate locations and sizes of structural supports with locations of vibration isolators and seismic/wind restraints (e.g., roof curbs, cooling towers, air-cooled chillers, etc.).
- .4 Isolated and restrained equipment, duct and piping located on roofs must be attached to the structure. Supports (e.g., sleepers) that are not attached to the structure will not be acceptable.

3.2 VIBRATION ISOLATION

- .1 Block and shim all bases level so that all electrical connections can be made to a rigid system at the proper operating level, before isolators are adjusted. Ensure that there are no rigid connections or incidental physical contacts between isolated equipment and the building structure or nearby systems.

- .2 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.
- .3 Select and locate vibration isolation equipment to give uniform loading and deflection, according to weight distribution of equipment.
- .4 Extent of Conduit Isolation:
 - .1 Isolate all conduits larger than 25 mm (1") dia. rigidly connected to vibration isolated equipment with 25 mm (1") static deflection spring hangers at spacing intervals in accordance with the following:

<u>Conduit Diameter</u>	<u>Distance from Vibrating Equipment</u>
2 inches to 4 inches	50 feet
<u>Pipe Diameter</u>	<u>Distance from Vibrating Equipment</u>
50 mm to 100 mm	15 m

3.3 SEISMIC RESTRAINTS

- .1 General
 - .1 All lighting, equipment and conduits shall be restrained to resist seismic forces per the applicable building code(s) as a minimum. Additional requirements specified herein are included specifically for this project.
 - .2 Install seismic restraint devices per the manufacturer's submittals. Any deviation from the manufacturer's instructions shall be reviewed and approved by the manufacturer.
 - .3 Attachment to structure for suspended equipment, pipe and duct: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
 - .4 Wall penetrations may be used as bracing locations provided the wall can provide adequate resistance without significant damage.
 - .5 Coordinate sizes and locations of cast-in-place inserts for post-tensioned slabs with seismic restraint manufacturer.
 - .6 Provide hanger rod stiffeners where indicated or as required to prevent buckling of rods due to seismic forces.
 - .7 Where rigid restraints are used on equipment, conduits, support rods for the equipment and conduits at restraint locations must be supported by anchors rated for seismic use. Post-installed concrete anchors must be in accordance with ACI 355.2.
 - .8 Ensure housekeeping pads have adequate space to mount equipment and seismic restraint devices and shall also be large enough to ensure adequate edge distance for restraint anchor bolts to avoid housekeeping pad breakout failure.
- .2 Concrete Anchor Bolts:
 - .1 Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre- or post-tensioned tendons, electrical and telecommunications conduits
 - .2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - .3 Mechanical Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - .4 Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

.5 Set anchors to manufacturer's recommended torque, using a torque wrench.

.3 Equipment Restraints:

.1 Install fasteners, straps and brackets as required to secure all electrical equipment.

.2 Install neoprene grommet washers on equipment anchor bolts where clearance between anchor and equipment support hole exceeds 3.2 mm (0.125 inch).

.3 Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

3.4 CONDUIT SYSTEMS

.1 Unless otherwise indicated on the drawings, the component importance factor for conduit systems shall be assigned as follows:

.1 Electrical conduits: $I_p=1.5$.

.2 For projects with a Seismic Design Category of C, provide seismic cable restraints on the following:

.1 All conduit systems assigned a component importance factor, I_p , of 1.5 with a nominal pipe diameter greater than 50 mm (2") or trapeze-supported piping with combined operating weight over 15 kg/m (10 lb/ft).

.3 For projects with a Seismic Design Category of D, E or F, provide seismic cable restraints on the following:

.1 All conduit greater than 75 mm (3") nominal diameter.

.2 All conduit systems assigned a component importance factor, I_p , of 1.5 with a nominal pipe diameter greater than 25 mm (1") or trapeze-supported conduits with combined operating weight over 15 kg/m (10 lb/ft).

.4 This specification does not allow the use of the "12-inch rule" where conduit may be exempted from seismic restraint based on the length of the support rods.

.5 Restraint spacing:

.1 For conduits, space lateral supports a maximum of 12 m (40 feet) o.c., and longitudinal supports a maximum of 24 m (80 feet) o.c.

.2 For conduit risers, restrain the piping at floor penetrations using the same spacing requirements as above.

.6 Brace a change of direction longer than 3.7 m (12 feet).

.7 Longitudinal restraints for single conduit supports shall be attached directly to the conduit, not to the conduit hanger.

.8 For supports with multiple conduits (trapezes), secure conduits to trapeze member with clamps approved for application.

.9 Install restraint cables so they do not bend across edges of adjacent equipment or building structure.

.10 Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement.

.11 Install flexible connectors where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment.

.12 Coordinate seismic restraints with thermal expansion compensators, guides and anchor points. Thermal expansion anchor points shall be designed to accommodate seismic forces.

3.5 PANELBOARDS, LIGHTING, EMERGENCY LIGHTING BATTERY UNITS, AND EMERGENCY REMOTE HEADS

- .1 Wall mounted panelboards, lighting, emergency lighting battery units, and emergency remote heads can be directly mounted to the building structure with approved fasteners to suit. Minimum two or more anchors shall be provided on each side of all wall mounted equipment.
- .2 For emergency battery units, pre-installed brackets must be used.

3.6 FIELD TESTS AND INSPECTIONS

- .1 After installation, arrange and pay for the vibration isolation product manufacturer 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 installed perpendicular to bases or housing, adjustment bolts are tightened up on equipment mountings, and hangers are not cocked.
- .2 After installation, arrange and pay for the seismic restraint product manufacturer to visit the site to verify that the seismic restraint systems are installed properly, and shall submit a certificate so stating.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Nameplates and labels.
- .2 Wire and cable markers.
- .3 Conduit markers.
- .4 Receptacle labels.
- .5 Signage.

1.2 RELATED REQUIREMENTS

- .1 Section 27 05 53 – Identification for Communications Systems.

1.3 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.

1.4 REGULATORY REQUIREMENTS

- .1 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

2 Products

2.1 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 Engineer 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 approved by the Engineer prior to manufacture.
 - .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.

2.2 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.

2.3 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.

2.4 CONDUIT MARKERS

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Location: Provide markers for each conduit longer than 2 m.
- .3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .4 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
- .5 Confirm colours with Engineer prior to commencing rough-in.

2.5 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.

2.6 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

3.1 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.

3.2 CONDUIT 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 50'-0" along every exposed conduit, duct or cable run exceeding 50'-0" in length.
 - .4 At every access point on concealed conduit duct or cable.
- .2 Place labels so as to be visible from 5'-0" above adjacent floor platform.

3.3 PREPARATION

- .1 Degrease and clean surfaces to receive nameplates and labels.

3.4 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.

3.5 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 inch) diameter, sticker on emergency light fixture frame. Include circuit number on sticker with thin permanent black mark pen.

3.6 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

1.1 SECTION INCLUDES

- .1 Provide a coordination study for the new portions of electrical distribution system. The basic analysis shall include a protective device evaluation, and a protective device coordination study.
- .2 The project shall begin at the point of utility service for the facility and continue down through the system to all downstream distribution and branch panelboards, motor control centres and significant motor locations.
- .3 The project shall include any new generators and any associated emergency power distribution equipment, including automatic transfer switches and generator ground fault protection.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 73.19 – Arc-Flash Hazard Analysis.
- .2 Single Line Diagram.

1.3 REFERENCE STANDARDS

- .1 Perform all studies in accordance with the latest applicable IEEE and ANSI standards.

1.4 SUBMITTALS

- .1 Submit the following in accordance with Section 26 05 00:
 - .1 Submit for review three copies of the protection coordination study.
 - .2 Shop drawings for equipment affected by the coordination study will not be reviewed until the coordination study has been submitted and reviewed.
 - .3 Include a one-line diagram of the system.
 - .4 Bind the final report in a three-ring binder, as well as a soft copy.
- .2 Projection System Coordination
 - .1 Prepare a graph or coordination curves, prior to manufacture of service entrance and distribution equipment on K & E No. 336E Time-Current characteristic graph paper. Time-current characteristics shall be plotted of the following:
 - .1 Supply Authorities relays or fuses protecting incoming service (Contractor under this section shall obtain this information).
 - .2 Main and feeder protective devices at every voltage level used in distribution system.
 - .3 Protective devices associated with largest motor and/or refrigeration compressor.
 - .2 Preliminary submission of graph for comment will be accepted. Submit graph to Supply Authority for approval by them as providing satisfactory co-ordination. When curves have been approved by Supply Authority, they shall be submitted for approval. After approval has been obtained, order protective devices and calibrate to conform with these curves.
 - .3 Each time-current characteristic curve sheet shall include:
 - .1 A single line diagram for the portion of the system involved.
 - .2 Transformer damage curves (where applicable).
 - .3 Cable damage curves (where applicable).
 - .4 Available fault levels for the portion of the system involved.
 - .4 Consult manufacturer of the refrigeration compressors and obtain recommendations for settings on starters. Incorporate information in co-ordination curves and submit the associated curves to Compressor Manufacturer and obtain approval from the manufacturer.
 - .5 Compressor manufacturer and mechanical trade contractor will determine and calibrate proper protection on motor starters and will ensure that it co-ordinates with protective devices on switchboard.

- .6 Co-ordination curves, mentioned above, shall be prepared by distribution equipment manufacturers as soon as possible after award of contract.
- .7 At the option of this contractor under this section, these co-ordination curves may also be prepared by an independent testing organization. In this case, the independent testing organization shall determine the proper settings of all protective relays and devices and pass them on to the Switchboard manufacturer for incorporation into the switchboards. Include all associated costs in the tender.
- .8 Distribution Equipment manufacturers shall examine drawings and specifications prior to award of contract to ensure that relays and devices being supplied by them will co-ordinate satisfactorily to Supply Authority requirements. Payment will not be allowed, after award of contract, for extra charges due to device changes to comply with recommended practices, due to oversight or negligence by distribution equipment manufacturers.

1.5 QUALITY ASSURANCE

- .1 Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems and similar to the system for this project.
- .2 The study shall be prepared in accordance with the latest edition of NETA ATS, the Canadian Electrical Code, as well as manufacturer's recommendations.
- .3 Short-Circuit Analysis and Coordination Study shall be performed by a registered Professional Engineer in Ontario. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years experience in the analysis, evaluation, and coordination of electrical distribution systems.
- .4 The firm conducting the study shall have one million worth of Professional Liability Insurance in addition to standard general insurance.

2 Products

2.1 ACCEPTABLE TESTING ORGANIZATIONS

- .1 Independent Testing Organizations
 - .1 AC Tesla.
 - .2 Brosz and Associates.
 - .3 C-INTECH.
 - .4 Eastenghouse.
 - .5 Enkompass.
 - .6 G.T. Wood.
- .2 Electrical distribution manufacturers:
 - .1 Eaton.
 - .2 Schneider Electric.

2.2 PROTECTIVE DEVICE COORDINATION STUDY

- .1 Prepare coordination time-current characteristic curves to determine the required settings/sizes of the protective devices to maximize selectivity. The utility upstream protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves shall be created through the use of the study software package, but must reflect actual protective devices to be installed. Adequate time-current curves shall be generated to depict coordination. In addition, protective device characteristics shall be suitably determined to reflect calculated short-circuit levels at the location.

- .2 A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation. System coordination, recommended ratings, and setting of protective devices shall be accomplished by a registered professional electrical engineer with a minimum of eight years of current experience in the coordination of electrical power systems.
- .3 The following information shall be provided on all curve sheets.
 - .1 Device identification and associated settings/size.
 - .2 Voltage at which curves are plotted.
 - .3 Current multiplier.
 - .4 ANSI frequent fault damage curve.
 - .5 Cable insulation damage curves.
 - .6 Transformer inrush point.
 - .7 Single-line for the portion of the system.
 - .8 Motor starting profiles (where applicable).

2.3 SINGLE LINE DIAGRAM

- .1 The final report shall include a multi-color single-line diagram of the electrical distribution system within the scope of the project. The single-line shall include:
 - .2 Transformer rating, voltage ratio, impedance, and winding connection.
 - .3 Feeder cable phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
 - .4 Switchboards, panelboards, fuses, circuit breakers, ATS's and switches continuous current ratings.
 - .5 Protective relays with appropriate device numbers and CT's and PT's with associated ratios.
 - .6 Detailed legend indicating device type identification and other significant details.

3 Execution

3.1 SUMMARY

- .1 The results of the system studies shall be summarized in a final report.
- .2 Where required, copies of the final report shall be submitted to the Supply Authority for their review and approval. Approved copies or the report shall be submitted to the Consultant.

3.2 ADJUSTING

- .1 The contractor shall engage the manufacturer's service group or alternately a qualified independent testing firm to perform field adjustments of the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.
- .2 Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved protective device coordination study, shall be carried out by manufacturer's service group.
- .3 Submit a final service report confirming that settings have been completed.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 The contractor shall provide an Arc Flash Hazard Analysis Study per the requirements described in CSA-Z462 Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are obtained in CSA-Z462-08, Annex D.
- .2 The scope of the studies shall include all existing distribution equipment and all new distribution equipment supplied by the equipment Manufacturer under this contract.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 73.16 – Coordination Studies.
- .2 Single Line Diagram.

1.3 REFERENCES

- .1 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 - 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 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
 - .4 ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.
 - .3 The National Fire Protection Association (NFPA)
 - .4 OESC – Ontario Electrical safety Code
 - .5 CSA-Z462 – Workplace Electrical Safety

1.4 ACTION SUBMITTALS

- .1 Submit the protective device coordination 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.

1.5 SUBMITTALS FOR CONSTRUCTION

- .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 2462-08 Annex Q) shall be provided in hard copy only.

1.6 QUALIFICATIONS

- .1 Arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- .2 The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer or an approved engineering firm.
- .3 The Registered 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

1.7 COMPUTER ANALYSIS SOFTWARE

- .1 The studies shall be performed using the latest revision of the SKM or equivalent.

2 Products

2.1 ACCEPTABLE TESTING ORGANIZATIONS

- .1 Independent Testing Organizations
 - .1 AC Tesla.
 - .2 Brosz and Associates.
 - .3 C-INTECH.
 - .4 Eastenghouse.
 - .5 Enkompass.
 - .6 G.T. Wood.
- .2 Electrical distribution manufacturers:
 - .1 Eaton.
 - .2 Schneider Electric.

2.2 STUDIES

- .1 The contractor shall furnish an Arc Flash Hazard Analysis Study per CSA 2462-08 Standard for Electrical Safety in the Workplace, reference Section 4.1.8.2.2, 4.3.3

2.3 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.

2.4 ARC FLASH HAZARD ANALYSIS

- .1 The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in CSA Z462-08 Annex D.
- .2 The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, 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 1584-2002 section B.1.2.
- .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.

2.5 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

3.1 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.

3.2 ARC FLASH WARNING LABELS

- .1 The contractor of the Arc Flash Hazard Analysis shall provide a 3.5 inch by x 5 inch 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 low voltage switchboard, one arc flash label shall be provided.
- .5 Arc Flash Warning Label General Instruction
 - .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 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

1.1 SECTION INCLUDES

- .1 Electrical connections to equipment specified in other sections.

1.2 RELATED REQUIREMENTS

- .1 Division 08 – Openings.
- .2 Division 11 – Equipment.
- .3 Division 21 – Fire Suppression.
- .4 Division 22 – Plumbing.
- .5 Division 23 – Heating, Ventilating, and Air Conditioning.

1.3 REFERENCES

- .1 NEMA WD 1 - General Colour Requirements for Wiring Devices.
- .2 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

1.4 COORDINATION

- .1 Coordinate work to Section 26 05 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.

1.5 SUBMITTALS

- .1 Submit to Section 26 05 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.

1.6 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

2.1 COMMON MOTOR REQUIREMENTS

- .1 Motors up to and including 1/3 HP, shall be 1 phase, 60 Hz, 120 volts.
- .2 Motors 1/2 HP and above shall be 3 phase, 60 Hz, 575 volts or 208 volts.

2.2 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

3.1 WIRING OF EQUIPMENT PROVIDED UNDER OTHER DIVISIONS

- .1 Use the following procedure with regard to 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 Control wiring.
- .3 In every instance, install starter, variable frequency drivers (VFD), etc. and wire to line side of the starter or VFD. Extend wiring from starter 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, 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 Plumbing Equipment
 - .1 Ascertain exact locations of starters, 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.
- .9 HVAC Equipment
 - .1 Ascertain exact locations of starters, 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.

3.2 EXAMINATION

- .1 Verify that equipment is ready for electrical connection, wiring, and energization.

3.3 ELECTRICAL CONNECTIONS

- .1 Make electrical connections to equipment manufacturer's instructions.
- .2 Make conduit connections to equipment using flexible conduit. Use liquid-tight flexible conduit with watertight connectors in damp or wet locations.
- .3 Make wiring connections using wire and cable with insulation suitable for temperatures encountered in heat producing equipment.
- .4 Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.
- .5 Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- .6 Install disconnect switches, controllers, control stations, and control devices as indicated.
- .7 Modify equipment control wiring with terminal block jumpers as indicated.
- .8 Provide interconnecting conduit and wiring between devices and equipment where indicated.
- .9 Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

End of Section

1 General

1.1 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.

1.2 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.

1.3 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.

1.4 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.

1.5 SUBMITTALS

- .1 Conform to Section 26 05 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.

1.6 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.

1.7 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

2.1 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

3.1 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

3.2 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.

3.3 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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

3.8 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.

3.9 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 16 – Panelboards.
 - .4 Section 27 51 16 – Public Address Systems.
 - .5 Section 28 46 21.11 – Addressable 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 Architect, 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 DEMONSTRATION AND TRAINING

- .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 taped by the Commissioning Consultant.
- .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 Commissioning Consultant 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 46 21.11 – Addressable 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

Task	Contractor	Consultant	Commissioning
Manufacturer's Start-Up Checklist Completed			
Cooling System			
Inspect heat exchanger/radiator for leaks, damages and debris			
Check filter cap gasket and sealing surfaces			
Check ventilation louver operation			
Check coolant level, PH level, oil and rust contaminate			
Check hoses and connections for deterioration and tightness			
Check jacket water heater hoses for proper operation			
Check jacket water pump for leaks and unusual noises			
Check coolant conditioner concentration and temperature protection			
Check fan drive pulleys, belts and fan for proper lubrication, tension and wear, and clearance.			
Fuel System			
Verify tank has proper gauge and overfill protection device.			
Ensure the tank is installed plumb and level.			
Ensure tank is not leaking at bottom.			
Ensure proper piping of fill and vent pipe.			
Check fuel tanks for leaks and fuel level			
Test day tank pump for proper operation			
Drain off water and sediment from trap or separator			
Check fuel lines for leaks and tightness			
Check fuel line brackets for wear points			
Inspect governor oil level			
Check all governor control linkages for free movement			
Inspect primary and secondary fuel filters for leaks			
Air Induction and Exhaust System			
Inspect air filter restriction indicator for reading			
Inspect and clean air filter			
Inspect air filter housing and piping for leaks			
Inspect turbo chargers for oil/exhaust leaks			
Inspect exhaust manifolds for leaks, loose hardware and oil carry over.			
Inspect muffler and piping for leaks, loose hardware, rain cap and supports, drain muffler			
Inspect crankcase vent for restrictions or excessive blow by			
Lubrication System			
Check lube oil level and top up			
Check proper operation of oil pressure gauge			
Check hoses and piping for leaks			
Inspect unit for leaks			

Task	Contractor	Consultant	Commissioning
Starting System			
Check starting batteries for electrolyte level and specific gravity.			
Clean and check batteries for loose/corroded connections			
Load test batteries, measure voltage drop			
Inspect starter for loose connection and unusual noises			
Check battery charger output/float rate and equalize timer			
Inspect battery charger output/float rate and equalize timer			
Inspect charging alternator belts, pulleys and voltage output.			
Engine Monitors and Safety Controls			
Check operation of LOP, HWT and over speed shutdown circuits			
Inspect and test all alarms for proper operation			
Inspect wiring harness for weak and loose connections			
Check operation of engine mounted control panel and do an ATS Transfer Test if Allowed.			
Check oil pressure, water temperature, and alternator gauges for readings			
Control Panel			
Check for proper manual operation			
Operational check for correct voltmeter reading (adjust if necessary)			
Operational check for correction ammeter reading			
Operational check for correct frequency reading			
Inspect electrical connections			
Training and Demonstration			
Manufacturer's Performance Verification Checklist submitted to Cx Manager for final PV.			

End of Section

AUTOMATIC TRANSFER SWITCH			
<u>Task</u>	<u>Contractor</u>	<u>Consultant</u>	<u>Commissioning</u>
Manufacturer's Start-Up Checklist Completed			
ATS Visual Inspections			
ATS is correct voltage, ampacity			
Check terminations.			
Check for no voltage on Normal terminals with Normal source locked out and engine start disabled			
Check for no voltage on Emergency terminals with Emergency source locked out and engine start disabled			
Check ATS free from debris			
Check buswork and supporting hardware for carbon tracking, cracks, corrosion, or any other types of deterioration.			
Check stationary and movable contacts.			
Check system hardware for loose connections.			
Check all control wiring and power cables (especially wiring between or near hinged door) for signs of wear or deterioration.			
Check all control wiring and power cables for loose connections.			
Check cabinet interior for loose hardware.			
Check phase rotation.			
Tighten buswork, control wiring, power cables, and system hardware, as necessary.			
ATS Operation			
Connect the set starting batteries. Connect the normal Bypass Operation			
Verify proper operation of the battery charger.			
Test system operation by enabling test function on transfer switch and verify transfer sequence and timers.			
Test system bypass isolation operation.			
Verify Bypass/Isolation interlocks			
Verify Bypass/Isolation indicator lights.			
Close and lock the cabinet door.			
Verify engine startup and transfer to generator on loss of normal source.			
Verify engine cooldown and shutdown after transfer back to normal power.			

Verify alarm contacts.			
Training and Demonstration			
Manufacturer's Performance Verification Checklist submitted to Cx Manager for final PV.			

End of Section

1 General

1.1 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.

1.2 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.

1.3 REFERENCES

- .1 ASHRAE
 - .1 ASHRAE Guideline 0-2005 – The Commissioning Process.
 - .2 ASHRAE 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.

1.4 ACTION SUBMITTALS

- .1 Refer to Section 26 05 00.
- .2 Submit sample commissioning forms.

1.5 CLOSEOUT SUBMITTALS

- .1 Section 26 05 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

3.1 COMMISSIONING

- .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.

3.2 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

1.1 SECTION INCLUDES

- .1 Materials and installation for contactors for system voltages up to 600 V.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No.14, Industrial Control Equipment.

2 Products

2.1 CONTACTORS

- .1 Contactors shall be electrically held 60 Hz, 120 V coil; NEMA Type 1 general purpose enclosure.
- .2 Acceptable Manufacturers:
 - .1 Allen Bradley "500L" series
 - .2 Equivalent by Eaton.
 - .3 Equivalent by Schneider Electric.
 - .4 Equivalent by Siemens.

2.2 CONTACTORS

- .1 Contactors: to CSA C22.2 No.14.
- .2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
- .3 Fused switch combination contactor as indicated.
- .4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .5 Mount in CSA Enclosure 1 unless otherwise indicated.
- .6 Include following options in cover:
 - .1 Red indicating lamp.
 - .2 Hand-Off-Auto selector switch.
- .7 Provided complete with control transformer, in contactor enclosure.

3 Execution

3.1 INSTALLATION

- .1 Install contactors and connect auxiliary control devices.

3.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 53.
- .2 Size 4 nameplate indicating name of load controlled as indicated.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Occupancy and Vacancy sensors.
- .2 Power packs, and auxiliary relays, momentary switches.
- .3 Manual controls devices, including dimming switches and low voltage momentary switches.
- .4 Timer switches.
- .5 Daylight harvesting photo sensors.
- .6 Emergency lighting control units.

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

- .1 Line voltage manual control devices, as described in Section 26 27 26 – Wiring Devices.

1.3 RELATED REQUIREMENTS

- .1 Section 26 08 50 – Commissioning of Lighting.
- .2 Section 26 27 26 – Wiring Devices.
- .3 Section 26 50 00 – Lighting.

1.4 REFERENCES

- .1 Canadian Standards Association (CSA) (www.csa.ca).
 - .1 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code.
 - .3 CSA C22.2 No. 14 Industrial Control Equipment
 - .4 CSA C22.2 No. 184 - Solid-State Lighting Controls
 - .5 CSA C22.2 No. 184.1 - Solid State Dimming Controls.
 - .6 CSA C22.2 No. 156 - Solid-State Speed Controls
 - .7 CSA C22.2 No. 42.1 - Cover Plates for Flush Mounted Wiring Devices
 - .8 CSA C22.2 No. 42 - General Use Receptacles
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 WD1 (R2005) — General Color Requirements for Wiring Devices.
 - .2 WD6 – Dimensional Specifications
- .3 Ontario Building Code.
- .4 UL 924 - Standard for Safety of Emergency Lighting and Power Equipment.

1.5 SUBMITTALS

- .1 In accordance with Section 26 05 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

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Products free of defects in material and workmanship.

1.7 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

2.1 MANUFACTURERS

- .1 Wattstopper (Basis of Design).
- .2 Cooper Lighting Solutions.
- .3 Hubbell.
- .4 Leviton.
- .5 Lutron.
- .6 Sensorswitch.

2.2 GENERAL REQUIREMENTS OF ALL SENSORS AND POWER PACKS

- .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 In the event of failure, provide a bypass manual "override on" feature on each sensor.
- .4 When bypass utilized, lighting to remain on constantly, or control is to be diverted to a wall switch until sensor is replaced. The override feature is to be designed for use by building maintenance personnel and not be readily achieved by building occupants.

2.3 OCCUPANCY AND VACANCY SENSORS

- .1 General:
 - .1 Sensors using passive infrared, ultrasonic, microphonic, and multi-technology adaptive technology.
 - .2 Sensor timeouts configurable by system software.
 - .3 Electrical: Rating: 24 VDC input voltage, up to 40 mA current draw.
 - .4 Mechanical: Mounting: Sensors for mounting on ceilings and walls, including corners, must be available.
 - .5 Environmental:
 - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
 - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing.
- .2 Dual Technology Wall Switch Sensor, 24V
 - .1 Wattstopper DW-100-24-W series (Basis of Design).
 - .2 Sensor capable of detecting presence in the control area by detecting Doppler shifts in transmitted ultrasound and passive infrared heat changes.
 - .3 Utilize a dual sensing verification principle for coordination between ultrasonic and Passive Infrared (PIR) Technologies to reduce likelihood of false triggering.
 - .4 For best results, sensor shall feature a trigger mode where the end-user can choose which technology will activate the sensor from Off mode (initial), the type of detection that will reset the time delay (maintain), and the type of detection that will cause the sensor to be turned back on immediately after the lights are

- turned off due to lack of motion (re-trigger). Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
- .5 Sensor shall have its trigger mode factory preset to allow for quick installation in most applications. In this default setting, both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain the lighting on, and detection by either technology shall turn lights back on after lights were turned off for 5 seconds or less in automatic mode, and 30 seconds or less in manual mode.
 - .6 Robotic test method, as referred in the NEMA WD 7 Guide, shall be utilized for minor motion coverage verification.
 - .7 Ultrasonic sensing shall be volumetric in coverage with a frequency of 40 kHz. It shall utilize Advanced Signal Processing which automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
 - .8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall filter short wavelength IR, such as those emitted by the sun and other visible light sources. Face lens grooves in to avoid dust and residue build up which affects IR reception.
 - .9 Utilize zero crossing circuitry to reduce stress on relay, and therefore increase sensor life.
 - .10 Operate at 24 VDC and halfwave rectified and utilize a power pack or lighting control system input module to supply power.
 - .11 To blend in aesthetically, sensor protrusion not more than 3/8" from the wall and utilize colour-matched lens.
 - .12 To assure detection at desktop level uniformly across the space, sensor shall have a 28 segment, 2 level, Fresnel injection molded lens.
 - .13 Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by DIP switch.
 - .14 To avoid false ON activations and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
 - .15 Coverage up to 1,000 sq. ft. for walking motion, with a field view of 180 degrees.
 - .16 Automatic-ON or manual-ON operation, adjustable with a DIP switch.
 - .17 Sensor shall have an adjustable time delay.
 - .18 Each sensing technology shall have an LED indicator that remains active at all times, in order to verify detection within the area to be controlled.
 - .19 Sensor shall have a service switch to allow end-users to operate the sensor in the unlikely event of a failure; set by a trim pot.
 - .20 Sensor shall have a built-in light level that features simple, one-step daylighting setup that works from 8 fc to 180 fc.
 - .21 The Dual Technology wall switch sensor shall be a completely self-contained control system that replaces a standard toggle switch
- .3 Dual Technology Ceiling Mounted Sensor, 24V
- .1 Wattstopper DT-300 series (Basis of Design).
 - .2 The Dual Technology sensor shall be capable of detecting presence in the control area by detecting doppler shifts in transmitted ultrasound and passive infrared heat changes.

- .3 Sensor shall utilize Dual Sensing Verification Principle for coordination between ultrasonic or microphonic and Passive Infrared (PIR) Technologies. Detection verification of both technologies must occur in order to activate lighting systems. Upon verification, detection by either technology shall keep the lighting on.
- .4 Sensor shall have a retrigger feature in which detection by either technology shall retrigger the lighting system on within 5 seconds of being switched off.
- .5 Sensors shall be ceiling mounted with a flat, unobtrusive appearance, and provide 360 degree coverage.
- .6 Ultrasonic sensing shall be volumetric in coverage, with a frequency of 40 kHz. It shall utilize Advanced Signal Processing that automatically adjusts the detection threshold dynamically to compensate for changing levels of activity and airflow throughout a controlled space.
- .7 To avoid false ON activations, and to provide immunity to RFI and EMI, Detection Signature Analysis shall be used to examine the frequency, duration, and amplitude of a signal, in order to respond only to those signals caused by human motion.
- .8 The PIR technology shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens. The lens shall be Poly IR4 material to offer superior performance in the infrared wavelengths and filter short wavelength IR, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception.
- .9 Sensors shall operate at 24 VDC, and halfwave rectified, and utilize a 24 V power pack.
- .10 Sensors shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds.
- .11 The sensor shall have a built-in light level sensor that works from 10 fc to 300 fc.
- .12 The sensors shall feature terminal style wiring.
- .13 Each sensing technology shall have an LED indicator that remains active at all times in order to verify detection within the area to be controlled. The LED can be disabled for applications that require less sensor visibility.

2.4 POWER PACKS

- .1 General:
 - .1 Self-contained transformer and relay module.
 - .2 Internal relay controlling up to 20A for 120, 230, 277VAC or 347VAC ballast loads and 120VAC incandescent loads.
 - .3 Provide a 24 VDC, 150 mA output.
 - .4 Capable of parallel wiring without regard to AC phases on primary.
 - .5 Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.
 - .6 Construction: high impact, UL rated plastic case
 - .7 Power pack shall be UL/CUL Listed, FCC Certified, UL 2043 plenum rated and meets ASHRAE 90.1 requirements
 - .8 Shall at minimum meet the following environmental specifications:
 - .1 Operating Temperature Range: 0 degrees C to 40 degrees C
 - .2 Relative Humidity: 0 per cent to 95 per cent non-condensing

2.5 DECORATOR LOW VOLTAGE MOMENTARY SWITCHES

- .1 Wattstopper DCC2 series (Basis of Design).
- .2 Switch intended for use with power packs and sensors requiring a momentary contact switch that provides on/off signals.

- .3 12 VAC/VDC, 24 V Rectified, 24 VAC/VDC
- .4 50 mA Max. Internal Contact rating
- .5 500 mΩ resistance when closed
- .6 Single pole, double throw with center position rest.

2.6 DIMMING SWITCHES

- .1 Direct control of dimming luminaires up to the luminaire manufacturer's specified rating.
- .2 Coordinate dimming signal configuration (2-wire phase cut, 3-wire, 4-wire 0-10V, or 4-wire DALI) with the fixture ballast or driver per Section 26 50 00, lighting fixture schedule, and related sections.
- .3 Compatible with related lighting control devices i.e. occupancy sensors.
- .4 Submit luminaire manufacturer's dimmer compatibility documentation to demonstrate compatibility and limits of dimming level.
- .5 Acceptable Manufacturers:
 - .1 Lutron NovaT* style dimmers.
 - .2 Equal by Cooper.
 - .3 Equal by Philips.
 - .4 Approved Equal.

2.7 TIMER SWITCHES

- .1 Digital time switch programmable to turn loads off after a preset time.
- .2 Capable of operating as an ON/OFF switch.
- .3 Five terminal, completely self-contained control system that replaces a standard toggle switch. Switching mechanism 30 V @ 1 A air gap relay.
- .4 24 VAC when used in conjunction with power packs. For small rooms, or small localized loads, line voltage is permitted.
- .5 No minimum load requirement.
- .6 Time scroll feature permitting manual overriding of the preset time-out period. Selecting time scroll UP shall allow time-out period to scroll up throughout the timer possibilities to the maximum. Time scroll DN (down) shall allow time-out period to scroll down to minimum.
- .7 Options available for user to enable:
 - .1 One second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
 - .2 Beep warning sounding every five seconds once the time switch countdown reaches one minute.
- .8 Manual timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
- .9 Liquid crystal display (LCD) that shows the timer's countdown.
- .10 Incorporates two pulsed, open collector NPN transistor outputs for external latching relay coil drives or lighting control panel inputs.
- .11 Fit behind a decorator style faceplate. Concealed calibration switch for setting time-out, time scroll, one second light flash, and beep warning to prevent tampering of adjustments and hardware.
- .12 Time-out period adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.

- .13 Operate with power packs in order to control additional loads.
- .14 Utilize terminal style wiring.
- .15 For safety, in the event there is an open circuit in the low voltage line, automatically switch to OFF mode.
- .16 Warranty: 5 year warranty.
- .17 CUL listed.
- .18 Wattstopper TS-400 and TS-400-24 series (Basis of Design).

2.8 DAYLIGHT HARVESTING PHOTO SENSORS

- .1 General:
 - .1 Class 2, low voltage.
 - .2 Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.
 - .3 Supply an analog signal to the Lighting Control System proportional to the light measured.
 - .4 Sensor output shall provide for zero or offset based signal.
 - .5 Capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 per cent accuracy at 21 degrees C.
 - .6 Input: 10 VDC.
 - .7 Output: 0 VDC to 10 VDC.
 - .8 Flame retardant housing and meet UL 94 HB standards.
 - .9 Operating temperature: -10 degrees C to 60 degrees C.
- .2 Interior sensors: Fresnel lens, with a 60 degree cone of response. Range between 0 fc and 750 fc.
- .3 Exterior sensors: Complete with hood over the aperture to shield the sensor from direct sunlight. Outdoor sensor circuitry completely encased in an optically clear epoxy resin. Sensor range between 0 fc and 750 fc.

2.9 SEQUENCES OF OPERATION

- .1 Vacancy Sensor Operation: Manual On, Manual/Auto Off.

3 Execution

3.1 INSTALLATION

- .1 In accordance with manufacturer's instructions.
- .2 Minimum 14 AWG from the circuit control hardware relays.
- .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.

3.2 TRAINING

- .1 Provide training in accordance with Section 26 05 00.

3.3 COMMISSIONING

- .1 In accordance with Section 26 08 50.
- .2 Upon completion of the installation, the system shall be completely commissioned to verify all adjustments and sensor placement to ensure a trouble-free lighting control system.
- .3 Submit commissioning report to the Consultant and the commissioning authority for review.
- .4 Provide the Consultant and Commissioning Authority with ten working days written notice of the scheduled commissioning date.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Metering transformer cabinets.
- .2 Meter bases.
- .3 Utility Requirements.
- .4 A new service will be provided from a new padmount transformer, built to the requirements of the Local Hydro Authority as per the Standard Details.

1.2 REFERENCES

- .1 Ontario Electrical Safety Code c/w Bulletins and Amendments.
- .2 Ontario Building Code and its referenced standards.
- .3 CSA C22.2 No. 52 - Underground Service-Entrance Cables

1.3 PRE-INSTALLATION MEETING

- .1 Convene one week prior to commencing work of this section.
- .2 Review service entrance requirements and details with utility company's representatives.

1.4 ACTION SUBMITTALS

- .1 Product Data: Provide ratings and dimensions of transformer cabinets and meter bases.

1.5 INFORMATIONAL SUBMITTALS

- .1 Submit utility company's prepared drawings.

1.6 QUALITY ASSURANCE

- .1 Perform Work to utility company's written requirements.
- .2 Obtain approval from Supply Authority and Inspection Authority on complete service. Coordinate work with Utility.
- .3 Maintain one copy of each document on site.

1.7 REGULATORY REQUIREMENTS

- .1 Products: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

2 Products

2.1 SYSTEM DESCRIPTION

- .1 Electric Utility Company: Alectra Utilities
- .2 System Characteristics: 600Y volts, 3-phase, 3-wire.
- .3 Available Fault Current: Confirm with Alectra Utilities.

2.2 METERING TRANSFORMER CABINET

- .1 Manufacturers: As per Utility Requirements
- .2 Description: Sheet metal cabinet with hinged door, conforming to utility company requirements, with provisions for locking and sealing.
- .3 Dimensions: 48 inch wide by 48 inch high (depth to suit Hydro requirements).

2.3 METER BASES

- .1 Meter Base: Provided by utility company.

2.4 PT'S AND CT'S

- .1 Supplied by the utility for inclusion in main switchboard.

3 Execution

3.1 VERIFICATION OF CONDITIONS

- .1 Verify that field measurements are as indicated on utility company's drawings.

3.2 PREPARATION

- .1 Arrange with utility company to obtain permanent electric service to the project.

3.3 INSTALLATION

- .1 Local Hydro Authority will provide high voltage cable and transformer. Primary duct bank, transformer vault and pad, secondary duct, secondary cable, grounding etc., to be provided by this Division.
- .2 Utility Metering (Supplied by Local Hydro Utility - Alectra)
 - .1 Current and potential transformers for utility metering shall be in accordance with requirements of Supply Authority.
 - .2 Equipment manufacturer shall submit complete metering details for approval to utility and obtain their approval prior to manufacture.
 - .3 Compartment housing utility metering transformers shall be suitable for utility padlocking.
- .3 Metering Instruments
 - .1 A flush mounted voltmeter and a flush mounted ammeter, along with three phase selector switches and associated metering transformers shall be provided.
- .4 Work of this and related requirements
 - .1 Provision of concrete encased primary and secondary ducts, transformer vault to Local Hydro Authority requirements. Provision of fish wire in primary ducts.
 - .2 Provision of feeder from transformer to main switch.
 - .3 Grounding installation.
- .5 Work by the Local Hydro Authority
 - .1 Provision of high voltage cable.
 - .2 Provision of transformer.
 - .3 Provision of all equipment at property line.
 - .4 Termination of medium voltage cables at both ends with stress cones.
 - .5 Termination of secondary cables and ground cable(s) at transformer.
- .6 Service Entrance
 - .1 Connect to service entrance breaker as shown and as specified.
 - .2 Provide incoming and outgoing cable connections, torque same as required.
 - .3 Ground equipment as required by Code.
- .7 Provide complete shop drawings for all distribution equipment. Local Hydro Authority will provide high voltage cable and transformer. Primary duct, transformer vault, secondary duct, secondary cable, grounding etc., to be provided by this Contractor.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

1.2 REFERENCES

- .1 ANSI/ASHRAE/IES Standard 90.1-2013 -- Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 Canadian Standards Association (CSA):
 - .1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (25th Edition / 2012).
 - .3 CAN/CSA C22.2 No. 47 - Air-Cooled Transformers (Dry Type).
 - .4 CSA C802.2-18 Minimum Efficiency Values for Dry-Type Transformers.
- .3 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA ST-20 for Sound Level.
- .4 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- .5 Ontario Building Code and its referenced standards.

1.3 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.

1.4 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.

1.5 CLOSEOUT SUBMITTALS

- .1 Record actual locations of transformers in project record documents.

1.6 REGULATORY REQUIREMENTS

- .1 Products: Listed and classified by CSA (Canadian Standards Association).
- .2 Efficiency ratings:
 - .1 Meet or exceed the efficiency levels indicated in CSA C802.2-12, and ASHRAE 90.1, Table 8.1.

1.7 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.

1.8 WARRANTY

- .1 The transformer shall carry a 1 year warranty from the time of substantial performance.

2 Products

2.1 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 CAN/CSA-C22.2 No.47 and CSA-C9.
- .3 Manufacturers:
 - .1 STI.
 - .2 Delta Transformer.
 - .3 Eaton.
 - .4 Hammond.
 - .5 Powersmiths.
 - .6 Rex Power Magnetics.
 - .7 Siemens.
 - .8 Schneider Electric.
 - .9 Substitutions: permitted if approved by Consultant prior to Tender closing date.

2.2 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 ASA 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.

2.3 PRIMARY VOLTAGE

- .1 600 volts delta, 3 phase;

2.4 SECONDARY VOLTAGE

- .1 120/208 volts, 3 phase wye.

2.5 INSULATION SYSTEM AND AVERAGE WINDING TEMPERATURE RISE FOR RATED KVA AS FOLLOWS:

- .1 1-15 kVA: Class 185 with 80 degrees C rise.
- .2 16-500 kVA: Class 220 with 80 degrees C rise.

2.6 CASE TEMPERATURE

- .1 Do not exceed 35 degrees C rise above ambient at warmest point at full load.

2.7 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).

2.8 BASIC IMPULSE LEVEL:

- .1 10 kV BIL.

2.9 GROUNDING

- .1 Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.10 MOUNTING

- .1 1-15 kVA: suitable for wall mounting.
- .2 16-75 kVA: suitable for wall or floor, as shown.
- .3 Larger than 75 kVA: suitable for floor mounting.

2.11 COIL CONDUCTORS

- .1 Continuous windings with terminations brazed or welded.

2.12 ENCLOSURE

- .1 NEMA ST-20, CSA, Type 2 ventilated, Sprinkler-proof. Provide lifting eyes or brackets.

2.13 SOUND LEVELS

- .1 To NEMA ST-20 for transformers up to 300 kVA:
 - .1 Up to 9 kVA: 40 dB.
 - .2 10 – 50 kVA: 45 dB.
 - .3 51 – 150 kVA: 50 dB.
 - .4 151 – 300 kVA: 55 dB.

2.14 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.

2.15 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 53.

2.16 SOURCE QUALITY CONTROL

.1 Production test each unit according to NEMA ST-20.

3 Execution

3.1 INSTALLATION

- .1 Set transformer plumb and level.
- .2 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.
- .3 Mount wall-mounted transformers using integral flanges or accessory brackets provided by the manufacturer.
- .4 Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- .5 Mount trapeze-mounted transformers as indicated.
- .6 Provide seismic restraints.
- .7 Provide grounding and bonding to Section 26 05 26.
- .8 Mount dry type transformers up to 75 kVA, as indicated.
- .9 Mount dry type transformers above 75 kVA on floor.
- .10 Ensure adequate clearance around transformer for ventilation.
- .11 Install transformers in level upright position.
- .12 Remove shipping supports only after transformer is installed and just before putting into service.
- .13 Loosen isolation pad bolts until no compression is visible.
- .14 Make primary and secondary connections in accordance with wiring diagram.
- .15 Energize transformers after installation is complete.

3.2 FIELD QUALITY CONTROL

- .1 Section 26 05 00: Field Inspection, Testing, Adjusting.
- .2 Perform inspections and tests listed in NETA ATS, Section 7.2.

3.3 ADJUSTING

- .1 Measure primary and secondary voltages and make appropriate tap adjustments.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Power distribution panelboards – Circuit breaker type.
- .2 Lighting and Appliance Branch Circuit Panelboards.

1.2 RELATED REQUIREMENTS

- .1 Section 26 28 16.02 – Molded Case Circuit Breakers.
- .2 Section 26 43 13 – Surge Protective Devices for Low-Voltage Electrical Power Circuits.

1.3 REFERENCES

- .1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations
- .2 Ontario Electrical Safety Code (25th Edition / 2012)
- .3 CSA C22.2 No.29 - Panelboards and Enclosed Panelboards.
- .4 NEMA AB1 - Molded Case Circuit Breakers, Molded Case Switches, and Circuit - Breaker Enclosures.
- .5 NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
- .6 NEMA KS1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- .7 NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (published by the International Electrical Testing Association).
- .8 The panelboards and circuit breakers referenced herein are designed and manufactured according to the latest revision of the following specifications.
 - .1 NEMA PB 1 - Panelboards
 - .2 NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
 - .3 NEMA AB 1 - Molded Case Circuit Breakers
 - .4 CSA C22.2 No. 29-M1989 - Panelboards and Enclosed Panelboards
 - .5 CSA C22.2 No. 5-M91 - Molded Case Circuit Breakers

1.4 ACTION SUBMITTALS

- .1 Submit in accordance with Section 26 05 00.
- .2 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.
- .3 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 Engineer:
 - .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 Engineer:
 - .1 Key interlock scheme drawing and sequence of operations

.4 Submittals for Construction

- .1 The following information shall be submitted for record purposes:
 - .1 Installation information

1.5 CLOSEOUT SUBMITTALS

- .1 Refer to Section 26 05 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.

1.6 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.

1.7 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 Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.8 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.

1.9 MANUFACTURER 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

2.1 GENERAL

- .1 Description: CSA C22.2 No.29, circuit breaker type.

2.2 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 Engineer 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.

2.3 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 volt 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-ampere frame and through 100-ampere 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 amperes symmetrical at 240 volts, and 14 000 amperes symmetrical at 480 volts, 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 Lighting and receptacle panels shall be surface or flush-mounting type, as shown.
- .27 Panels shall be dead front type in code gauge steel enclosures. All panels shall be sprinkler proof c/w drip hoods as required.
- .28 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.
- .29 Where panels exceed 42 circuits, use multi-section panel with main cross-over solid bus bars. Main bus capacity of each section shall be full size to match cross-over bus.
- .30 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.
- .31 Panels for 120/208 volt, 3-phase, 4-wire systems shall be complete with full size breakers.
- .32 Where shown on drawings or required by code, certain breakers shall include ground fault interrupter.
- .33 Provide lighting and receptacle panels, surface or flush-mounting type, as shown.
- .34 Provide locking bars on non-switched circuits where panels are used for switching lighting circuits.
- .35 Panels for non-linear loads shall be complete with lugs for double neutrals.
- .36 Panels shall be given a rust-resistant treatment to both tub and trim.
- .37 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.
- .38 Surface mounted panels shall have manufacturer's standard surface door trim complete with lock and latch. Finish shall be grey.
- .39 Recessed panels shall have standard flush trims.
- .40 Co-ordinate panel finish with Room Finish Schedule.

2.4 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.
- .7 Provide breakers for externally mounted Surge Protective Devices in accordance with Section 26 43 13.

2.5 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. Key same as existing.
- .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.

2.6 BUS

- .1 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 degrees C above an ambient of 40 degrees C maximum.
- .2 A copper system ground bus shall be included in all panelboards.
- .3 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.

2.7 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.

3 Execution

3.1 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 06 10 00. 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 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 revised directories for existing panels if revised.
- .19 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.

3.2 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.

3.3 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.

3.4 FACTORY TESTING

- .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 UL standards.

3.5 CLOSEOUTS

- .1 Provide three 27 mm empty conduits from top of lighting, receptacle, telephone, signal and communication panels recessed in walls, to ceiling space.
- .2 Include a copy of each panelboard schedule in the Operation and Maintenance manual.

End of Section

1 General

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- .1 Section 26 09 23 – Lighting Control Devices.

1.3 REFERENCES

- .1 Canadian Standards Association
 - .1 CSA C22.1 - Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code.
 - .3 CSA-C22.2 No.42-99(R2004), General Use Receptacles, Attachment Plugs and Similar Devices.
 - .4 CAN/CSA-C22.2 No.42.1-00(R2004), Cover Plates for Flush-Mounted Wiring Devices (Bi-National standard, with UL 514D).
 - .5 CSA-C22.2 No.55-M1986 (R2003), Special Use Switches.
 - .6 CSA-C22.2 No.111-00(R2005), General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).
- .2 International Electrotechnical Commission (IEC)
 - .1 IEC 60309 – Plugs, socket-outlets and couplers for industrial purposes.

1.4 ACTION SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 26 05 00.
- .2 Product Data: Provide manufacturer's catalogue information showing dimensions, colours, and configurations.

1.5 INFORMATIONAL SUBMITTALS

- .1 Submit manufacturer's installation instructions.

1.6 REGULATORY REQUIREMENTS

- .1 Provide products listed and classified by CSA (Canadian Standards Association).

2 Products

2.1 MANUFACTURERS

- .1 Eaton.
- .2 Hubbell Bryant.
- .3 Molex.
- .4 Pass & Seymour (Legrand).

2.2 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 ampere, 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 volt, AC as indicated.
- .6 Current: 20 amperes.
- .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 volt:
 - .1 Hubbell HBL2121 series.
- .10 Example Products (Toggle style):
 - .1 120 volt:
 - .1 Hubbell HBL1221 (single pole).
 - .2 Hubbell HBL1222 (double pole).
 - .3 Hubbell HBL1223 (three-way).
 - .4 Hubbell HBL1224 (four-way).
- .11 Local switches and receptacles shall be of the same manufacturer throughout except where a specified item is not made by that manufacturer.

2.3 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 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U- ground type CSA Configuration 5-15R.
 - .2 20 ampere, 120 volt, single phase grounded duplex receptacle shall be NEMA-U-ground type CSA Configuration 5-20RA
 - .3 15 ampere, 120 volt, weatherproof receptacles shall be equal to those above but complete with gasketted 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 (Decorator style duplex 5-15R):
 - .1 Pass & Seymour 26252 Series.
 - .2 Hubbell HBL2152 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 of a sink must be GFCI protected.
 - .3 Any receptacle located outdoor must be GFCI protected.
- .10 Wet Location and weatherproof devices:
 - .1 Receptacles and cover plates suitable for wet locations, cover plates to provide shielding with and without a plug inserted into the receptacle in accordance with OESC rule 26-702. Cover plates to be marked "Extra Duty".
 - .2 Receptacles shall be 20A rated, GFI.

2.4 COVER PLATES

- .1 Cover plates for wiring devices to: CAN/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 Decorative Cover Plate: Polycarbonate.
 - .1 Pass & Seymour TP26W Series
- .9 Switch, receptacle, telephone and other plates shall be stainless steel 18-8 chrome metal alloy, Type 302, non-metallic in finished areas and pressed steel in unfinished areas. Finish brush marks shall be run in a vertical direction.

- .10 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 OESC rule 26-702.

2.5 RECEPTACLE CORD REELS

- .1 Retractable cable reel, mounted to structure above. 125 V, 5-15R or 5-20R (as indicated on drawings) C/W 40 feet of cabtire (or equal).
- .2 Provide framing bracket to support reel at underside of structure above.
- .3 Connect to GFCI breakers.
- .4 Manufacturers:
 - .1 Hubbell HBL-C40-123TT
 - .2 Woodhead (Molex) 997 series.
 - .3 Approved equal.

3 Execution

3.1 MOUNTING HEIGHTS

- .1 In accordance with Section 26 05 00.

3.2 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.

3.3 PREPARATION

- .1 Provide extension rings to bring outlet boxes flush with finished surface.
- .2 Clean debris from outlet boxes.

3.4 INSTALLATION

- .1 Install to CSA C22.1.
- .2 Install devices plumb and level.
- .3 Install switches with OFF position down.
- .4 Install wall dimmers to achieve full rating specified and indicated after de-rating for ganging as instructed by manufacturer.
- .5 Do not share neutral conductor on load side of dimmers.
- .6 Install receptacles with grounding pole on bottom.
- .7 Connect wiring device grounding terminal to outlet box with bonding jumper.
- .8 Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- .9 Connect wiring devices by wrapping conductor around screw terminal.
- .10 Use jumbo size plates for outlets installed in masonry walls.
- .11 Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- .12 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.
 - .13 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 for maintenance of HVAC and similar equipment located on rooftops
 - .1 Provide weatherproof GFI 5-20R receptacles on roof, installed at 750 mm (30 inches) above finished roof level, complete with wet location cover plate.
 - .2 Locate within 7500 mm (25 feet) of new HVAC equipment, and at least 1800 mm (6 feet) away from roof line.
 - .3 Refer to 2018 OESC rules 2-316, 26-708, and 26-710, and OESC bulletin 26-27-0, or latest edition.
 - .14 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.
 - .15 Circuit identification: in accordance with Section 26 05 53.
- 3.5 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.
- 3.6 ADJUSTING**
- .1 Adjust devices and wall plates to be flush and level.
- 3.7 CLEANING**
- .1 Clean exposed surfaces to remove splatters and restore finish.

End of Section

1 General

1.1 SUBMITTALS

- .1 Provide submittals in accordance with Section 26 05 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 26 05 00.

1.2 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 26 05 00.

1.3 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 26 05 00.
- .2 6 spare fuses of each type and size installed up to and including 600 A.

2 Products

2.1 MANUFACTURERS

- .1 Bussman by Eaton.
- .2 GEC.
- .3 Littelfuse.
- .4 Mersen.
- .5 Substitutions are not permitted.

2.2 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 1-600A or Class-L for 650 Amps and above.

2.3 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.

2.4 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.

3 Execution

3.1 INSTALLATION

- .1 Install fuses to manufacturer's instructions.
- .2 Install fuse with label oriented such that manufacturer, type, and size are easily read.
- .3 Provide a complete set of fuses in each fusible device supplied under this Division and provide 3 spare fuses for each size used.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Materials for Molded-Case Circuit Breakers (MCCB).
- .2 Accessories

1.2 RELATED REQUIREMENTS

- .1 Section 26 24 16 – Panelboards.

1.3 REFERENCES

- .1 CSA C22.1-12 - Canadian Electrical Code, Part I (22nd Edition), Safety Standard for Electrical Installations
- .2 Ontario Electrical Safety Code 25th Edition / 2012.
- .3 CSA-C22.2 No. 5-02, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).
- .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).

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 26 05 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 Engineer for approval.
 - .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 Engineer. Unless complying with this requirement, Engineer 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
- 2 Products
- 2.1 **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.
- 2.2 **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 panelboard and switchboard Specification Sections.
- 2.3 **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.
- 2.4 **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.
- 2.5 **MOLDED CASE CIRCUIT BREAKERS – 151 TO 399 AMPERE**
 - .1 Variable magnetic trip elements. Provide push-to-trip button on cover of breaker for mechanical tripping.
- 2.6 **MOLDED CASE CIRCUIT BREAKERS – 400 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 400 Amps.
 - .3 1000 Amp and Above:
 - .1 Modbus Communications
 - .1 Breaker status.
 - .1 Open.
 - .2 Closed.
 - .3 Tripped.

1 General

1.1 SECTION INCLUDES

- .1 Fusible and non-fusible enclosed low-voltage disconnect switches from 30 to 800 amps.

1.2 RELATED REQUIREMENTS

- .1 Section 26 28 13 – Fuses.

1.3 REFERENCES

- .1 Canadian Standards Association
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (OESC) 27th Edition, 2018.
 - .3 CAN/CSA-C22.2 No. 4-16 – 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.

1.4 SUBMITTALS FOR REVIEW

- .1 Product Data: Provide switch ratings, and enclosure dimensions.

1.5 SUBMITTALS FOR CLOSEOUT

- .1 Record actual locations of enclosed switches in project record documents.

1.6 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 Products

2.1 MANUFACTURERS

- .1 Eaton Cutler-Hammer
- .2 Siemens.
- .3 Square D by Schneider Electric.

2.2 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 1 sprinkler-proof, or as noted.
- .5 Switches throughout project of same manufacturer.

3 Execution

3.1 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 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

1.1 SECTION INCLUDES

- .1 Factory assembled packaged engine generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
- .2 Exhaust silencer and fittings.
- .3 Fuel fittings and sub-base fuel tank.
- .4 Battery and charger.
- .5 Weatherproof skin-tight sound attenuating enclosure.
- .6 Enclosure accessories.
- .7 Remote annunciator panel.

1.2 RELATED REQUIREMENTS

- .1 Section 26 36 23.13 – Bypass Isolation Automatic Transfer Switches.
- .2 Section 26 52 13.13 – Emergency Lighting.
- .3 Section 28 46 21.11 – Addressable Fire Alarm Systems.

1.3 ALTERNATIVES

- .1 The generator set manufacturer shall supply an itemized listing of optional prices to provide additional service and maintenance as per semi-annual (Table 4) and annual inspections (Table 5) identified in CSA C282 and show as an alternative price with the quotation.

1.4 REFERENCES

- .1 CSA Group:
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th Edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (27th edition/2018).
 - .3 CAN/CSA-C22.2 No. 5 – Molded-Case Circuit Breakers: Molded case switches and circuit breaker enclosures (Tri-National standard, with UL 489 and NMX-J-266-ANCE).
 - .4 CAN/CSA-C22.2 No. 94 – Special Purpose Enclosures.
 - .5 CSA C22.2 No. 100 – Motors and Generators.
 - .6 CSA C22.2 No. 141 – Emergency Lighting Equipment.
 - .7 CSA C282-15 – Emergency Electrical Power Supply for Buildings.
 - .8 CSA B139 Series-15 – Installation Code for Oil-Burning Equipment.
 - .9 CSA Z245.1-18, Steel pipe.
- .2 CCME: Canadian Council of Ministers of the Environment – Environmental Code of Practice for Aboveground and Underground Storage Tank System Containing Petroleum and Allied Petroleum Products.
- .1 Ontario Fire Code, latest edition.
- .2 O.Reg. 524/98, Environmental Compliance Approvals – Exemptions for Section 9 of the Act.
- .3 National Fire Code of Canada 2010.
- .4 Underwriters' Laboratories of Canada:
 - .1 CAN/ULC-S524 – Standard for Installation of Fire Alarm Systems.

- .2 CAN/ULC-S601 – Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids.
- .3 CAN/ULC-S661 – Standard for overfill protection devices for flammable and combustible liquid storage tanks.
- .5 Technical Standards & Safety Authority (TSSA) of Ontario:
 - .1 FS-219-26 – Fuel Oil Code Adoption Document Amendment: Ontario amendments to CSA B139-15 series.

1.5 SUBMITTALS

- .1 To Section 26 05 00.
- .2 Shop Drawings:
 - .1 Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams, including schematic and interconnection diagrams.
 - .2 Outline drawings of assembly, including sound attenuated weatherproof enclosure and accessories.
 - .3 Weight of complete assembly, including fuel.
 - .4 One line diagrams and wiring diagrams for assembly and components.
 - .5 Interconnection wiring diagrams
- .3 Product data:
 - .1 Provide data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, fuel tank, and remote radiator.
 - .2 Technical data on all major components. Technical data must include an alternator thermal damage curve, description and operating characteristics of the alternator protection device, and an alternator reactive capability curve. Alternator data demonstrating compliance to section.
 - .3 Certification of the emissions performance of the generator set engine by the engine manufacturer.
 - .4 Seismic certification, as required.
 - .5 Acoustical information of enclosure.
- .4 Test Reports: Indicate results of performance testing.
- .5 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- .6 Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- .7 Manufacturer's Field Reports: Indicate procedures and findings.
- .8 Provide four printed copies of submittals and one electronic copy.
- .9 Data for Ministry of Environment Environmental Activity and Sector Registry (Certificate of Approval).
 - .1 The maximum electrical output rating of the generator set (kW),
 - .2 Manufacturer's combustion contaminant emissions data or U.S. EPA emissions standard certification sheet.
 - .3 Layout drawing showing engine exhaust stack orientation, for generator sets installed in outdoor enclosures.

- .4 Enclosure layout drawing,
- .5 Manufacturer's enclosure noise emissions data.
- .10 Colour samples for custom enclosure colour.
- .11 Project information:
 - .1 Test reports and certifications.
 - .2 Factory test procedures.
- .12 Contract closeout information: Operating and maintenance data.

1.6 CLOSEOUT SUBMITTALS

- .1 AHJ inspection documentation:
 - .1 Fuelling compliance certificate.
 - .2 Variance approval correspondence, as applicable.
- .2 Maintenance Contracts
 - .1 Manufacturer to maintain model and serial number records of each generator set provided for at least 20 years.
 - .2 The manufacturer shall itemize the complete offering of preventative and full-service maintenance contracts for the generator with submission, as described for each maintenance period described below.
 - .3 Maintenance service as part of base bid submission:
 - .1 Provide 7 x 24 x 365 service and maintenance of Generator for two years from Date of Substantial Completion. Price is to include two (2) full service maintenance program visits per each year.
- .3 Operation and Maintenance Data
 - .1 Operation Data: Include instructions for normal operation.
 - .2 Maintenance Data: Include instructions for routine maintenance requirements, service manuals for engine and fuel tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.
 - .3 Provide electronic copies of all documents, test data, shop drawings, etc.
- .4 Training records including attendance sheet, date, and training syllabus.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide three copies of maintenance materials.
- .2 Spare Parts
 - .1 Provide two of each of the following:
 - .1 Fuel oil filter element.
 - .2 Lube oil filter element.
 - .3 Air filter element.
 - .4 Fuel water separator.
- .3 Tools: provide one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal tool box.

1.8 MANUFACTURER'S QUALIFICATIONS

- .1 The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

- .2 The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
- .3 The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.
- .4 The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
- .5 The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Consultant, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- .6 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience, and with service facilities within 160 km of project.
- .7 Supplier: Authorized or franchised distributor of specified manufacturer with minimum three years documented experience.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Store equipment in original, undamaged package.
- .2 Deliver to the project site in manufacturer's original wrapping and containers, labelled with manufacturer's name, product information, etc.
- .3 Coordinate delivery date and time with the Owner and equipment supplier.
- .4 Installing contractor to accept unit on site, inspect for damage, provide craning c/w spreader bars, and install equipment.

1.10 WARRANTY

- .1 Warrant the material and workmanship of the generator set and associated equipment for a minimum of [two] years from registered commissioning and start-up, or 30 months from date of arrival on site.
- .2 The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.
- .3 Warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Service of the generators sets to be performed by technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier.

2 Products

2.1 MANUFACTURERS

- .1 Manufacturer List:
 - .1 Cummins Power Generation, (Basis of Design).
 - .2 Caterpillar.
 - .3 Gal Power.
 - .4 Kohler Power Systems.
 - .5 LMR Power Systems.
 - .6 Sommers.
 - .7 Wajax Power Systems (MTU Onsite Energy).

- .2 Substitution Limitations: Only approved bidders shall supply equipment provided under this contract. Proposals must include a line-by-line compliance statement based on this specification.

2.2 REGULATORY REQUIREMENTS

- .1 Generator set to be listed and labelled by a certification organization accredited by the Standards Council of Canada.
- .2 Comply with all applicable EPA emissions standards at the date of installation.
- .3 Conform to requirements of CSA C22.1, the Ontario Electrical Safety Code, and other requirements of the Electrical Safety Authority (ESA).
- .4 Conform to all requirements of CSA C282.
- .5 Provide products listed and classified by CSA (Canadian Standards Association) as suitable for purpose specified and indicated.
- .6 Installation in accordance with the National Fire Code of Canada.

2.3 GENERATOR SET

- .1 Ratings
 - .1 The generator set shall operate at 1800 rpm and at a voltage of: 600 Volts AC, three phase, 3-wire, 60 Hz.
 - .2 The generator set shall be rated per ISO 8528 at [200 kW] at 0.8 PF, standby rating, based on site conditions of:
 - .1 Altitude: 914 meters (3000 feet).
 - .2 Ambient temperatures up to 40 degrees C (104 degrees F)
 - .3 Emissions:
 - .1 25 kW to 300 kW – EPA Tier 3 certified.
 - .4 Standby rating, based on site conditions of: Altitude 400 meters above sea level, ambient temperatures of 40 degrees C, based on temperature measured at the control for indoor installations, and measured at the air inlet closest to the alternator for outdoor equipment.
- .2 Performance
 - .1 Voltage regulation to not exceed one percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load to not exceed plus or minus 0.5 percent.
 - .2 Frequency regulation to be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
 - .3 The engine-generator set to be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine generator set at operating temperature.
 - .4 Motor starting capability shall be a minimum of [920 kVA]. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
 - .5 Alternator: produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic, and no 3rd order harmonics or their multiples. Telephone influence factor shall be less than 40.
 - .6 The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

- .7 The time required to automatically start, accelerate to rated speed and voltage, synchronize and parallel all generator sets to the system bus on a normal power failure shall not exceed 15 seconds, assuming that the generator sets are in an ambient temperature of 15 degrees C or greater, and water jacket heaters are operating properly.
- .8 The generator set, complete with sound attenuated enclosure, shall be tested by the generator set manufacturer per ANSI S1.13. Data documenting performance shall be provided with submittal documentation.
- .3 Construction
 - .1 Engine generator set mounted on a heavy-duty steel base to maintain alignment between components. The base to incorporate a battery tray with hold-down clamps within the rails.
 - .2 All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.
- .4 Connections
 - .1 Load connections composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the quantity and size as shown on the drawings.
 - .2 Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
 - .3 Generator set control interfaces to other system components made on a common, permanently labeled terminal block assembly.

2.4 ENGINE AND ENGINE EQUIPMENT

- .1 Diesel engine, 4 cycle, radiator and fan cooled. Minimum displacement 23.1 litres, with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable. Engine accessories and features shall include:
 - .1 An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.
 - .2 Skid-mounted radiator and cooling system rated for full load operation in 50 degrees C ambient as measured at the generator air inlet, based on 0.5 inches H2O external static head. Radiator sized based on a core temperature which is 10 degrees C higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.
 - .3 Electric starters capable of three complete cranking cycles without overheating.
 - .4 Positive displacement, mechanical, full pressure, lubrication oil pump.
 - .5 Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
 - .6 An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

- .7 Replaceable dry element air cleaner with restriction indicator.
- .8 Flexible supply and return fuel lines.
- .9 Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
- .2 Coolant heater
 - .1 Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. The coolant heater shall be UL499 listed and labeled.
 - .2 The coolant heater shall be installed on the engine with SAEJ20 compliant materials. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using isolation valves to isolate the heater for replacement of the heater element. The design shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
 - .3 The coolant heater shall be provided with a 24 V DC thermostat, installed at the engine thermostat housing. An AC power connection shall be provided for a single AC power connection to the coolant heater system.
 - .4 Coolant heater(s) sized as recommended by the engine manufacturer to warm the engine to a minimum of 40 degrees C in a 15 degree C ambient, in compliance with CSA C282 requirements, as a minimum, or the temperature required for starting and load pickup requirements of this section.
- .3 Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location
- .4 Starting and Control Batteries: lead acid type, 24 volt DC, sized as recommended by the engine manufacturer for compliance to CSA C282 starting requirements, complete with battery cables and connectors.
- .5 Exhaust Silencer
 - .1 Provide exhaust silencer for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer.
 - .2 The silencer shall be selected by the manufacturer to suit the overall noise rating of the enclosed unit in Article 2.10.
 - .3 Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.
 - .4 Complete exhaust system to be installed within the enclosure, with vertical exhaust discharge.
- .6 Provide fully regulated, constant voltage, current limited, multi-rate battery charger(s) for the generator set. The chargers shall be designed for heavy-duty industrial service, primarily to quickly recharge and maintain batteries that start internal combustion engines. Charger shall be rated a minimum of 12 amps, and be capable of operating in parallel with another like charger for reliability and added charging capacity.
 - .1 Charger shall provide 4 distinct charge states: "dead battery", "bulk charge", "absorption", and "float". Charge rate shall be temperature compensated to provide proper charging in ambient conditions from – 20 degrees C to +55 degrees C.
 - .2 Provide LED indication of general charger condition, including charging, fault, and equalize. Provide a 2 line LCD display to indicate charge rate, battery voltage, faults, and provide for charger set up. Charger shall provide relay contacts for fault conditions as required by CSA C282.
 - .3 The charger shall operate properly during fault conditions, including battery disconnection while charging, reversed battery polarity connections, and shorted battery.

- .4 The charger shall be compliant to the same RFI/EMI and voltage surge performance as are specified for the genset control.

2.5 LOW VOLTAGE AC ALTERNATOR

- .1 The AC alternator shall be; synchronous, four pole, 2/3 pitch, brushless, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. The alternator design shall prevent shaft current from flowing and eliminate the need for insulated bearings. All insulation system components shall meet NEMA MG1 requirements for Class H insulation systems. Actual temperature rise measured by resistance method at full load shall not exceed 105 degree C in a 40 degree C ambient.
- .2 The alternator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage up to 5 percent above or below rated voltage.
- .3 A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.
- .4 The alternator shall be supplied with a dedicated, independent power source for the voltage regulation system, which provides sufficient excitation for the alternator to supply 300 per cent of rated output current for 10 seconds.
- .5 The subtransient reactance of the alternator to not exceed 15 per cent, based on the standby rating of the generator set.
- .6 Provide an anti-condensation heater for the alternator for generator sets installed outdoors or in unheated environments.
- .7 Provide two embedded resistance temperature detectors per phase and temperature indication equipment. The control system shall annunciate high alternator temperature as a fault condition.
- .8 The alternator shall be capable of operation with reverse kVAR of 0.15 per unit.

2.6 GENERATOR SET CONTROL

- .1 The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, protection, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification.
- .2 The control shall be mounted on the generator set in an accessible location. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- .3 The generator set mounted control shall include the following features and functions:
 - .1 Control Switches
 - .1 Mode Select Switch.
 - .1 The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
 - .2 EMERGENCY STOP switch.
 - .1 Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from

- automatic restarting. The switch shall include a lockout provision for use in safely disabling the generator set for necessary service.
- .2 Locate inside Generator Enclosure.
- .3 RESET switch.
 - .1 The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
- .4 PANEL LAMP switch.
 - .1 Operating the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is operated, or after the switch is operated a second time.
- .5 Voltage and Frequency Adjustment. The genset mounted control shall include digital raise/lower switches for adjustment of voltage and frequency.
- .2 Generator Set AC Output Metering
 - .1 Digital metering set, 1% accuracy, to indicate generator RMS voltage and current, frequency, output current, output kW, kWh, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three-phase voltages (line to neutral or line to line) simultaneously.
 - .2 Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (kW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Both analog and digital metering are required.
 - .3 The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments. The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.
 - .4 The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.
 - .5 Generator Set Alarm and Status Display.
 - .1 The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of all alarm, shutdown, and status conditions associated with the generator set, including all paralleling control functions and the engine ECM on an alphanumeric display on the genset. The following alarm, shutdown, and status conditions are required, as a minimum:
 - .1 low oil pressure (alarm)
 - .2 low oil pressure (shutdown)
 - .3 oil pressure sender failure (alarm)
 - .4 low coolant temperature (alarm)
 - .5 high coolant temperature (alarm)
 - .6 high coolant temperature (shutdown)
 - .7 engine temperature sender failure (alarm)
 - .8 low coolant level (alarm or shutdown--selectable)
 - .9 fail to crank (shutdown)

- .10 fail to start/overcrank (shutdown)
 - .11 overspeed (shutdown)
 - .12 low DC voltage (alarm)
 - .13 high DC voltage (alarm)
 - .14 weak battery (alarm)
 - .15 low fuel day-tank (alarm)
 - .16 high AC voltage (shutdown)
 - .17 low AC voltage (shutdown)
 - .18 under frequency (shutdown)
 - .19 over current (warning)
 - .20 over current (shutdown)
 - .21 short circuit (shutdown)
 - .22 ground fault (alarm)
 - .23 over load (alarm)
 - .24 emergency stop (shutdown)
 - .2 Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.
- .3 Engine Status Monitoring
 - .1 The following information shall be available from a digital status panel on the generator set control:
 - .1 engine oil pressure (psi or kPa)
 - .2 engine coolant temperature (degrees F or C)
 - .3 engine oil temperature (degrees F or C)
 - .4 engine speed (rpm)
 - .5 number of hours of operation (hours)
 - .6 number of start attempts
 - .7 battery voltage (DC volts)
 - .2 The control system shall also incorporate a data logging and display provision to allow logging of a minimum of the last 20 warning or shutdown indications on the generator set, the time of the last fault of each type, and the number of faults of each type, and total time of operation at various loads as a percent of the standby rating of the generator set.
- .4 Engine Control Functions:
 - .1 The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
 - .2 The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
 - .3 The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

- .4 The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
- .5 Alternator Control Functions:
 - .1 The generator set shall include an automatic microprocessor-based voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The voltage regulation system shall be based on a full wave rectified input, pulse-width modulated output design. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below an adjustable frequency threshold. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
 - .2 Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown).
 - .3 Controls shall be provided to individually monitor all three phases of the output current for 1, 2, or 3-phase short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).
 - .4 Controls shall be provided to monitor the kW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
 - .5 An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.
 - .6 A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC
 - .7 During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
 - .8 The control System shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8-1200 amps, and include adjustable time delay of 0-10.0 seconds. The relay shall be for indication only, and not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that will function correctly in system as installed.
- .6 The generator set shall be provided with a network communication module to allow real time communication with the generator set control by remote devices. The control shall communicate all engine and alternator data; alarm, shutdown and status conditions; and allow starting and stopping of the generator set via the network in both test and emergency modes.
- .4 Provide and install a 20-light LED type remote alarm annunciator with horn, located as shown on the drawings or in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the

audible and visual alarms called for by CSA 282; and in addition shall provide indications for high battery voltage, low battery voltage, loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switch(es) shall be provided. LED lamps shall be replaceable, and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn (when switched on) shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared.

- .5 The generator set shall be provided with a utility grade protective relay, designed to provide thermal overload protection for the alternator, and performance certified for that purpose by a 3rd party testing organization. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. Relay shall be installed to allow shutdown of the generator excitation system on an alternator overload condition, with the engine operating for a cool-down period before shutdown. The relay shall not include an instantaneous trip function.

2.7 CONTROL INTERFACES FOR REMOTE MONITORING

- .1 No field connections for control devices shall be made in the AC power output enclosure. Provide the following features in the control system:
- .1 Form "C" dry contact set rated 2 A @ 30 VDC to indicate existence of any alarm or shutdown condition on the generator set.
 - .1 Warning Alarms
 - .1 Common Alarm
 - .2 High Battery Voltage
 - .3 Low Battery Voltage
 - .4 Charger AC Failure
 - .5 Pre-High Engine Temperature
 - .6 Pre-Low Oil Pressure
 - .7 Low Engine Temperature
 - .8 High Engine Temperature
 - .9 Low Oil Pressure
 - .10 Low Coolant Level
 - .11 Low Fuel Level
 - .2 Critical Alarms
 - .1 Fail to Start
 - .2 Low Fuel
 - .3 Overspeed
 - .3 Information Contacts
 - .1 Genset Running
 - .2 Genset Not in Auto
 - .2 One set of contacts rated 2 A @ 30 VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
 - .3 A fused 10 amp switched 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
 - .4 A fused 20 amp 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

2.8 CIRCUIT BREAKERS

- .1 CAN/CSA-C22.2 No. 5, molded case circuit breakers on generator output with integral thermal and instantaneous magnetic trip in each pole, sized to CSA C22.1. Include battery-voltage operated shunt trip, connected to open circuit breakers on engine failure. Unit mount in enclosure to meet CSA C22.2 No. 100, Type 1 requirements.
- .2 Bolt-on, molded case, temperature compensated for 40 deg. C ambient, dual thermal-magnetic trip. Electronic trip type with adjustments for long-time, instantaneous and short-time functions.
- .3 Breaker status dry contacts for remote monitoring of the following functions:
 - .1 Breaker contact status (Open / Closed).
 - .2 Breaker trip status.
- .4 Schedule of generator output circuit breakers:
 - .1 Generator Output Breaker to feed emergency side of Automatic Transfer Switches.
 - .1 Equipped with shunt trip capability.
 - .2 Load Bank Breaker
 - .1 Rating and ampacity of load bank breaker to match generator output breaker.
 - .2 Equipped with shunt trip capability to ensure that the breaker will be tripped during testing upon receiving engine start signal from Automatic Transfer Switch. Electrical contractor to provide cables from ATS to breaker to suit manufacturer's instructions.
 - .3 Provide lugs allowing ease of connection for load bank cables.

2.9 REMOTE ANNUNCIATION AND MONITORING

- .1 Provide remote annunciator panel for field installation by installing Contractor.
- .2 Provide NIC Card for SNMP Monitoring.

2.10 WEATHERPROOF SKIN-TIGHT ENCLOSURE

- .1 Sound attenuating enclosure with sound attenuation to provide sound levels of no greater than 75 dB(A) at 7 m perimeter.
- .2 To suit conduit entry from below grade.
- .3 Access doors with key locks, welded hinges, and door lock port hole to keep door open during maintenance.
- .4 Primed for corrosion protection and finish painted in a custom colour to be selected by the Owner and confirmed at submittal review.
- .5 Interior of enclosure to consist of high reflectance materials to improve light levels when servicing or maintaining unit.

2.11 ACCESSORIES

- .1 Factory provided accessories in the generator enclosure prewired to a panelboard in the generator enclosure:
 - .1 Heating:
 - .1 Battery thermal wrap, 120 volt, minimum 75 watts per battery to maintain battery temperature of 27 degrees C (80 degrees F), and complete with thermostat to eliminate batter damage caused by overheating or acid spill.
 - .1 Basis of design: HOTSTART, Inc., KBW series.
 - .2 Motorized intake dampers, 5 kW 208 volt 3-phase forced flow heater in enclosure complete with reverse acting thermostat for control to maintain 10 degrees C at all times.
 - .3 Engine block circulating coolant heater with thermostat sized to engine manufacturer's recommendations.

- .2 Lighting:
 - .1 Emergency battery unit complete with 2 hours runtime on loss of utility power and complete with two MR16 LED heads, light output equivalent to two 20 W MR16 incandescent lamps, in accordance with CSA C282 clause 6.11.1.
 - .1 Minimum illumination: 50 lx (5 fc).
 - .2 Battery units shall include automatic self-diagnostic circuitry, and a surge protection device (SPD) on the supply site of power to the unit.
 - .3 Battery unit to be c/w CSA 5-15 plug and plugged into a dedicated emergency lighting receptacle installed immediately adjacent to the battery unit.
 - .3 Minimum one 5-15R GFI duplex receptacle on generator (in addition to the battery unit receptacle).
 - .4 If spring isolators are to be used, provide generator frame-bottom metal sealing plate to maintain heat inside enclosure, proper directionality of airflow, maintain noise rating, and prevent animal ingress.
 - .5 Other accessories as indicated on the generator enclosure layout drawing, and as required for a complete operating system, and as recommended by the generator manufacturer.
 - .6 Accessories to be fed from a panelboard pre-installed within the generator enclosure, rated 100 A 120/208V, 3-Ph, 4W, 10 kA IC, c/w main breaker, and c/w full size, bolt-on breakers, installed with vibration isolation from the generator enclosure.
 - .1 Single phase, or plug-on breaker panelboard, or panelboard installed outside the skin-tight enclosure will be rejected and field replaced at manufacturer's expense.
 - .2 Acceptable panelboard and circuit breaker manufacturers:
 - .1 Eaton PRL1 series.
 - .2 Schneider Electric NQ series.
 - .3 Siemens equal.
- .2 Supplier to include an inspection for unit enclosure and generator accessories by the Electrical Authority Having Jurisdiction (ESA in Ontario) prior to shipment to site. Submit ESA inspection report to Consultant.

2.12 SUB-BASE FUEL TANK

- .1 Fuel tank of sufficient capacity to enable minimum 48 hour runtime at full load.
- .2 Approvals:
 - .1 CAN/ULC-S601.
 - .2 TSSA (Technical Standards and Safety Authority) certified.
- .3 Construction:
 - .1 Sub-base type.
 - .2 Double walled steel tank.
 - .3 Complete with interstitial monitoring between the steel walls.
 - .4 To come complete with leak detection monitoring system.
 - .5 Where the height of the sub-base fuel tank equals or exceeds 914 mm (36 inches), provide an integrated platform complete with steps, and handrail for access to the generator for maintenance. Platform shall provide 1 metre clear working space on each side of the generator.
- .4 Fill Pipe:
 - .1 Minimum 50 mm (2 inch) diameter pipe size.
 - .2 Terminated outside of the enclosure to current CSA B139 series and TSSA requirements.

- .3 Designed and installed in such a manner as to ensure the transfer of fuel to the tank without flow restriction and to avoid spillage.
- .4 Each fill opening and each entry to a fill pipe shall be provided with a weather-tight cover designed to discourage tampering.
- .5 Tank shall be equipped with vent whistles or other applicable warning devices.
- .6 Tank to be equipped with an overfill protection device in accordance with ULC-S661.
- .7 Piping shall be of steel construction.
- .8 Provide lockable stainless steel spill containment box outside the enclosure complete with drain.
- .9 Sub-base tank finish colour: white.
- .5 Vent Pipes:
 - .1 Fuel tank shall be vented in accordance with manufacturer's instructions or recommendations and the standard to which they are certified.
 - .2 Generator shall be complete with vent pipe not less than 50 mm (2 inch) diameter, and emergency vent pipe not less than 75 mm (3 inch) diameter.
 - .3 Vent pipes to be terminated outside of the enclosure to current CSA B139 code requirements.
 - .4 The vent pipes shall be provided with a weatherproof hood or vent cap having a free open area at least equal to the cross-sectional open area of the vent pipe. The vent hood or cap shall prevent ingress of foreign objects and blockage by ice build-up.
 - .5 Vent pipes shall be installed to drain towards the tank, and shall be installed without sags or traps in which liquid can collect.
 - .6 Pipes shall be of steel or galvanized construction.
- .6 Fuel Level Gauge
 - .1 Fuel tank shall be complete with an approved glass sight fuel-level gauge.
 - .2 Gauging by means of a dipstick shall not be permitted.
 - .3 The gauge shall not be fitted in a location that can:
 - .1 Permit a discharge of fuel from the tank at the normal liquid level within the tank; or
 - .2 Interfere with the operation of the vent alarm if the gauge were broken.

2.13 SEQUENCE OF OPERATION

- .1 Start generator set on receipt of a start signal from remote equipment (automatic transfer switch). The start signal shall be via hardwired connection to the generator set control and a redundant signal over the required network connection.
- .2 Start generator within 15 s of loss of normal power.
- .3 The generator set shall complete a time delay start period as programmed into the control.
- .4 The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 - .1 The control system shall verify that the engine is rotating when the starter is signalled to operate. If the engine does not rotate after three attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.
 - .2 The engine shall start and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the

engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".

- .3 The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- .5 On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
- .6 When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
- .7 On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
 - .1 Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

2.14 SOURCE QUALITY CONTROL

- .1 Provide factory test, start-up by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
- .2 The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided to the Consultant. All testing shall be performed with calibrated metering.
- .3 Factory testing may be witnessed by the Owner and Consultant. Costs for travel expenses will be the responsibility of the Owner and Consultant. Supplier is responsible to provide two weeks notice for testing.
- .4 Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be acceptable. Tests shall include:
 - .1 Four (4) hour run at full load.
 - .2 Maximum power.
 - .3 Voltage regulation.
 - .4 Transient and steady-state governing.
 - .5 Single step load pickup:
 - .1 Zero to 100% to zero.
 - .2 Zero to 75% to zero.
 - .3 Zero to 50% to zero.
 - .4 Zero to 25% to zero.
 - .6 Function of safety shutdowns.

3 Execution

3.1 EXAMINATION

- .1 All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.2 PREPARATION

- .1 Location of generator with sub-base tank in accordance with the National Fire Code of Canada:
 - .1 Locate at a minimum distance of 3 metres to a building on the same property.

- .2 Locate at a minimum distance of 3 metres to a property line.
- .3 Locate at a minimum distance of 1 metre from an adjacent tank.

3.3 INSTALLATION

- .1 Install equipment in accordance with final submittals and contract documents. Comply with applicable provincial and local codes as required by the Authority Having Jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of CSA listed products.
- .2 Perform Work to CSA C22.1.
- .3 Conform to CSA C282 and CSA B139.
- .4 Concrete housekeeping pad:
 - .1 Install generator on concrete housekeeping pads designed by Structural Engineer.
 - .2 Cast-in-place concrete housekeeping pad to extend a minimum of 1 metre beyond footprint of generator.
 - .3 Coordinate exact conduit entry point with equipment submittals prior to fabricating pad.
 - .4 Permanently fasten equipment to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- .5 Provide all interconnecting wiring between all major equipment provided for the on-site power system. Provide interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- .6 Install remote annunciator adjacent to the automatic transfer switch, or as noted on drawings.
- .7 Systems Integration:
 - .1 Use stranded conductors to connect start-stop signal from Automatic Transfer Switch in Section 26 36 23.13.
 - .2 Fire Alarm System Supervision: Use stranded conductors to connect to Fire Alarm System per Section 28 46 21.11 for the following signals:
 - .1 Common generator fault condition (including main disconnect open) to provide a supervisory signal at the fire alarm system.
 - .2 Generator Running.
 - .3 Low Fuel.
 - .4 Not in auto.

3.4 GROUNDING AND BONDING (3-POLE ATS)

- .1 Ground and bond to Electrical Code requirements, and Section 26 05 26.
- .2 Remove bonding jumper from generator neutral to suit 3-pole ATS.
- .3 For 3-pole transfer switches utilized on 4-wire systems with unswitched neutrals, provide warning sign at the generator to clearly indicate the use of a floating neutral and that the generator neutral is not separately grounded.

3.5 FIELD QUALITY CONTROL

- .1 Inspect equipment for physical damage. Repair scratches and other installation damage prior to final system testing. Thoroughly clean equipment to remove all dirt and construction debris prior to initial operation and final testing of the system.
- .2 Manufacturer Services:

- .1 On completion of the installation, conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.
- .2 Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the Consultant.
- .3 Inspections
 - .1 Complete all verifications, inspections, and reports prior to scheduling TSSA inspection.
 - .2 Carry for the cost of all inspections by authorities having jurisdiction, including, but not limited to, the Electrical Safety Authority (ESA), and Technical Standards Safety Authority (TSSA).
 - .3 Carry the cost of all TSSA variances, i.e. variance due to fuel tank larger than 2500 L, or as detailed in CSA B139.
- .4 On Site Acceptance Test
 - .1 The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. Notify the Consultant in advance of the test for the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system.
 - .2 Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 - .3 Installation acceptance tests to be conducted on-site shall include a "cold start" test, a four hour full load (resistive) test, and a one step rated load pickup test in accordance with CSA C282. Provide a resistive load bank and make temporary connections for full load test, if necessary.
 - .4 Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least two hours. Coordinate timing and obtain approval for start of test with site personnel.
 - .5 The generator set supplier shall issue a test report documenting the results of testing, and including a complete list of all settings in the control system.
 - .6 Upon completion of testing, provide fuel to fill generator fuel tank.

3.6 TRAINING

- .1 The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the Owner.
- .2 Familiarize the Owner's Representative in the testing and maintenance requirements prescribed by Ontario Regulations, O.Reg 524/98:
 - .1 The system shall be used and operated for the purpose of testing or performing maintenance for a maximum of 60 hours in any 12-month period.
 - .2 The system shall be used and operated for the purpose of testing or performing maintenance only between the hours of 7 a.m. and 7 p.m.
 - .3 When the system is used and operated for the purpose of testing or performing maintenance, the air intakes, doors and windows of any buildings or structures located on the same site as the system shall be closed, if doing so would reduce the likelihood of emissions from the system entering the building or structure.
 - .4 If more than one generator unit is part of the system, only one unit shall be used and operated at any time for the purpose of testing or performing maintenance.

- .5 If the Ministry of the Environment issues a smog advisory that identifies an area in which the system is located, the system shall not be used or operated for the purpose of testing or performing maintenance until a termination notice with respect to the advisory has been issued for that area.

3.7 MAINTENANCE

- .1 Perform equipment maintenance as described in PART 1 of this section.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.
- .2 The Automatic Transfer Switch will transfer the load in delayed transition (break and delay-before-make) mode.
- .3 The transfer switch shall feature a double-sided bypass isolation mechanism.

1.2 RELATED REQUIREMENTS

- .1 Section 26 32 13.13 – Diesel-Engine-Driven Generator Sets.
- .2 Section 28 46 21.11 – Addressable Fire Alarm Systems.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.1-18, Canadian Electrical Code, Part I (24th Edition), Safety Standard for Electrical Installations
 - .2 Ontario Electrical Safety Code (OESC) 27th Edition, 2018.
 - .3 CSA C22.2 No.5-09, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
 - .4 CSA C22.2 No.178.1-12, Transfer Switch Equipment.
 - .5 CSA C282-09, Emergency Electrical Power Supply for Buildings.
 - .6 CAN/CSA C60044-1-07 (R2011), Instrument Transformers.
- .2 IEEE
 - .1 IEEE 446, Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
- .3 National Electrical Manufacturers Association (NEMA)
 - .1 ANSI/NEMA ICS 2-1996(R2009), Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.
 - .2 NEMA ICS 1 - General Standards for Industrial Control and Systems.
 - .3 NEMA ICS 2 -Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
 - .4 NEMA ICS 6 - Industrial Controls and Systems: Enclosures.
 - .5 NEMA ICS 10-1993, AC Automatic Transfer Switches.

1.4 ACTION SUBMITTALS

- .1 Within ten days after award of contract, provide electronic copies of the following information for review:
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations, including voltage, switch size, ratings and size of switching and overcurrent protective devices, operating logic, short circuit ratings, dimensions, weights, and enclosure details.
 - .2 A copy of the markings that are to appear on the transfer switches when installed.

- .3 Manufacturer's Installation 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.
- .4 Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
- .5 Manufacturer's certification of prototype testing.
- .6 Manufacturer's published warranty documents.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Make, model and type.
 - .2 Single line diagram showing controls and relays.
 - .3 Description of equipment operation including:
 - .1 Automatic starting and transfer to standby unit and back to normal power.
 - .2 Test control.
 - .3 Manual control.
 - .4 Automatic shutdown.
 - .2 Submit drawing of the engraved phenolic equipment nameplate.

1.5 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 26 05 00. Make prints of electronic submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for transfer switches for incorporation into manual.
- .3 Detailed instructions to permit effective operation, maintenance and repair.
- .4 Technical data:
 - .1 Schematic diagram of components, controls and relays.
 - .2 Illustrated parts lists with parts catalogue numbers.
 - .3 Certified copy of factory test results.
- .5 On-site commissioning and functional testing reports.
- .6 Warranty card, specifying the warranties for all ATS's.

1.6 OPERATIONS AND MAINTENANCE DATA

- .1 Operation Data: Include instructions for operating equipment. Include instructions for operating equipment under emergency conditions.
- .2 Maintenance Materials:
 - .1 Include routine preventative maintenance and lubrication schedule.
 - .2 List special tools, maintenance materials, and replacement parts, or indicate if there are no special tools or user serviceable parts.
 - .3 Provide two of each special tool required for maintenance, if applicable.

1.7 QUALITY ASSURANCE

- .1 Manufacturer Qualifications

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience, and with service facilities to respond in timely manner.
- .2 Supplier: Authorized distributor of specified manufacturer with minimum three years documented experience.
- .3 The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours/day, 365 days/year.
- .4 The transfer switch shall be serviced by a local service organization that is trained and factory certified in transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours/day, 365 days/year.
- .5 Manufacturer certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

.2 Regulatory Requirements

- .1 Provide products listed and classified by CSA or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- .2 CSA listed and labeled.
- .3 Meet all requirements as described in CSA C282.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect transfer switches from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.9 FIELD MEASUREMENTS

- .1 Verify that field measurements are as indicated on shop drawings.

1.10 MAINTENANCE SERVICE

- .1 Provide service and maintenance of transfer switch for one year from date of Substantial Completion.

1.11 WARRANTY

- .1 Minimum one year from the date of commissioning, warranted against defects in materials and workmanship.

2 Products

2.1 MANUFACTURERS

- .1 ASCO 7000 Series automatic transfer and bypass isolation switch (basis of design).
- .2 Equal by Cummins Power Generation.
- .3 Equal by Caterpillar.
- .4 Equal by Eaton.
- .5 Equal by Kohler Power Systems.

2.2 RATINGS

- .1 As indicated on single line diagram.
- .2 Minimum interrupting capacity per the following table, unless a higher value is indicated on the drawings:

<u>Switch Rating (Amps)</u>	<u>AIC Rating (kA)</u>
70 - 225	25
250	25
400	35
600, 800	65
1000, 1200	65
1600, 2000	100 Optional
2500, 3000	100
4000	100

2.3 SYSTEM DESCRIPTION

- .1 Automatic load transfer equipment to:
 - .1 Monitor voltage on all phases of normal (utility) and emergency (generator) power sources.
 - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
 - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
 - .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
 - .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.

2.4 AUTOMATIC TRANSFER AND BYPASS/ISOLATION SWITCH

- .1 Description: NEMA ICS 2, automatic transfer switch with manual bypass switch suitable for continuous operation.
- .2 Configuration: Draw-out type electrically-operated, mechanically-held transfer switch with manually-operated CONNECTED, TEST, AND DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch in both NORMAL and EMERGENCY positions.
- .3 The transfer switch shall feature a double sided bypass-isolation mechanism to allow power transfer switches to be inspected, tested, and maintained without any interruption of power to the load.
- .4 The isolate and bypass procedure shall not exceed 15 seconds.
- .5 Transfer switch shall permit bypass of the load to either source without load interruption.
- .6 Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.
- .7 Transition: Delayed.

2.5 CONSTRUCTION

- .1 Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
- .2 Transfer switches shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms.
- .3 Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

- .4 Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plugs, to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
- .5 Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
- .6 Transfer switches shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

2.6 ENCLOSURE

- .1 Enclosure: ICS 6, Type 1.
- .2 Finish: Manufacturer's standard gray enamel.
- .3 Maximum dimensions and space restrictions: refer to drawings.
 - .1 Ensure adequate space is available at sides and rear of the equipment as required to allow access during installation.
- .4 Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of CSA standards. The cabinet door shall include permanently mounted key type latches.
- .5 Transfer switch equipment shall be provided in a minimum NEMA 1 sprinklerproof enclosure.
- .6 Enclosures shall be the NEMA type specified. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.
- .7 Enclosure shall be complete with wireway as required to accept top, side, or bottom cable entry.

2.7 CONNECTIONS

- .1 Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
- .2 Transfer switch shall be provided with mechanical lugs suitable for copper conductors and sized to accept the full output rating of the switch.
- .3 Lugs suitable for multiple parallel runs of conductors.
- .4 Contractor to field verify exact size and quantity of conductors.

2.8 SERVICE CONDITIONS

- .1 Transfer switches rated to carry 100 per cent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 degrees C to +60 degrees C, relative humidity up to 95 per cent non-condensing, and altitudes up to 3000 m (10 000 feet).

2.9 MATERIALS

- .1 Instrument transformers: to CAN/CSA C60044-1.
- .2 Contactors: to NEMA ICS2.

2.10 CONTROLS AND INDICATORS

- .1 Selector switches:
 - .1 2 position for system test with load "Test", "Auto"
 - .2 3 position for generator control "Auto", "Manual", "Engine Start"

- .3 Test position - normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
- .4 Auto position - normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
- .5 Manual position - transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
- .6 Engine start position - engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- .2 Control transformers: dry type with 120 V secondary to isolate control circuits from:
 - .1 Normal power supply.
 - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
 - .1 Voltage sensing: 3 phase for normal power and on three phases for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage and over voltage protection.
 - .2 Time delays as indicated in the Sequence of Operation section
 - .3 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
- .4 Product Options and Features
 - .1 Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION, NORMAL BYPASS, ALTERNATE SOURCE BYPASS.
 - .2 Test Switch: Mount in cover of enclosure to simulate failure of normal source.
 - .3 Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.
 - .4 Transfer Switch Auxiliary Contacts: two normally open; two normally closed.
 - .5 Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 percent from rated nominal value.
 - .6 Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal value.
- .5 Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
 - .1 High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which sources are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.
 - .2 High intensity LED lamps to indicate that the transfer switch is "not in auto" (due to control being disabled or due to bypass switch enabled or in operation) and "Test/Exercise Active" to indicate that the control system is testing or exercising the generator set.
 - .3 "OVERRIDE" pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
 - .4 "TEST" pushbutton to initiate a pre-programmed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.

- .5 "LAMP TEST" pushbutton(s) to test all lamps on the panel by lighting them, either simultaneously from one control, or individually.
- .6 The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool or an operator display panel.
- .7 Security Key Switch or password on control panel to allow the user to inhibit adjustments.
- .8 Key operated test operator switch to prevent manual operation or testing of the transfer switch unless key is in place and operated.
- .9 Digital AC meter display panel, to display 3-phase AC Volts, Hz, kW load level, and load power factor. The display shall be colour-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.
- .10 Vacuum LED alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
 - .1 Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
 - .2 Display source status, to indicate source is connected or not connected.
 - .3 Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, kW, kVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
 - .4 The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - .1 Adjust voltage and frequency sensor operation set points.
 - .2 Set up time clock functions.
 - .3 Set up load sequence functions.
 - .4 Enable or disable control functions in the transfer switch, including program transition.
 - .5 Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
 - .5 Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
 - .6 Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
 - .7 Display fault history on the transfer switch, including condition, date/time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.
- .6 Internal Controls
 - .1 Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
 - .2 Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:

- .1 Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
- .2 Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
- .3 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
- .4 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
- .5 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
- .6 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
- .7 Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
- .8 Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.
- .3 All transfer switch sensing shall be configurable from the Transfer Switch or a Remote PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.
- .4 The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not acceptable.
- .5 The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cool-down) (adjustable in a range of 0-30 minutes).
- .6 The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
- .7 The control system shall be designed and prototype tested for operation in ambient temperatures from -40 degrees C to +70 degrees C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards
- .8 The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

2.11 ACCESSORIES

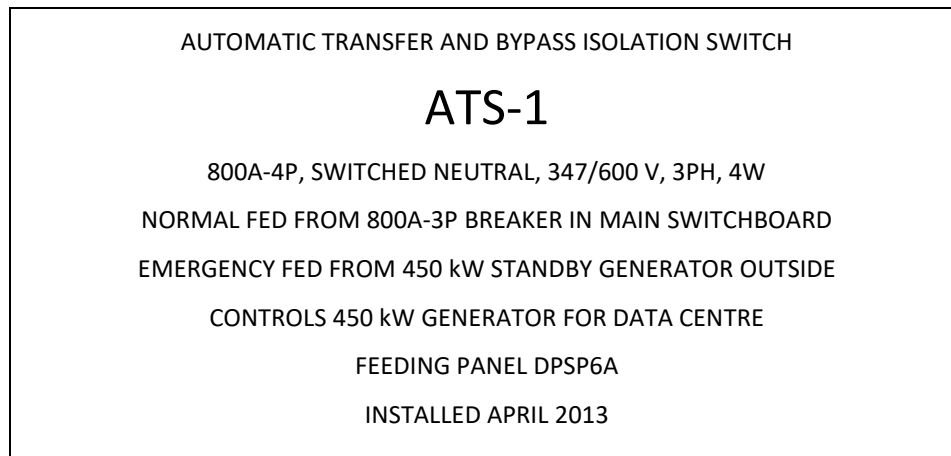
- .1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Plant exerciser.
- .3 Auxiliary Relays:
 - .1 Auxiliary relays to provide normally open (NO) and normally closed (NC) contacts for remote alarms.
 - .2 The transfer switch will provide the following dry contact monitoring points to determine status of the ATS remotely:

- .1 Normal power available
 - .2 Emergency power available
 - .3 ATS in "Normal" position
 - .4 ATS in "Emergency" position
 - .5 ATS "Not in Auto"
 - .6 Pre-Transfer
 - .7 Failure to Synchronize
 - .8 Extended Parallel Alarm
- .4 Instruments:
 - .1 Digital true RMS, indicating type 2 per cent accuracy, flush panel mounting:
 - .1 Voltmeter: AC, scale 0 to nominal system voltage +10%.
 - .2 Ammeter: ac, scale 0 to 10% above continuous rating.
 - .3 Frequency meter: scale 55 Hz to 65 Hz.
 - .4 Voltmeter selector switch: rotary, maintained contacts, panel mounting type, round notched handle, four position, labelled "OFF-Phase A-Phase B-Phase C".
 - .5 Ammeter selector switch: rotary, maintained contacts, panel mounting type, designed to prevent opening of current circuits, round notched handle, four position labelled "OFF - Phase A - Phase B - Phase C".
- .6 Bypass and Isolator
 - .1 A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors. All main contacts shall be manually driven.
 - .2 Power interconnections shall be silver-plated copper bus bar. The only field installed power connections shall be at the service and load terminals of the bypass-isolation switch. All control interwiring shall be provided with disconnect plugs.
 - .3 Separate bypass and isolation handles shall be utilized to provide clear distinction between the functions. Handles shall be permanently affixed and operable without opening the enclosure door. Designs requiring insertion of loose operating handles or opening of the enclosure door to operate are not acceptable.
 - .4 Bypass to the load-carrying source shall be accomplished with no interruption of power to the load (make before break contacts). Designs that disconnect the load when bypassing are not acceptable. The bypass handle shall have three operating modes: "Bypass to Normal," "Automatic," and "Bypass to Emergency." The operating speed of the bypass contacts shall be the same as the associated transfer switch and shall be independent of the speed at which the manual handle is operated. In the "Automatic" mode, the bypass contacts shall be out of the power circuit so that they will not be subjected to fault currents to which the system may be subjected.
 - .5 The isolation handle shall provide three operating modes: "Closed," "Test," and "Open." The "Test" mode shall permit testing of the entire emergency power system, including the automatic transfer switches with no interruption of power to the load. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance to conform to code requirements without removal of power conductors or the use of any tools.
 - .6 When the isolation switch is in the "Test" or "Open" mode, the bypass switch shall function as a manual transfer switch.
 - .7 Designs requiring operation of key interlocks for bypass isolation or ATSs which cannot be completely withdrawn when isolated are not acceptable.
- .7 Communications Module

- .1 The communications shall be capable of connecting to the Ethernet TCP/IP network with BacNet card for BAS communication. This module shall allow for the seamless integration of communication transfer devices.
- .2 Allow remote viewing of transfer switch information from a PC, including transfer switch name, real time load in kW on the transfer switch, current source condition, and current operating mode.

2.12 EQUIPMENT IDENTIFICATION

- .1 Identify equipment in accordance with Section 26 05 53.
- .2 Control panel:
 - .1 For selector switch and manual switch: size 4 nameplates.
 - .2 For meters, indicating lights, minor controls: use size 3 nameplates.
- .3 Warning labels:
 - .1 For 3-pole transfer switches utilized on 4-wire systems with unswitched neutrals, provide warning sign on transfer switch to clearly indicate the use of a floating neutral and that the generator neutral is not separately grounded.
 - .2 For 4-pole transfer switches utilized on a 4-wire system with a switch neutral, provide warning sign on transfer switch to clearly indicate that each source is separately grounded.
- .4 Nameplates:
 - .1 Engraved phenolic nameplate, 3 mm (1/8 in) thick plastic engraved sheet.
 - .2 Red face, white core unless noted otherwise.
 - .3 To be mechanically attached with self-tapping screws.
 - .4 White letters, 12 mm (1/2 in.) high unless otherwise noted below.
 - .5 To include:
 - .1 Identity of equipment (i.e. ATS-1), 20 mm (3/4 in.) high letters.
 - .2 Voltage.
 - .3 Ampacity.
 - .4 Number of phases.
 - .5 Identity, switchboard section (if applicable), circuit number, and size of Normal Power source.
 - .6 Identity, switchboard section (if applicable), circuit number, and size of Emergency Power source.
 - .7 Identity of device or panelboard on the Load side of the transfer switch.
 - .8 Date of installation.
 - .9 If upstream or downstream device is located in a separate room from ATS, indicate the room name and number.
 - .6 Confirm exact colours and text with the engineer prior to fabrication.
 - .7 Example of nameplate:



2.13 SOURCE QUALITY CONTROL

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.
- .2 Notify Consultant 5 days minimum in advance of date of factory test.
- .3 Tests:
 - .1 Operate equipment both mechanically and electrically to ensure proper performance.
 - .2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.
 - .3 Check voltage sensing and time delay relay settings.
 - .4 Check:
 - .1 Automatic starting and transfer of load on failure of normal power.
 - .2 Retransfer of load when normal power supply resumed.
 - .3 Automatic shutdown.
 - .5 Provide copy of test reports and include with Commissioning Manual.

2.14 SEQUENCE OF OPERATION

- .1 The automatic and manual control of an emergency electrical power supply system, including the starting of a generator set or generator sets, and actuation of automatic transfer switches to connect a load to the emergency supply and reconnect it to the normal supply, shall be in the following sequence:
 - .1 Confirm initial set points with the Consultant prior to start up and commissioning.
 - .2 The generator sets shall be started when the normal supply at the transfer switch on one or more phase has been interrupted or is at a voltage that is less than 70 per cent of the nominal system voltage for 3 seconds.
 - .1 Initiate time delay to start alternate source engine generator: Upon initiation by normal source monitor.
 - .2 Time delay to start alternate source engine generator: 0 to 3 seconds, adjustable. Initial set point 3 seconds.
 - .3 Initiate transfer load to alternate source: Upon initiation by normal source monitor and permission by alternate source monitor.
 - .4 Time delay before transfer to alternate power source: 0 to 60 minutes, adjustable.
 - .1 Initial set point for "Life Safety" transfer switches: zero (immediate transfer).
 - .2 Initial set point for "Non-Life Safety" transfer switches: 30 seconds.

- .5 The set points for the items above shall be configured such that the generator is connected to and powering life safety equipment within 15 seconds of the loss of normal power.
- .3 Where delayed emergency loads are arranged to be connected to the emergency supply later than the emergency loads, all of the delayed emergency loads and any other loads that have been arranged for connection at the same time.
- .4 On restoration of the normal supply, and after nominal voltage and frequency have been maintained at nominal levels on all phases of the transfer switch for a period of 1 to 30 minutes, the automatic transfer switches shall transfer the loads back to the normal supply, except that the transfer shall occur without delay when an emergency supply fails.
 - .1 Initiate retransfer load to normal source: upon permission by normal source monitor.
 - .2 Time delay before transfer to normal power: 0 to 60 minutes, adjustable; bypass time delay in event of alternate source failure. Initial set point 15 minutes.
 - .3 Delayed transition duration: 0.5 to 3 seconds. Initial set point 0.5 seconds.
- .5 After the transfer of loads back to the normal supply, the automatic shutdown of the generator set shall be delayed for 5 minutes or a reasonable length of time to stabilize the operating temperature under no-load conditions.
 - .1 Time delay before engine shut down: 0 to 60 minutes, adjustable, of unloaded operation. Initial set point 5 minutes.
- .2 Implementation of pre-transfer elevator control sequence should be coordinated with Division 14 to confirm if required:
 - .1 On a failure of normal power and a transfer to emergency power, the pre-transfer contacts shall be disabled and a transfer of the elevator load to the emergency power source shall take place without additional delay.
 - .2 On a retransfer from emergency power to normal power, the pre-transfer contacts shall inhibit a transfer to normal power for a minimum of 20 seconds.
 - .3 When the system is under test conditions in which both the normal and the emergency power sources are live, the pre-transfer contacts shall be enabled and shall inhibit a transfer to the emergency source for at least 20 seconds.
- .3 Automatic engine exerciser:
 - .1 Engine Exerciser: Start engine every 7 days; run for 30 minutes before shutting down. Bypass exerciser control if normal source fails during exercising period.
 - .2 Alternate System Exerciser: Transfer load to alternate source during engine exercising period.
 - .3 Initial set point: turn off automatic engine exerciser.
- .4 Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - .1 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - .2 The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.
 - .3 When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
 - .4 When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate

- source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
- .5 The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 - .6 On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - .7 The transfer switch shall operate the generator set unloaded for a cool-down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.
- .5 Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:
- .1 Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - .2 When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
 - .3 At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3 Execution

3.1 FACTORY TESTING

- .1 The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. Tests shall be conducted as per CSA standards. A certified test report shall be included in each copy of the Operations Manual. Test process shall include calibration of voltage sensors. The following factory tests shall be performed:
 - .1 Visual inspection to verify that each ATS is in accordance with the specifications.
 - .2 Mechanical test to verify that ATS sections are free of mechanical hindrances.
 - .3 Insulation resistance test to ensure integrity and continuity of entire system.
 - .4 Main switch contact resistance test.
 - .5 Electrical tests to verify complete system electrical operation and to set up time delays and voltage sensing settings.
- .2 Provide for the Owner and Consultant to witness factory testing.

3.2 EXECUTION

- .1 Verify conditions, including restrictions for moving equipment into position and ensure equipment can suit these limitations.
- .2 Coordinate disassembly and field assembly of equipment with the manufacturer.

3.3 INSTALLATION

- .1 Install transfer switches to in accordance with codes, as shown on the drawings, and as recommended by manufacturer's instructions.
- .2 Emergency Lighting at Life Safety Transfer Switches

- .1 Provide Emergency Battery Units in rooms containing Life Safety automatic transfer switches in accordance with Section 26 52 13.13. Units require sufficient capacity to provide 2 hours duration in accordance with CSA C282 clause 6.11.1.
- .2 Minimum illumination: 50 lx (5 fc).
- .3 Battery units shall include automatic self-diagnostic circuitry, and a transient voltage surge suppressor on the supply site of power to the unit.
- .3 Provide engraved plastic nameplates.
- .4 Locate, install and connect transfer equipment as indicated.
- .5 Check relays and solid state monitors and adjust as required to ensure correct operation.
- .6 Install and connect remote alarms and IP based monitoring.
 - .1 For Life Safety transfer switches, provide signal cabling to connect "Automatic transfer switch in bypass mode" to Fire Alarm System per Section 28 46 21.11 to provide remove visual and audible indication per CSA C282-09 clause 9.5.3.
- .7 Connect generator control wiring.
- .8 Set field-adjustable intervals and delays, relays, and engine exerciser. Verify exact set points with the Consultant.

3.4 MANUFACTURER'S FIELD SERVICES

- .1 The manufacturer shall provide disassembly, field assembly, and field certification services to suit restrictions of moving equipment into place.
- .2 A factory-authorized service representative is to perform start-up and testing of the ATS in the presence of the commissioning authority.

3.5 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00, and Section 26 08 00.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.
- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown. Repeat, at 1 hour intervals, 4 times, complete test with selector switch in each position, for each test.

3.6 COMMISSIONING

- .1 Submit commissioning reports to the Consultant.
- .2 A factory-authorized service representative is required to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
- .3 Following completion of automatic transfer switch installation and after making proper adjustments and settings, site tests shall be performed by the manufacturer's representative in accordance with manufacturer's written instructions to demonstrate that each automatic transfer switch functions satisfactorily and as specified. Advise the Consultant of the site testing within five days prior to its scheduled date, and provide certified field test reports within 14 days following successful completion of the site tests. Test reports shall describe adjustments and settings made and site tests performed. Minimum operational tests shall include the following:

- .1 Insulation resistance shall be tested, both phase-to-phase and phase-to-ground.
- .2 Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
- .3 Verify that manual transfer warnings are properly placed.
- .4 Perform manual transfer operation.
- .5 After energizing circuits, demonstrate the interlocking sequence and operational function.
- .6 Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
- .7 Simulate loss of phase-to-ground voltage for each phase of normal source.
- .4 Verify time-delay settings.
- .5 Verify pickup and dropout voltages by data readout or inspection of control settings.
- .6 Verify proper sequence and correct timing of automatic engine starting, transfer time delay, re-transfer time delay on restoration of normal power, and engine cool-down and shut-down.
- .7 Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
- .8 Power failure of normal source shall be simulated by opening upstream protective device. This test shall be performed a minimum of five times.
- .9 Power failure of emergency source with normal source available shall be simulated by opening upstream protective device for emergency source. This test shall be performed a minimum of five times.
- .10 Low phase-to-ground voltage shall be simulated for each phase of normal source.
- .11 Operation and settings shall be verified for specified automatic transfer switch operational feature, such as override time delay, transfer time delay, return time delay, engine shutdown time delay, exerciser, auxiliary contacts, and supplemental features.
- .12 Manual and automatic transfer and bypass isolation functions shall be verified.

3.7 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00. Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 26 05 00.

3.8 DEMONSTRATION

- .1 At the final inspection in the presence of the Consultant, demonstrate that the complete auxiliary electrical power system operates properly in every respect
- .2 Coordinate this demonstration with the demonstration of the engine-generator.
- .3 Demonstrate operation of transfer switch in bypass, normal, and emergency modes.
- .4 Demonstrate operation of IP based monitoring and configuration.

3.9 TRAINING

- .1 The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided.
- .2 The training program shall be not less than two hours in duration.

- .3 Training date shall be coordinated with the Owner.

End of Section

1 General

1.1 SUMMARY

.1 Section Includes

- .1 These specifications describe pertinent material requirements and installation practices for Low Voltage AC Power Panel Surge Protective Devices (SPDs). Furnish and install the SPDs equipment having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract drawings.
- .2 The specifications in this section describe the electrical and mechanical requirements for a protection system provided by high-energy Surge Protective Devices. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments (as tested by ANSI/IEEE C62).

.2 Applicability

- .1 SPDs shall be fully applicable for the purpose of protecting all facility AC electrical circuits from the hazardous effects of transient voltages. These transients may be generated externally by lightning induced energies, utility load factor corrections, and substation switching or they can be internally generated due to inductive and/or capacitive load switching.

.3 Suitability

- .1 SPDs shall be suitable for all service entrance panelboards as indicated on the electrical layouts and single line diagrams. Products are to be configured for parallel installation - no series designs shall be considered acceptable. Design products to allow installation as a stand-alone device allowing mounting adjacent to panelboards. Installation is to be accomplished by a qualified electrical contractor.

1.2 RELATED REQUIREMENTS

- .1 Section 26 24 16 – Panelboards.
- .2 Section 26 28 16.02 – Molded Case Circuit Breakers.

1.3 REFERENCES

.1 Canadian Standards Association:

- .1 CSA C22.1-18 – Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
- .2 Ontario Electrical Safety Code (27th Edition / 2018).
- .3 CSA C22.2 No. 269.2-13 – Surge Protective Devices - Type 2 - Permanently Connected.

.2 Institute of Electrical and Electronics Engineers (IEEE):

- .1 IEEE C62.41.1-2002 - IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
- .2 IEEE C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
- .3 IEEE C62.45-2002, Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- .4 IEEE C62.62-2010, Standard Test Specifications for Surge Protective Devices.
- .5 IEEE 142-2007, Recommended Practice for Grounding of Industrial and Commercial Power Systems - Green Book.
- .6 IEEE 1100-2005, Recommended Practice for Powering and Grounding Electronic Equipment - Emerald Book.

.3 National Electrical Manufacturers Association (NEMA):

- .1 NEMA LS-1. Document rescinded in entirety August 19, 2009. No replacement document has been issued.
- .4 Ontario Building Code and its referenced standards.
- .5 Underwriters Laboratories Inc. (UL):
 - .1 ANSI/UL 1449, (4th Edition), Standard for Safety, Surge Protective Devices.
 - .2 UL 1283 (Fourth Edition) - 2005, Standard for Electromagnetic Interference Filters.
- .6 Other relevant standards:
 - .1 MIL-STD-220C, Method of Insertion-Loss Measurement.

1.4 DEFINITIONS

- .1 Surge Protective Device: A device composed of at least one non-linear component and intended for limiting surge voltages on equipment by diverting or limiting surge current and is capable of repeating these functions as specified. SPDs were previously known as Transient Voltage Surge Suppressors (TVSS) or secondary surge arresters.
- .2 L-G: measurements from phase to equipment grounding conductor as line terminals of utilization equipment.
- .3 L-L: measurements from phase to phase in a polyphase system, or from one line to another line in a single phase system.
- .4 L-N: measurement from phase(s) to neutral for both single and three phase systems.
- .5 N-G: measurements from neutral to equipment grounding conductor at line terminal of utilization equipment.
- .6 External mounted surge suppressor: Surge Protective Device (SPD) mounted outside of the power panel as a separate component.

1.5 SUBMITTALS FOR REVIEW

- .1 Submit in accordance with Section 26 05 00.
- .2 Shop Drawings:
 - .1 Line drawings or catalog sheets detailing dimensions and weight of enclosure, lifting and support points, and enclosure details.
 - .2 Internal wiring diagram illustrating all modes of protection in each type of SPD required.
 - .3 Wiring diagram showing all field connections and manufacturer's recommended wire size, recommended circuit breaker or fuse size, required overcurrent protection type, and maximum lead length.
- .3 Provide the following product data:
 - .1 Voltage Protection Ratings (VPRs), I-nominal ratings, Short Circuit Current Ratings, SPD type designations, dimensions showing construction, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period, and replacement terms.
 - .2 List and detail all protection systems such as fuses, disconnecting means, and protective features.
- .4 Submit product data for all components and accessories.
- .5 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, installation, and starting of product.
- .6 Test reports:

- .1 Submit cover sheet of test report from a recognized independent testing laboratory certifying compliance with UL 1449.
- .2 Provide verification that the SPD complies with the required UL 1449 latest edition, latest revision, and Canadian approvals.
- .3 Provide spectrum analysis of each unit based on MIL-STD-220C test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds values indicated in this section.
- .4 UL documentation verifying Short Circuit Current Rating (SCCR).
- .5 Proof of UL 1283 listing for EMI filters.
- .7 Upon request, present unencapsulated but complete SPD for visual inspection; proprietary technology included. MOV type and quantity shall reflect kA ratings on cut sheets, verification of monitoring, thermal, overcurrent protection, etc.
- .8 Include the following information:
 - .1 Data for each suppressor type indicating conductor sizes, conductor types, and connection configuration and lead lengths.
 - .2 Manufacturer's certified test data indicating the ability of the product to meet or exceed requirements of this specification.
 - .3 Drawings, with dimensions, indicating SPD mounting arrangement and lead length configuration, and mounting arrangement of any optional remote diagnostic equipment and assemblies.
 - .4 List and detail all protection systems such as fuses, disconnecting means and protective materials.
 - .5 Indicate SPD wiring, bonding, and grounding connections on wiring diagrams for each system. Include installation details demonstrating mechanical and electrical connections to equipment to be protected.
 - .6 Wiring diagram of SPD diagnostic indicators.

1.6 CLOSEOUT SUBMITTALS

- .1 Maintenance data: submit operation and maintenance data, and engineering data for incorporation into manual specified in Section 26 05 00.
- .2 Warranty Document.

1.7 ENVIRONMENTAL REQUIREMENTS

- .1 Operating temperature range: -40 degrees C to 70 degrees C (-40 degrees F to 160 degrees F).
- .2 Elevation: Operation up to 3 658 m (12 000 feet) above sea level.
- .3 Generate no appreciable magnetic fields.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle in accordance with Section 26 05 00.
- .2 Store materials in dry, secure location and protect from weather.
- .3 Protect from moisture and humidity.
- .4 Store in accordance with manufacturer's written instructions.
- .5 Waste management and disposal in accordance with Section 26 05 00.

1.9 MANUFACTURER WARRANTY

- .1 Five-year warranty.

- .2 Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPD shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. This is, the warranty shall cover the effects of lightning, single phasing, and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

1.10 MANUFACTURER QUALIFICATIONS

- .1 Manufacturer regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years. Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.

1.11 QUALITY ASSURANCE

- .1 All SPDs manufactured by a single ISO-9001 registered company normally engaged in the design, development and manufacture of such devices for electrical and electronic system equipment protection.
- .2 Manufacturer regularly engaged in the manufacture of surge suppression products for the specified categories for minimum of ten years.
- .3 Manufacturer shall offer repair or replacement service for all materials and components incorporated in the Surge Protective Devices.
- .4 Technical assistance (no cost to customer) provided by manufacturer through a factory representative or a local distributor and a factory staffed toll-free technical hotline.
- .5 Manufacturer shall provide a toll-free customer service phone number to facilitate all inquiries regarding product returns, warranty claims, purchasing requirements and payment or credit issues.
- .6 Listed to most recent edition of UL 1449 and UL 1283. (UL 1449 Fourth Edition since August 2014).
- .7 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 UL 1449, and assigned Voltage Protection Ratings.
- .2 Listed by ETL.
- .3 Listed and classified by CSA (Canadian Standards Association).
- .2 SPD to be cUL labeled with no less than a 100 kA Short Circuit Current Rating (SCCR).

2 Products

2.1 OUTDATED AND DEFUNCT SPECIFICATION CRITERIA

- .1 Selection of SPD is not be made, solely, or in part, based upon any of the following ambiguous specifications, and obsolete terminology. These terms are no longer recognized by ANSI, NEMA, IEEE, or IEC standards as bonafide suppressor performance parameters. Submittals bearing reference to any of the following will be rejected.
- .1 A1 ringwave: removed in 2002 revisions of IEEE C62 documents.
- .2 Joule ratings: there is no recognized standard for SPD joule ratings.
- .3 NEMA LS-1: document rescinded by NEMA.
- .4 Response time: not endorsed by IEEE, NEMA, or UL as a valid SPD rating parameter.
- .5 Suppressed Voltage Ratings (SVR): terminology deprecated with UL 1449 third and subsequent editions.
- .6 UL 1449, second edition. Replaced by third edition in 2009.
- .7 UL 1449, third edition. Replaced by fourth edition in 2014.

2.2 MANUFACTURERS

- .1 The inclusion of a manufacturer in the following list does not indicate the manufacturer meets all the requirements in this specification. Likewise, the omission of a manufacturer is not indicative of any lack of qualification. The manufacturer and product must meet all the requirements of this specification.
- .2 No unit will be accepted as an “approved equal” unless it meets the warranty, strength, safety features, performance ratings, and all other requirements of this specification.
- .3 Manufacturers.
 - .1 Asco.
 - .2 Current Technology.
 - .3 Mersen.
 - .4 Raycap Electrical Protection Systems.
 - .5 Total Protection Solutions.
- .4 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. Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.

2.3 SURGE PROTECTION DEVICES – GENERAL

- .1 Obtain all surge suppression devices through one source from a single manufacturer.
- .2 SPD separate from panelboards. Integral SPDs not acceptable.
- .3 The SPD listed by recognized testing agency accredited by the Standards Council of Canada, and bear a certification mark from that agency indicating acceptance to Canadian standards, and to UL’s 1283 and UL’s 1449 standards (latest edition, latest revision), and not merely the components or modules. Label all SPDs as a Type 2 for use in Type 1 and Type 2 locations.
- .4 Protect all modes L-G, L-N, L-L, and N-G, have discrete suppression circuitry in L-G, L-N, and N-G, and have bidirectional, positive, and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only four modes are not acceptable. In delta systems, line-to-ground-to-line protection is not acceptable where line-to-line is specified.
- .5 If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a minimum 100 kA symmetrical fault current with 600 VAC applied.
- .6 Suppression Components:
 - .1 Metal Oxide Varistors (MOVs).
 - .2 Gas tubes, silicon avalanche diodes, or selenium cells: not permitted.
 - .3 Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls, such as through the use of Thermally Protected MOVs (TPMOVs).
 - .4 Where SPD is not equipped with overtemperature controls, pack all surge components, current carrying paths and fusing in fuse grade silica sand or epoxy potting for arc quenching capability, minimization of smoke and contaminants in the event of failure.
- .7 Internal Fusing - Overcurrent Protection
 - .1 Individually fuse each suppression component for safety and performance.
 - .2 Fusing shall be present in every mode, including Neutral-to-Ground.

- .3 All overcurrent protection must be included within the device, and not require external overcurrent protection.
- .8 Surge Current Rating
 - .1 Service Entrance: 200 kA per phase.
 - .2 Distribution: 100 kA to 200 kA per phase.
 - .3 Point of Use: 100 kA per phase.
- .9 Short Circuit Current Rating (SCCR), sometimes referred to as fault current rating: minimum 100 kA.
- .10 Nominal Discharge Current (In, or I-nominal):
 - .1 UL labelled with a minimum 10 kA I-nominal.
- .11 Maximum Continuous Operating Voltage (MCOV): The maximum continuous operating voltage (MCOV) of all components not less than 125 per cent for a 120 V system, 120 per cent for 220 and 240 V systems, and 115 per cent for 347 and 600 V systems.
 - .1 277 V systems: 320 V MCOV.
 - .2 480 V systems: 552 V MCOV.
- .12 UL 1449 Listed Voltage Protection Ratings (VPRs) to not exceed the following:

<u>Voltage</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>
208Y/120	800 V	800 V	800 V
480Y/277	1200 V	1200 V	1200 V
600Y/347	1500 V	1500 V	1500 V
<u>Voltage</u>	<u>L-L</u>	<u>L-G</u>	
480 Delta	1800 V	1800 V	
600 Delta	2500 V	2500 V	

- .13 Minimum EMI/RFI filtering of -50 dB at 100 kHz.
- .14 SPD enclosure:
 - .1 Minimum NEMA type 12 rating in indoor applications.
 - .2 Minimum NEMA type 4 in outdoor applications.
- .15 Diagnostics and Monitoring:
 - .1 Visual LED diagnostics to indicate failure of a suppression component. Monitor every suppression component of every mode, including N-G.
 - .2 Form C dry contacts (NO or NC) for remote monitoring capability to indicate the failure of any MOV in the unit.
 - .3 Surge event counter with backup power source.

2.4 SERVICE ENTRANCE AND TRANSFER SWITCH SPDS:

- .1 cUL 1449 listed and labeled as a Type 2 device.
- .2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.
- .3 cUL 1449 listed and labeled with a minimum I-nominal rating of 20 kA.
- .4 A cUL approved disconnect switch provided as a means of service disconnect if a 60 A breaker is not available.

- .5 Connect SPD using the manufacturer's breaker/wire recommendations. If recommendations are not available, use a 60 amp breaker and 6 AWG cable with full size ground.

- .6 Minimum Surge Current Rating: 200 kA per phase (100 kA per mode).

2.5 DISTRIBUTION PANELBOARD SPDS:

- .1 cUL 1449 listed and labeled as a Type 2 device.
- .2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.
- .3 cUL 1449 listed and labeled with a minimum I-nominal rating of 20 kA.
- .4 SPD connected using the manufacturer's breaker/wire recommendations. If recommendations are not available a 60 A breaker and 6 AWG with full size ground will be used.
- .5 Minimum Surge Current Rating: 100 kA per phase (50 kA per mode).

2.6 LIGHTING AND RECEPTACLE BRANCH CIRCUIT PANELBOARD SPDS:

- .1 cUL 1449 listed and labeled as a Type 2 device.
- .2 SPDs relying on an external breaker or fuse as supplemental overcurrent protection do not meet the intent of this specification and will be rejected.
- .3 cUL 1449 listed and labeled with a minimum I-nominal rating of 10 kA.
- .4 SPD connected using the manufacturer's breaker/wire recommendations. If recommendations are not available a 60 A breaker and 6 AWG will be used.
- .5 Minimum Surge Current Rating: 100 kA per phase (50 kA per mode).

3 Execution

3.1 PRE-INSTALLATION MEETINGS

- .1 Pre-installation meetings: conduct pre-installation meeting one week prior to commencing work of this Section and on-site installations to verify project requirements, substrate conditions and co-ordination with other building sub-trades, to review manufacturer's installation instructions and warranty requirements.

3.2 FIELD QUALITY CONTROL

- .1 Have manufacturer of products supplied under this Section review Work involved in the handling, installation, application, protection, and cleaning of its products. Submit written reports in acceptable format to verify compliance of Work with Contract in accordance with Section 01 33 00 and Section 01 78 00.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits to review work at stages listed:
 - .1 After delivery and storage of products, and when preparatory work on which the work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of work at 66 per cent and 99 per cent complete.
 - .3 Upon completion of the work, after cleaning is carried out.
- .4 Obtain reports within three (3) days of review and submit immediately to Consultant.

3.3 EXAMINATION

- .1 Verify service and separately derived system Neutral to Ground bonding jumpers.

3.4 INSTALLATION

- .1 Do complete installation in accordance with CSA-C22.1, CAN/CSA-C22.2 No. 0, ANSI/IEEE C62.41, and all other applicable codes.
- .2 Manufacturer's instructions
 - .1 Install SPD in accordance with manufacturer's installation instructions with lead lengths as short and as straight as practically possible. Lead lengths no greater than 600 mm (24 inches). Gently twist conductors together.
 - .2 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions.
- .3 Connect SPD to service panel being protected via a circuit breaker for each phase, based on the number of poles and the connecting wire size, with a 100 A maximum.
- .4 Follow the SPD manufacturer's recommended installation practice as outlined in the equipment installation manual. Ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.
- .5 Installation position of SPD:
 - .1 Locate SPD adjacent to the panelboard, in a position as close as possible to the neutral and ground lugs. Rearrange breaker positions for SPDs to minimize the length of the phase, neutral, and ground conductors.
 - .2 Mount SPD as close as possible to panel being protected in a position that will minimize lead lengths between suppressor and control breaker(s) to which suppressor connects. Utilize conduit, preferably metallic, to accomplish these connections with a recommended minimum wire size of 10 AWG, a maximum wire size of 4 AWG (for ease of dressing), or as noted on the single line diagram. Do not extend suppressor leads beyond manufacturer's recommended maximum length without specific engineering approval. The rationale for this is the longer connecting leads between the SPD and the power panel, the higher the residual transient voltage.
 - .3 Locate surge suppressors as indicated and mount securely, plumb, true, and square to adjoining surfaces.
 - .4 Install surface mounted surge suppressors on fire-retardant plywood backboards as recommended in manufacturer's written instructions. Where practical, group SPDs on common backboard with other equipment.
 - .5 Mount housings and enclosures on fire-retardant plywood backboard with top not higher than 1.8 m (6 feet) above finished floor.
- .6 Wiring:
 - .1 Install units on a breaker, sized, where indicated, that meets or exceeds the fault current rating of the panelboard.
 - .2 Connect SPD to service panel being protected via a circuit breaker for each phase, based on the number of poles and the connecting wire size. Connect SPD using the manufacturer's breaker/wire recommendations.
 - .1 If recommendations are not available, a 60 A breaker and 6 AWG phase, neutral, and ground conductors will be used.
 - .2 If the SPD is supplied with lead wires, the match overcurrent protection to the 75 degree C ampacity of the wiring as described in Ontario Electrical Safety Code, Table 2; i.e. a 30 A breaker to suit 10 AWG lead wires.
 - .3 Install SPD in a neat, workmanlike manner. Lead dress as short and as straight as possible and be consistent with recommended industry practices for the application on which these units are installed.

Bind phase, neutral, and ground conductors tightly (one twist per 30 cm) over entire run, from suppressor to service panel, and always use the shortest length of connecting cable possible.

- .4 If the SPD is supplied by the manufacturer with lead wires, cut excess lead length.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Common requirements for all electric lighting, including interior, exterior, and emergency lighting.

1.2 RELATED REQUIREMENTS

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 52 13.13 – Emergency Lighting.
- .3 Section 26 52 13.16 – Exit Signs.
- .4 Section 26 56 19 – LED Exterior Lighting.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code, 25th Edition / 2012.
 - .3 CSA C22.2 No. 9.0 - General Requirements for Luminaires.
 - .4 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).
- .2 Illumination 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.
- .3 NEMA WD 6 - Wiring Devices - Dimensional Requirements.

1.4 SUBMITTALS FOR REVIEW

- .1 Refer to Section 01 33 00.
- .2 General
 - .1 The Contractor shall be responsible for supplying equipment product data, and as indicated in the specification, partial or complete working samples of the specified equipment in a timely fashion for design team approval, prior to releasing orders on equipment. Contractor shall be responsible for coordinating all aspects of order placement, deposits, shop drawing procurement, order release, order follow-up, delivery tracking, etc. with Distributor in a timely fashion. Some luminaires may require at least 12 to 16 weeks of lead time or more- the Contractor is responsible for allowing sufficient time for the order-and-deposit process, shop drawing procurement, submittal, and review process. Substitutions will not be accepted on the basis of the contractor's obligation to make any deadlines, contractual or otherwise, agreed by the contractor toward the completion of this project. Lamp submittals are as important and necessary as luminaire submittals and must be supplied by the Contractor to assure correct lamp wattage, color and efficacy.
 - .2 All submittals shall be generated by respective factories with their seals or other authentication marks and each submittal sheet shall be clearly labeled with respective luminaire type, complete catalog number relevant to submitted luminaire, date of submittal generation and name, phone number, and email address of submittal author in order to track provenance of information. The Consultant may contact respective factory submittal source.
 - .3 The lighting equipment specified herein has been carefully chosen for its ability to meet the luminous environment requirements of this project. Calculations were typically made to determine luminances, luminance ratios, and/or horizontal and vertical illuminances and uniformities. In some instances, virtual

reality "images" were generated with lighting calculation software to assist the Design Team and/or the Client in assessing the lighting quality of the spaces or areas. Equipment and/or manufacturers which have been shown to comply with the established criteria, including ASHRAE/IES 90.1 or California Title 24 or other such energy code as applicable by ordinance, code, Federal law, or mandate, and/or intended LEED or other green-building certification, is specified herein. Substitutions in all likelihood will be unable to meet all or some of the salient criteria as the specified equipment.

- .4 Substitution of products supplied by a manufacturer not named as acceptable is not allowed during bid period.
- .5 The Contractor shall be responsible for obtaining from his supplying lighting manufacturers, for each luminaire, a recommended maintenance manual including:
 - .1 Vendor and local representative's contact information
 - .2 Tools required
 - .3 Instructions
 - .4 Types of cleaners to be used
 - .5 Replacement parts identification lists
 - .6 Equipment product data (high-quality reproducible copies)
 - .7 Warranty documentation
- .3 Shop Drawings:
 - .1 Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - .2 Wiring diagrams for power, signal and control wiring.
- .4 Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes and the following:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 The product literature shall provide an explanation of all options and descriptors in the catalog number as submitted.
 - .3 Include luminaire weight.
 - .4 Provide complete photometric data prepared by independent testing laboratory for each luminaire, for approval by Engineer.
 - .5 Physical description of lighting fixtures including dimensions.
 - .6 Ballast, including BF.
 - .7 Energy-efficiency data, including ballast input wattage.
 - .8 Life, output (lumens, CCT and CRI), and energy efficiency data for lamps.
- .5 Photometric Data and Calculations
 - .1 Provide Luminaire Data Photometric Testing performed by an independent agency complying with IESNA Lighting Measurement Testing and Calculation Guides.
 - .2 Submit photometric calculations for typical areas based on layouts as indicated on the drawings.
 - .1 Submit a photometric calculation for the typical areas based on the conditions.
 - .2 Submit a photometric calculation for the same typical areas based on the proposed new fixtures.
 - .3 Clearly indicate mounting heights, heights of calculation zones, light loss factors and surface reflectance values.

- .4 Use the follow photometric parameters:
 - .1 Recoverable Light Loss Factors: 0.8
 - .2 Ceiling reflectance values of 80 per cent.
 - .3 Wall reflectance value of 50 per cent.
 - .4 Floor reflectance value of 20 per cent.
- .3 Submittals shall be in PDF format, and the native file of the software used to make the photometric analysis.
- .4 Submit IES photometric data files for the proposed luminaires.

1.5 SUBMITTALS FOR CLOSEOUT

- .1 Section 01 33 00 and Section 01 78 00: Submittals for project closeout.
- .2 Submit manufacturer's operation and maintenance instructions for each product.
- .3 Provide a list of all lamp types used on the project, use ANSI and manufacturer's codes.

1.6 DEFINITIONS

- .1 BF: Ballast factor.
- .2 CCT: Correlated colour temperature.
- .3 CRI: Colour-rendering index.
- .4 HID: High-intensity discharge.
- .5 LER: Luminaire efficacy rating.
- .6 LED: Light Emitting Diode.
- .7 Lumen: Measured output of lamp and luminaire, or both.
- .8 Luminaire: Complete lighting fixture, including ballast housing if provided.

1.7 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.8 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 All equipment and parts specified herein shall bear the "ULC Approved" label (or other NRTL label) indicating compliance with UL requirements or as otherwise allowed by the Authority Having Jurisdiction. All luminaires shall be ULC/ NRTL or CSA listed and labeled for installation in fireproof or non-fireproof construction, dry, damp, or wet locations as required.

1.9 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.

1.10 EXTRA MATERIALS

- .1 Provide the following additional equipment as listed herein.
 - .1 Provide an additional 2 per cent spare luminaires of each new type to be provided.
 - .2 Provide 1 per cent of each plastic lens type.
 - .3 Provide 2 per cent replacement lamps for each lamp type.

- .4 Provide three of each type of any special tools required for system use and maintenance.

1.11 WARRANTY

- .1 Refer to Section 26 05 00.
- .2 LED Luminaires shall have a manufacturer's warranty for a period of not less than five years.

2 Products

2.1 LUMINAIRES

- .1 In accordance with related sections.

2.2 MANUFACTURERS

- .1 Basis of Design Supplier / Manufacturer:
 - .1 Peerless Electric (Omnilumen).
- .2 Accepted alternate manufacturers and suppliers:
 - .1 Acuity Brands Lighting.
 - .2 Cooper Lighting Solutions.
 - .3 Salex.
 - .4 Signify.

2.3 LUMINAIRE DISCONNECT PLUGS

- .1 Shall be installed on all 120 V luminaires before the ballast or LED driver inputs.
- .2 Shall be a bright colour to aid in identification as a safety device.
- .3 600V rated.
- .4 Types and application:
 - .1 3-wire disconnect plug to be used for all 3-wire ballasts, such as dimming ballasts using three-wire phase control.
 - .2 2-wire disconnect plug to be used on all other luminaires.
- .5 Code requirements:
 - .1 Listed to UL 2459
 - .2 Listed to CSA 182.3
- .6 Example Manufacturers:
 - .1 Thomas and Betts Marrette Series Luminaire Disconnect
 - .2 Ideal Industries Inc. PowerPlug Series Luminaire Disconnect

3 Execution

3.1 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 Luminaires shall be integrated 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 UL/CSA/NOM requirements.

- .3 Contractor shall be responsible for sealing all outdoor 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 The Contractor shall coordinate the lighting system installation with the relevant trades so as to eliminate interferences with hangers, mechanical ducts, sprinklers, pipes, steel, etc.
- .5 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.
- .6 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.
- .7 All luminaires shall be installed plumb and true and level as viewed from all directions unless specifically identified otherwise in the Luminaire Schedule. Luminaires shall remain plumb and true without continual adjustment or visibly obvious means beyond what is shown on luminaire submittal drawings.
- .8 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.
- .9 Luminaire finishes which are disturbed in any way during construction shall be touched up or refinished in a manner satisfactory to the Consultant.
- .10 Reflector cones, louvers, baffles, lenses, trims and other decorative elements shall be installed after completion of ceiling tile installation, plastering, painting and general cleanup.
- .11 Whenever a luminaire or its hanger canopy is installed directly to a surface mounted junction box, a finishing ring painted to match the ceiling, shall be used to conceal the junction box.
- .12 All lamps shall be seasoned for a minimum of 12 hours and a maximum of 100 hours in full-on mode without dimming. All lamps used for convenience lighting during construction shall be replaced with identical new lamps, which shall then be seasoned as described above, immediately prior to the date of substantial completion as determined by the Consultant.
- .13 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).
- .14 Locate and install luminaires as indicated.
- .15 Provide adequate support to suit ceiling system.
- .16 Install suspended luminaires and exit signs using pendants supported from swivel hangers. Provide pendant length required to suspend luminaire at indicated height.
- .17 Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- .18 Install clips to secure recessed grid-supported luminaires in place.
- .19 Install wall mounted luminaires at height as indicated.
- .20 Install accessories provided with each luminaire.
- .21 Install specified lamps in luminaire.
- .22 Check lighting luminaires and mountings for their electrical and physical characteristics in relation to conditions due to building construction and mechanical equipment. Make necessary adjustments to luminaires or hanging arrangement without expense to Owners. Give notification at time of shop drawings and before construction if decision on necessary changes is required.
- .23 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidably tight locations, provide hangers to clear obstruction. Check layouts of other trades on job and plan co-operatively. Luminaires in any room

shall hang at one height. Obtain approval before any changes are made to layouts shown.

3.2 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 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.
- .3 The Contractor shall be responsible for notifying the Consultant of appropriate time for staking any outdoor luminaire locations which are called out as "to be field located" on drawings and Luminaire Schedule, and shall supply equipment and personnel for staking at the direction of the Consultant.
- .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.

3.3 WIRING

- .1 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.
- .2 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.
- .3 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .4 Bond products and metal accessories to branch circuit equipment grounding conductor.

3.4 LUMINAIRE SUPPORTS

- .1 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.
- .2 Provide chain hangers for new luminaires.

3.5 LUMINAIRE ALIGNMENT

- .1 Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Recessed luminaires shall be installed 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.

3.6 FIELD QUALITY CONTROL

- .1 Operate each luminaire after installation and connection. Inspect for proper connection and operation.
- .2 Wiring connections to the branch circuit shall be made using building wire with insulation suitable for temperature conditions within luminaire.
- .3 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.
- .4 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(s).
- .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.

3.7 CLEANING

- .1 All luminaires and accessories shall be thoroughly cleaned after being installed. All fingerprints, dirt, tar, smudges, drywall mud and 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.

3.8 PROTECTION OF FINISHED WORK

- .1 Re-lamp luminaires that have failed lamps.
- .2 Re-lamp luminaires used for temporary lighting at Substantial Completion.

3.9 COMMISSIONING

- .1 Measure samples of each new luminaire type to be replaced as described in PART 1 of this section for demonstration of energy savings.
- .2 Sensor placement and orientation for all sensor types.
- .3 Occupancy sensor function, sensitivity, and time delays.
- .4 Daylight harvesting sensor calibration.
- .5 Automated shade operation.
- .6 Manual control placement and operation.
- .7 Automated control operation, including scheduled on/off functions and dimming trims and presets.
- .8 Override operation, access, and functionality.
- .9 Centralized control interfaces and operation.
- .10 Client education of operations.
- .11 Documentation archived to client.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Solid state, light emitting diode (LED) source interior luminaires.
- .2 New, fully integrated luminaires for indoor applications.

1.2 RELATED REQUIREMENTS

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 50 00 – Lighting.
- .3 Section 26 52 13.13 – Emergency Lighting.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code, 25th Edition / 2012.
 - .3 CSA C22.2 No. 9.0 - General Requirements for Luminaires.
 - .4 CSA C22.2 No. 250.0 - Luminaires (Bi-National Standard, with UL 1598).
- .2 DesignLights Consortium (DLC).
 - .1 Technical Requirements Table v2.1, 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 TM-21-11- IES Technical Memorandum on Projecting Long Term Lumen Maintenance of LED Light Sources.
- .5 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.

1.4 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.

1.5 ACTION SUBMITTALS

- .1 Refer to Section 26 50 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.

1.6 INFORMATIONAL SUBMITTALS

- .1 Installation instructions.

1.7 CLOSEOUT SUBMITTALS

- .1 Section 26 05 00: Submittals for project closeout.
- .2 Submit manufacturer's operation and maintenance instructions for each product.

1.8 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.

1.9 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 26 05 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

1.11 EXTRA STOCK MATERIALS

- .1 Provide the following additional equipment as listed herein.
 - .1 Provide an additional 2 per cent spare luminaires of each new type to be provided.
 - .2 Provide 1 per cent of each plastic lens type.
 - .3 Provide three of each type of any special tools required for system use and maintenance.

1.12 WARRANTY

- .1 Refer to 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

2.1 MANUFACTURERS

- .1 Basis of Design Supplier / Manufacturer:
 - .1 Peerless Electric (Omnilumen).
- .2 Accepted alternate manufacturers and suppliers:
 - .1 Acuity Brands Lighting.
 - .2 Cooper Lighting Solutions.
 - .3 Salex.
 - .4 Signify.

2.2 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 LM79/80 and published L70 data.
- .4 Available in 3500 K correlated colour temperature, CRI greater than or equal to 80, or as indicated.
- .5 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.
- .6 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.
- .7 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.
- .8 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.
- .9 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.

2.3 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) +/- 10%.
 - .2 Refer to lighting fixture schedule.
- .3 Input frequency 60 Hz.
- .4 Load regulation: +/- 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 degrees C through +80 degrees 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.

2.4 INTERIOR WALL-WASH LED LUMINAIRES

- .1 Minimum Light Output: 575 lm.
- .2 Zonal lumen density:
 - .1 Minimum 60 per cent between 0 degrees and 90 degrees from nadir.
 - .2 Minimum 60 per cent of the lumens must be produced in the “forward” hemisphere, towards the wall.
- .3 Minimum luminaire efficacy: 45 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.5 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): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.6 NOMINAL 610 MM BY 610 MM (2 FOOT BY 2 FOOT) 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): 3500 K
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.7 NOMINAL 305 MM BY 1220 MM (1 FOOT BY 4 FOOT) 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): 3500 K
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.8 NOMINAL 610 MM BY 1220 MM (2 FOOT BY 4 FOOT) 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): 3500 K
- .6 Colour Rendition Index (CRI): 80 CRI minimum.
- .7 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.9 LINEAR AMBIENT LUMINAIRES: INDIRECT

- .1 Minimum Light Output: 500 lm per foot.
- .2 Zonal lumen density:
 - .1 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.10 LINEAR AMBIENT LUMINAIRES: INDIRECT/DIRECT

- .1 Minimum Light Output: 500 lm per foot.
- .2 Zonal lumen density:
 - .1 Minimum 25 per cent between 0 degrees and 60 degrees from nadir.
 - .2 Minimum 50 per cent between 90 degrees and 150 degrees from nadir.
- .3 Minimum luminaire efficacy: 85 lumens per watt.
- .4 Correlated Colour Temperature (CCT): 3500 K

- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.11 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): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.12 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): 3500 K
- .5 Colour Rendition Index (CRI): 80 CRI minimum.
- .6 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation.

2.13 LOW-BAY LUMINAIRES FOR COMMERCIAL AND INDUSTRIAL BUILDINGS

- .1 Minimum Light Output: 5 000 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 LM-80 testing data and TM-21 extrapolation.

3 Execution

3.1 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.

3.2 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 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).

3.3 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 All ladders, scaffolds, lifts, etc. required for aiming and adjusting luminaires shall be furnished by the Contractor.
- .3 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.

3.4 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 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.

3.5 WIRING

- .1 Install luminaire disconnect plugs on all new luminaires not provided as such from the manufacturer.
- .2 Connect luminaires to branch circuit outlets provided under Section 26 05 33.13 using flexible conduit.
- .3 Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- .4 Bond products and metal accessories to branch circuit equipment grounding conductor.

3.6 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.

3.7 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.

3.8 COMMISSIONING

- .1 In accordance with Section 26 08 50.

End of Section

1 General

1.1 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.

1.2 RELATED REQUIREMENTS

- .1 Section 26 50 00 – Lighting.
- .2 Section 26 52 13.16 – Exit Signs.

1.3 REFERENCES

- .1 Underwriters Laboratories, Inc. (UL):
 - .1 UL924 – Standard for Safety of Emergency Lighting and Power Equipment
- .2 Canadian Standards Association (CSA):
 - .1 CSA C22.2 No.141 – Unit Equipment for Emergency Lighting.
 - .2 CSA C22.1 – Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
 - .3 Ontario Electrical Safety Code.
- .3 Ontario Building Code.
- .4 National Building Code of Canada.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 26 05 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.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 26 05 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for emergency lighting for incorporation into manual.

1.6 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.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 26 05 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 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 26 05 00.
- .5 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 19 and Section 26 05 200.

1.9 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

2.1 EMERGENCY BATTERY UNITS

- .1 Manufacturers:
 - .1 Lumacell RG12S series.
 - .2 Approved equal by Emergi-Lite.
 - .3 Approved equal by Stanpro.
 - .4 Approved equal by Beghelli.
- .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 ever 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: 12 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,
 - .3 Voltage regulation: ± 5 per cent 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 12 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.

2.2 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 12 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 Approved equal by Emergi-Lite.

.3 Approved equal by Stanpro.

.4 Approved equal by Beghelli.

3 Execution

3.1 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.

3.2 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.

3.3 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 Testing shall be performed during non-daylight hours. Contractor shall aim all remotes to optimise illumination on the floor and stair.

.4 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.

- .5 Contractor shall notify Owner and consultant at least ten days prior to proposed testing date and schedule testing at time and date acceptable to the Owner.
- .6 Installation shall be in accordance to the electrical code and manufacturer's instructions.
- .7 Provide breaker lock on emergency lighting circuit at source panelboard.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by emergency lighting installation.

3.5 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

1.1 SECTION INCLUDES

- .1 Internally illuminated "Running Man" exit sign units for ordinary location use.

1.2 RELATED REQUIREMENTS

- .1 Section 26 52 13.13 – Emergency Lighting: Emergency Battery Units.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
- .1 CSA C22.2 No.141-10, Unit Equipment for Emergency Lighting.
- .2 CAN/CSA-C860-07, 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 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.
- .4 Ontario Electrical Safety Code.
- .5 Ontario Building Code.

1.4 SUBMITTALS

- .1 Provide submittals in accordance with Section 26 05 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.

1.1 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.

1.2 QUALITY ASSURANCE

- .1 Exit signs units shall be ULC Listed and/or CSA Certified to CSA C22.2 No 141 and 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.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 26 05 00.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 26 05 00.

1.5 WARRANTY

- .1 Product is warranted free of defects in material and workmanship for a minimum of one year from substantial completion.

2 Products

2.1 EXIT SIGNS, GENERAL

.1 Manufacturers

- .1 Aimplite.
- .2 Beghelli.
- .3 Emergi-Lite
- .4 Lumacell.
- .5 Stanpro.
- .6 Other manufacturers as indicated in Section 26 52 13.13.

.2 Substitution Limitations:

- .1 No alternate manufacturers will be accepted.
- .2 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.

.3 Description

- .1 Green and White LED Pictogram "Running Man" exit sign.
- .2 The pictogram sign shall be certified as CSA 22.2 No.141-10, 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 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 unacceptable.

.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 sign in a self-powered configuration shall use a sealed Nickel-Cadmium battery of 2.4V nominal voltage and shall stay illuminated during emergency operation for at least two hours upon AC failure.

2.2 DIE-CAST EDGE-LIT PICTOGRAM EXIT SIGNS FOR SURFACE OR RECESSED MOUNTING APPLICATIONS

- .1 Manufacturers
 - .1 Lumacell LDE series.
 - .2 Equivalent products from manufacturers as described in Article 2.01 of this specification.
- .2 Materials
 - .1 Surface mount:
 - .1 When specified for surface mount, the unit shall come standard with a trim plate, trim ring, back box and canopy made of die-cast aluminum. Colour as indicated in Emergency Lighting and Exit Sign Schedule on drawings.
 - .2 The trim plate shall have a flat (fully recessed) profile and allow for wall or ceiling mount installation.
 - .2 Recessed ceiling mount:
 - .1 When specified for recessed ceiling-mount, the unit shall come standard with a flat trim plate of die-cast aluminum, a back box of galvanized steel, and a hardware kit for back box installation between ceiling joists. The back box shall be provided with conduit knock-outs at the top, back and end.
 - .3 The legend shall be printed on a pure-acrylic panel.
 - .4 The panel shall come standard with double-face legend, for single-face and double-face applications.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install exit lights to manufacturer's recommendations, listing requirements, CSA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits normal power supply and emergency battery units specified in Section 26 52 13.13.
- .3 Ensure that emergency lighting circuit breaker is locked in ON position.
- .4 If arrow left and arrow right is required for T intersection, the contractor shall supply and install two separate pictogram signs.

3.3 CLEANING

- .1 Proceed in accordance with Section 26 05 00.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.4 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 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 Contractor shall notify owner and 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 to the electrical code and manufacturer's instructions.
- .5 Provide breaker lock on emergency lighting circuit at source panelboard.

3.5 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

1.1 SECTION INCLUDES

- .1 Materials and installation for steel lighting poles.
- .2 Cast-in-place architectural concrete bases.

1.2 RELATED REQUIREMENTS

- .1 Section 26 50 00 – Lighting.
- .2 Section 26 56 19 – LED Exterior Lighting.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA C22.2 No. 206-17, Lighting Poles.

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 26 50 00.

2 Products

2.1 CAST-IN-PLACE ARCHITECTURAL CONCRETE BASES

- .1 Use single-use Concrete Forms.
- .2 Provide cast-in-place architectural concrete bases for lighting poles, bollards, floodlights, flagpoles, signs, columns fence posts, other applications.
- .3 Provide bases in styles, sizes, depths and profiles indicated.
- .4 Reinforce bases with vertical steel reinforcing rods and horizontal steel reinforcing ties as noted on the drawings.
- .5 Cast and cure bases.
- .6 Coordinate with installation of conduit at bases for lighting poles, bollards, floodlights and signs.
- .7 Install self-locking, vandal-resistant, wraparound aluminum color accent band around finished bases, where indicated.
- .8 Example Manufacturers:
 - .1 ArtFORMS International Inc. Tel: 905 642-3225, Fax: 905-642-3227,
Email: ArtFORMS@ArtFORMSConcreteBases.com.

2.2 GALVANIZED STEEL POLES

- .1 Galvanized steel or steel poles as indicated on drawings: to CSA C22.2 No. 206 designed for underground wiring and:
 - .1 Suitable for mounting on concrete anchor base.
 - .2 Monotube style, minimum 3.0 mm thick, tapered round, or square as indicated.
 - .3 Access handhole 300 mm (12 inches) above pole base for wiring connections, with welded-on reinforcing frame and bolted-on cover.
 - .4 Galvanized anchor bolts complete with galvanized double nuts and galvanized washers, and plastic bolt covers.
 - .5 Two lugs: one for grounding and one for bonding.
 - .6 Square two-piece aluminium base covers.
 - .7 Manufacturer's standard flat pole cap.

- .8 Effective Projected Area (EPA) rating to meet or exceed the requirement of luminaires, mounting brackets, etc.
- .9 Finishes:
 - .1 Polyester powder coat finish.
 - .2 Inner-coating of water-based automotive-grade corrosion preventative.
- .10 Manufacturer's nameplate indicating manufacturer's name, model number of pole, and date of manufacture with a permanent, stamped/printed or engraved label.
- .2 Example Manufacturers:
 - .1 Aluminous Lighting Products.
 - .2 Dynapole.
 - .3 LSI Industries.
 - .4 Lumec.
 - .5 Polefab.
 - .6 Spina.
 - .7 Valmont West Coast Engineering.

2.3 LUMINAIRE MOUNTING BRACKETS

- .1 Mounting brackets for specified luminaires:
 - .1 Single, twin, and quad brackets as indicated.
 - .2 Provide fixture with mounting pattern to suit existing poles, or allow modification of same.

2.4 LUMINAIRES

- .1 In accordance with Section 26 56 19.

3 Execution

3.1 BASE INSTALLATION

- .1 Install specified below-grade fiber form, reinforcing steel, ducts, etc. to required grade.
- .2 Place form on top of empty fiber form. Position vertical seams in desired direction.
- .3 Pour specified concrete through open top of form into fiber form below. Avoid contact with inside surface. Bring concrete to top of formwork.
- .4 Mechanically vibrate concrete with small vibrator, and vigorously hand tap outside surface of formwork.
- .5 Place and center anchor bolt assembly (or post, etc.) into concrete. Trowel-finish top surface of concrete.
- .6 Base Stripping:
 - .1 Strip concrete form within 24 hours of pouring of base.
 - .2 Cut steel bands. Strip form in two halves. Pry open at the two vertical seams with flat-bladed hand-tool e.g. ice-scraper or square-nose shovel. Insert blade and separate form at top, middle, and bottom of first seam. Repeat for second seam.
 - .3 Wire brush any traces of form material remaining on finished concrete base.
 - .4 Use rubbing stone to make smooth any rough concrete edges around top of base and along vertical seams.
 - .5 If there is risk of damage by construction equipment to exposed base, protect base by tie-wiring or duct taping the two formwork halves back in place around base until safe to remove protection.

- .6 Install color accent band(s), where applicable, in horizontal reveal(s) around finished base.

3.2 POLE INSTALLATION

- .1 Install poles true and plumb, complete with brackets in accordance with manufacturer's instructions.
- .2 Provide label on each pole to allow for individual identification of each pole, minimum 125 mm (5 inch) text height of contrasting colour to that of pole finish, installed at approximately 3048 mm (10 feet) above finished grade.
- .3 Install luminaires on pole and install lamps.
- .4 Check luminaire orientation, level, and tilt.
- .5 Connect luminaire to lighting circuit.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Pole mounted, wall mounted, and canopy mounted solid state, light emitting diode (LED) source exterior luminaires.

1.2 RELATED REQUIREMENTS

- .1 Section 26 09 23 – Lighting Control Devices.
- .2 Section 26 50 00 – Lighting.
- .3 Section 26 56 13 – Lighting Poles and Standards.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code.
 - .3 CSA C22.2 No. 9.0 – General Requirements for Luminaires.
 - .4 CSA C22.2 No. 250.0 – Luminaires (Bi-National Standard, with UL 1598).
 - .5 CAN/CSA-C22.2 No. 250.13 – Light Emitting Diode (LED) equipment for lighting applications.
- .2 DesignLights Consortium (DLC):
 - .1 Technical Requirements table v4.4, 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 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.
- .4 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.
- .5 Underwriters Laboratories Inc. (UL):
 - .1 ANSI/UL 1449, (3rd Edition), Standard for Safety, Surge Protective Devices.

1.4 ACTION SUBMITTALS

- .1 Submit product data in accordance with Section 26 05 00.
- .2 Manufacturer Reports: Provide a point-by-point photometric analysis of the site, in accordance with the procedures laid out in IES RP-20-14, for review by the Consultant. Include point-by-point calculation zones along the property line.
- .3 Product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but not limited to):

- .1 Cut sheets:
 - .1 Luminaire cut sheets.
 - .2 Cut sheets for LED driver(s).
 - .3 Cut sheets for surge protective device, if applicable.
- .2 Highlight lumen package, IES distribution type (if applicable), and input watts of the luminaire.
- .3 Instructions for installation and maintenance.
- .4 Performance data:
 - .1 Maximum power, in Watts.
 - .2 L70 lumen maintenance data, in hours, when extrapolated for the worse case operating temperature. Submit IES TM-21 report to demonstrate this.
- .5 Performance data that is derived in accordance with appropriate IES testing standards and tested in a laboratory that is NVLAP accredited for Energy Efficient Lighting Products. Include:
 - .1 Name of test laboratory.
 - .2 Report number.
 - .3 Data.
 - .4 Complete luminaire catalogue number.
 - .5 Provide explanation if catalogue number in test report does not match catalogue number of luminaire submitted. Clarify whether discrepancy does not affect performance, e.g. in the case of differing luminaire housing colour.

1.5 QUALITY ASSURANCE

- .1 Luminaire tested to IESNA LM 79-08.
- .2 Design Qualification Testing performed by a National Voluntary Laboratory Accreditation Program (NVLAP) testing facility. Such testing may be performed by the manufacturer, or an independent testing lab hired by the manufacturer on new luminaire designs, and when a major design change has been implemented on an existing design. A major design change is defined as a design change (electrical or physical) which changes any of the performance characteristics of the luminaire, results in a different circuit configuration for the power supply, or changes the layout of the individual LED's in the module.
- .3 Products certified by a recognized testing agency accredited by the Standards Council of Canada, and bearing a certification mark from that agency. Certification shall include wet location rating.

1.6 WARRANTY

- .1 Manufacturer 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 to cover all components comprising the luminaire.
- .2 All warranty documentation shall be provided to customer prior to the first shipment.
- .3 Manufacturer to confirm that the addition of third party bird spikes will not compromise luminaire warranty.

2 Products

2.1 MANUFACTURERS

- .1 Basis of Design Supplier / Manufacturer:
 - .1 Peerless Electric (Omnilumen).
- .2 Accepted alternate manufacturers and suppliers:
 - .1 Acuity Brands Lighting.
 - .2 Cooper Lighting Solutions.

- .3 Salex.
- .4 Signify.

2.2 OUTDOOR LED LUMINAIRES, GENERAL

- .1 Maximum nominal luminaire input wattage as specified for each luminaire type as indicated on the Lighting Fixture Schedule. Nominal input wattage accounting for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
- .2 Luminaires designed for ease of component replacement and end-of-life disassembly.
- .3 Input Voltage:
 - .1 As indicated on Lighting Fixture Schedule.
 - .2 Driver to be compatible with system voltage without use of a step-down transformer. If the manufacturer's standard product offering cannot achieve this, clearly indicate on the shop drawings and clearly indicate location of transformer.
- .4 Surge Protection
 - .1 UL 1449 recognized surge protective device that is wired in front of the driver(s) and protects the luminaire to a minimum Category C Low (per ANSI/IEEE C62.41.2).
- .5 Power Factor and Total Harmonic Distortion
 - .1 Power factor of greater than or equal to 0.9.
 - .2 THD of less than or equal to 20 per cent.
- .6 Gasket: neoprene seal between refractor and housing.
- .7 Light Distributions:
 - .1 Fixtures available with IES distribution types I, II, III, IV, V, and other distributions, as noted, and distribution shall be adjustable or replaceable in the field.
 - .2 Pole mounted luminaire shall have an available option for low-profile house-side shield.
- .8 Self-locking latches of stainless steel and aluminum.
- .9 Factory wired including integral driver, terminated at terminal block.
- .10 Luminaires with cast aluminum weatherproof housing.
- .11 Ingress protection: sealed against moisture and environmental contaminants to IP65 rating or better for both light engines/optics and overall luminaire.
- .12 Finishes
 - .1 Housing and heat sink finished in polyester powder coat paint, minimum 2.5 mil nominal thickness.
 - .2 Standard finish colours to include black, bronze, grey, white, dark platinum and graphite metallic.
 - .3 RAL and custom color matches to be available as indicated on the lighting fixture schedule.

2.3 OUTDOOR POLE/ARM MOUNTED AREA AND ROADWAY LED LUMINAIRES

- .1 Pole mounted luminaires suitable for the EPA rating of the pole.
- .2 Pole finish colour to match that of luminaire.
- .3 Lamp type: Light Emitting Diode (LED) source.
 - .1 Minimum Light Output: 1 000 lm.
 - .2 Zonal Lumen Density:

- .1 100 per cent between 0 degrees and 90 degrees from nadir.
- .2 Less than or equal to 10 per cent between 80 degrees and 90 degrees from nadir.
- .3 Minimum luminaire efficacy: 70 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 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation. LM-80 testing is to utilize 10 000 hour testing data.

2.4 OUTDOOR WALL MOUNTED AREA LED LUMINAIRES

- .1 Lamp type: Light Emitting Diode (LED) source.
 - .1 Minimum Light Output: 300 lm.
 - .2 Zonal Lumen Density:
 - .1 100 per cent between 0 degrees and 90 degrees from nadir.
 - .2 Less than or equal to 10 per cent between 80 degrees and 90 degrees from nadir.
 - .3 Minimum luminaire efficacy: 70 lumens per watt.
 - .4 Correlated Colour Temperature (CCT): 4000 K
 - .5 Colour Rendition Index (CRI): 70 CRI minimum.
 - .1 Minimum L70 lumen maintenance to occur at 50 000 hours in accordance with LM-80 testing data and TM-21 extrapolation. LM-80 testing is to utilize 10 000 hour testing data.

2.5 FIXTURE MOUNTED CONTROLS PROVISION

- .1 Provide NEMA 7-pin receptacle on all pole mounted luminaires, complete with shorting cap.
 - .1 Shorting Cap, Locking-Type Mounting: 3-prong locking-type plug connector. It is used with luminaires with a photocontrol receptacle to complete circuit when a photocontrol is not required.
 - .2 Basis of design: Intermatic K4500 series.

3 Execution

3.1 INSTALLATION

- .1 Install luminaires on poles in accordance with Section 26 56 13.
- .2 Check luminaire orientation, level, and tilt.
- .3 For wall mounted luminaires:
 - .1 General Contractor to provide a smooth grinding of brick to ensure a flush contact between luminaires and wall.
 - .2 Provide a silicone seal around the luminaire.
- .4 Connect luminaire to lighting circuit.
- .5 Provide field installed bird spikes on all luminaires.
 - .1 Fasten to luminaire with adhesive, or ties to maintain manufacturer's warranty on luminaire.
 - .2 Fastening by screws or nails: not permitted.
- .6 Perform tests in accordance with Section 26 50 00.

3.2 SITE TESTS AND INSPECTIONS

- .1 Perform lighting system commissioning in accordance with Section 26 08 50.
- .2 Perform light meter testing at night and report values to the Consultant.

End of Section



The Corporation of the City of Brampton

IT Performance Specification

Division 27, Communications

New Build

Version 1.6

March 18, 2021

Revised by:

Marc Flores

Network Administrator – Cable Plant

**This document is a living document and will be updated as needed.
It is the Consultant / Contractors responsibility to inquire with CoB IT Department that
the latest version of this document is being used.**

Table of Contents

REVISION HISTORY	1
GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS	2
INTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS.....	4
EXTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS	8
IDENTIFICATION FOR COMMUNICATION SYSTEMS.....	12
FIRESTOPPING.....	15
COMMUNICATION EQUIPMENT ROOMS.....	21
COPPER BACKBONE CATEGORY 3.....	27
COMMUNICATIONS FIBRE BACKBONE MULTIMODE 550	30
COMMUNICATION HORIZONTAL CABLING CAT 6	34
COMMUNICATION CONSOLIDATION POINTS.....	39
COMMUNICATION WIRELESS ACCESS POINT OUTLETS.....	42
COMMUNICATION MUTOA OUTLETS.....	45
TESTING OF COMMUNICATIONS SYSTEMS	47
SYSTIMAX STANDARDS SPECIFICATION GUIDELINES.....	50
APPENDIX A – APPROVED MATERIALS LIST.....	52
APPENDIX B – TYPICAL LAN ROOM LAYOUTS	54
APPENDIX C – OUTLET MOUNTING HEIGHTS AND PATCH CABLE COLOURS.....	58

REVISION HISTORY

Version #	Date	Revised by	Description of Revisions
1.1	18-Jan-06	MCW Consultants	Initial Creation
1.2	26-Feb-10	David Barnwell	Addition of test-results/as-built documentation requirements, cabinet layout, triple became double drop standard. UPS requirements added
1.3	23-Feb-15	David Barnwell	Removed Cat5e and lower performance fibre
1.4	15-Jun-17	Marc Flores	Updated Labeling, added Appendixes, removed part numbers from spec materials and referred to appendixes (Refer to Appendix for part number changes). Document combined into 1 Living document. Added Fire stopping section.
1.5	31-Jan-19	Marc Flores	Updated patch cable colouring standards Removed Gigaspeed patch panel and replaced with only M2000 patch panels Revised appendix drawings
1.6	18-March-21	Marc Flores	Added CAT6a cabling for Wifi Access Points Revised part numbers in Wireless section 271544 appendix.

GROUNDING AND BONDING FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation, inspection and testing of grounding and bonding systems and items contained within as described in these performance specifications and summarized in the following elements of the work:

- .1 The scope of work included within the section includes grounding and bonding requirements of communication systems.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of grounding and bonding systems and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer-Owner Outside Plant Design Manual
- Cisca – Ceiling and Interior Systems Construction Association

2.2 All bonding and grounding elements shall be constructed from copper.

2.3 Provide a solid copper tin plated busbar with holes for use with standard-sized two hole lugs, have minimum dimensions of 6.3 mm x 100 mm x 610 mm (0.25 in x 4 in x 12 in) within the main communication room mounted to the backboard.

- 2.4 Provide a solid copper tin plated busbar with holes for use with standard-sized two hole lugs, have minimum dimensions of 6.3 mm x 100 mm x 305 mm (0.25 in x 4 in x 6 in) within each communication room mounted to the backboard.

- 2.5 Provide a continuous unbroken Telecommunication Bonding Backbone (TBB) wire between the main communication room grounding busbar and the grounding busbar of the communication room on the top floor of a multi-story building. TBB shall be sized based on the following:

TBB Length Linear m (ft)	TBB Size AWG
Less than 4 (13)	6
4 to 6 (13 to 20)	4
6 to 8 (20 to 26)	3
8 to 10 (26 to 33)	2
10 to 13 (33 to 44)	1
13 to 16 (44 to 52)	1/0
16 to 20 (52 to 66)	2/0
Greater than 20 (66)	3/0

- 2.6 Each communication room in a multi-story building shall be bonded to the TBB with a wire sized to match that of the TBB. The bonding wire shall be coupled to the TBB with an exothermic weld.
- 2.7 All cabinets, cable trays, conduits and intrabuilding armoured cable shall be bonded to the busbar in the room to which they are located with a minimum #6 AWG wire.
- 2.8 All metal parts of the access floor shall be bonded to ground in accordance with CEC Rule 10-406. A minimum of every fourth pedestal shall be bonded to ground with a minimum #6 AWG wire.
- 2.9 Bond wire basket cable trays to ground in the following way:
- .1 Ground at the end of a continuous run
 - .2 Ground continuous runs every 18.3 m (60 ft).
 - .3 All on-site fabricated sections (any sections that have been cut in any way) shall be bonded to ground at both ends. This includes but is not limited to Bends, Crosses, Tees, "Y" fittings and vertical fittings.
 - .4 Each section of tray that is spliced to another section of tray shall be spliced with a minimum of four (4) splices. Either Flexmate or Splice Washers shall be used for splicing.

3 **MATERIALS**
NIL

4 **FIELD QUALITY CONTROL**
NIL

INTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.2 Include detailed design, manufacturer, supply, installation and inspection of communication pathway systems as described in these performance specifications and summarized in the following elements of the work:

.2 The scope of work included within the section includes conduits, cable trays and slings supports.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of pathway systems shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure
- BICSI – Telecommunication Distribution Methods Manual

2.2 Outlet boxes shall be 100 mm (4 in) x 100 mm (4 in) x 57 mm (2.25 in) with a single gang adapter plate. Outlet boxes designated for an open office area shall be mounted at 775 mm (30.5 in) AFF. Outlet boxes designated as voice for a wall mounted public phone shall be mounted at 1120 mm (44 in) AFF. Mounting heights measured from the bottom of the outlet box.

2.3 A minimum of one 27 mm (1 in) conduit shall run from the outlet box to the ceiling space. A conduit run shall serve no more than one outlet box.

2.4 Sling supports shall support the cable every 1.2 m (4 ft) from the conduit to the nearest cable tray.

2.5 Cable tray sized not to exceed 40% fill shall be the main pathway system. Run cable tray in a continuous run through every main corridor and walk way and up to the exterior wall of the communication rooms.

2.6 Cable shall pass through into the communication rooms from the cable tray with the use of an appropriately rated re-enterable firestop sized to not exceed 40% fill.

2.7 Cable tray sized not to exceed 40% fill shall be the main pathway system within the communications rooms and data centres. Run cable tray in such a way as to continuously support horizontal cable and backbone cable between cable entrance points, backboards and cabinets.

- 2.8 Cable tray shall be modified on-site by the contractor as per manufacturer's specifications to suit the design and on-site conditions.
- 2.9 All cable tray inner corners shall consist of a 45-degree angle not a 90 degree angle. In corridors, a sweep bend shall be used consisting of a 300 mm (11.8 in) radius for 150 mm (6 in) wide cable tray, 400 mm (15.85 in) radius for 300 mm (12 in) wide cable tray and 500 mm (19.7 in) radius for 450 mm (18 in) wide cable tray.
- 2.10 Cable trays shall be installed a minimum of 75 mm (3 in) above T-bar ceilings and have a minimum of 150 mm (6 in) of clear space above the cable tray.
- 2.11 Cable trays shall be supported at both ends of each section of 3m (10 ft.), 600 mm (12 in) from the ends.
- 2.12 All pathways shall avoid potential sources of electromagnetic interference by maintaining clearances of at least:
- a. 305 mm (1 ft.) from fluorescent ballasts.
 - b. 305 mm (1 ft.) from electrical power distribution conduit and cable, less than 1kV.
 - c. 1000 mm (3.3 ft.) from electrical power distribution conduit and cable, more than 1kV.
 - d. 1220 mm (4 ft.) from motors and transformers.
 - e. 305 mm (1 ft.) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and power distribution and conduits.
 - f. 305 mm (1 ft.) from HVAC equipment, ducts and pipes
- 2.13 Conduit capacity shall never exceed 40% fill as per TIA/EIA-569-B standards. Conduit capacity shall be as follows:

Conduit Size mm (in)	Cable Diameter mm (in)	
	<=6.1 (0.24)	7.4 (0.29)
21 (0.75)	3	2
27 (1)	6	3
35 (1.25)	10	6
41 (1.5)	15	7
53 (2)	20	14
63 (2.5)	30	17
78 (3)	40	20

- 2.14 If the capacity of the conduit is exceeded, then the next trade size shall be used.
- 2.15 If conduit has an internal diameter of 53 mm (2 in) or less, then the bend radius shall be at least six times the internal diameter. If conduit has an internal diameter of more than 53 mm (2 in) then the bend radius shall be at least ten times the internal diameter.
- 2.16 The maximum number of bends between cable pull boxes in a conduit run shall be two 90° bends.
- 2.17 Conduit runs shall have no continuous sections longer than 30 m (100 ft.).

2.18 If a conduit run requires a reverse bend between 100 ° and 180 ° then a pull box shall be inserted at the bend.

2.19 Pull boxes shall be adequately sized for the radius of the connecting conduits and the manufacturer's specified cable bend radius, as follows:

Conduit Size mm (in)	Pull Box Width mm (in)	Pull Box Length mm (in)	Pull Box Depth mm (in)	Width Increase for Additional Conduit mm (in)
27 (1)	102 (4)	406 (16)	76 (3)	51 (2)
35 (1.25)	152 (6)	50 (20)	76 (30)	76 (3)
41 (1.5)	203 (8)	686 (27)	102 (4)	102 (4)
53 (2)	203 (8)	914 (36)	102 (4)	127 (5)
78 (3)	305 (12)	1219 (48)	127 (5)	152 (6)

2.20 Pull boxes shall be installed in fully accessible ceiling spaces.

2.21 Support and secure all boxes independent of the conduit connected thereto.

2.22 All conduit ends shall be protected by insulating bushings.

2.23 Use only manufacturer approved cable lubricants. Any excess lubricant shall be cleaned to leave conduit exteriors suitable for painting.

2.24 All conduits shall be left with a nylon pull string installed.

3 MATERIALS

3.1 Obtain cable tray components through one source from a single manufacturer.

3.2 Cable tray shall have the following characteristics:

- .1 Continuous, rigid, welded steel wire mesh.
- .2 Continuous T-weld on top rail of tray.
- .3 All cable tray shall be purchased in 3 m (10 ft.) straight sections.
- .4 Finish: electroplated zinc coating

3.3 Obtain sling support components through one source from a single manufacturer.

3.4 Sling supports shall have the following characteristics:

- .1 Comply with UL and EIA/TIA requirements for structured cabling systems.
- .2 Comply with NFPA 90A for plenum spaces.
- .3 Rated load weight shall be 100 lbs.

4 FIELD QUALITY CONTROL

4.1 NIL

EXTERIOR PATHWAYS FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

1.3 Include detailed design, manufacturer, supply, installation and inspection of communication pathway systems as described in these performance specifications and summarized in the following elements of the work:

.3 The scope of work included within the section includes underground ducts and maintenance holes.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of pathway systems shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- TIA/EIA-569-B Commercial Building Standard for Telecommunications Pathways and Spaces
- TIA/EIA
 - Provide a minimum of three 103mm (4") conduits from the property line (location to be recommended by the utility) to the entrance facility designated for Access Provider use. Do not include more than two 90-degree bends in the conduit run between pull points. Never exceed a 90-degree bend. Conduits entering the room shall extend above the floor by 103 mm (4 in) AFF or extend down below the ceiling to 2.4 m (8 ft.) AFF. All conduits entering the building shall be sealed with a rubber plug or water plug.
-
- -606-A Administration Standard for Commercial Telecommunications Infrastructure
- BICSI – Telecommunication Distribution Methods Manual
- BICSI - Customer Owner Outside Plant Design Manual

2.2 A minimum of four (4) 103 mm (4 in) underground ducts shall connect two campus buildings. All campus buildings shall be connected to the building containing the main campus equipment room or data centre in a star configuration.

2.3 Only data, voice, CATV, security and fire alarm communication cables shall occupy these underground ducts. All other services such as power shall be run in a separate duct system.

2.4 Data, voice, CATV and security/fire alarm shall each be run in a separate conduit within the same duct system.

-
- 2.5 A maintenance hole shall be located within a duct run whenever one of the following apply:
- When calculation results for conduit pulling, tension exceeds the cable manufacturers recommended limits (typical cable cannot exceed a total installation load of 2700 Newton, 600 lbs.).
 - When a cables maximum available reel length is exceeded and a splice to a second length of cable is required.
 - Whenever a splice is required to split a large cable into two or more cables (for example a 24-strand fibre cable spliced to two 12-strand fibre cables).
- 2.7 The following equation shall be used to calculated pulling tensions for straight inclined or horizontal conduit: $T = T_0 + w (fx \pm h)$
- T = the pulling tension.
 - T_0 = the tail load at the reel, typically a load of 890 Newton (200 lbf).
 - f = coefficient of friction between the cable and conduit, typically 0.36 for PVC conduit and low density polyethylene.
 - w = weight per unit length of cable (N/m or lb/ft). For metric units, the cable weight (Kg) must be converted to the force of its weight by multiplying it by 9.8 N/Kg.
 - x = horizontal projection of segment.
 - h = vertical projection of segment (h is positive for an increase in elevation, negative for a decrease in elevation and 0 for no change in elevation).
- 2.8 The following equation shall be used to calculated pulling tensions for uniformly curved segment of conduit: $T = (wr) PTR$
- T = the pulling tension.
 - T_0 = the tail load from the previous section.
 - f = coefficient of friction between the cable and conduit, typically 0.36 for PVC conduit and low density polyethylene.
 - w = weight per unit length of cable (N/m or lb/ft.). For metric units, the cable weight (Kg) must be converted to the force of its weight by multiplying it by 9.8 N/Kg.
 - r = radius of curvature of the bend (m or ft.).
 - a = displacement angle of bend (degrees).
 - PTR = pulling tension ratio as calculated from the chart below:

T ₀ (wr)	f a													
	5	10	15	20	25	30	35	40	45	50	55	60	65	70
0.2	0.29	0.38	0.48	0.58	0.68	0.79	0.90	1.02	1.15	1.29	1.44	1.59	1.76	1.95
0.4	0.50	0.60	0.70	0.81	0.92	1.05	1.18	1.32	1.47	1.63	1.80	1.99	2.19	2.41
0.7	0.81	0.92	1.05	1.18	1.32	1.47	1.63	1.80	1.99	2.19	2.41	2.65	2.90	3.18
1.1	1.23	1.38	1.53	1.70	1.88	2.07	2.28	2.50	2.75	3.01	3.30	3.62	3.96	4.33
1.8	1.99	2.19	2.41	2.64	2.90	3.18	3.48	3.81	4.17	4.56	4.99	5.45	5.96	6.51
2.8	3.07	3.36	3.68	4.03	4.41	4.82	5.27	5.76	6.29	6.87	7.50	8.19	8.95	9.77
4.5	4.92	5.38	5.88	6.42	7.01	7.66	8.36	9.13	10.0	10.9	11.9	13.0	14.1	15.4
6.5	7.10	7.75	8.47	9.24	10.1	11.0	12.0	13.1	14.3	15.6	17.1	18.6	20.3	22.2
9.3	10.2	11.1	12.1	13.2	14.4	15.7	17.2	18.7	20.4	22.3	24.3	26.6	29.0	31.6
12.0	13.1	14.3	15.6	17.0	18.6	20.3	22.1	24.2	26.4	28.8	31.4	34.2	37.4	40.8
16.0	17.5	19.1	20.8	22.7	24.8	27.0	29.5	32.2	35.1	38.3	41.8	45.6	49.8	54.3
20.0	21.8	23.8	26.0	28.4	31.0	33.8	36.9	40.2	43.9	47.9	52.3	57.0	62.2	67.9
24.5	26.7	29.2	31.8	34.7	37.9	41.4	45.1	49.3	53.7	58.7	64.0	69.8	76.2	83.2
30.0	32.7	35.7	39.0	42.5	46.4	50.6	55.3	60.3	65.8	71.8	78.4	85.5	93.3	102
37.0	40.4	44.1	48.1	52.5	57.2	62.5	68.2	74.4	81.2	88.6	96.6	105	115	126
45.0	49.1	53.6	58.5	63.8	69.6	76.0	82.9	90.5	98.7	108	118	128	140	153
54.0	58.9	64.3	70.2	76.6	83.5	91.2	99.5	109	118	129	141	154	168	183
65.0	70.9	77.4	84.5	92.2	101	110	120	131	143	156	170	185	202	221
77.0	84.0	91.7	100	109	119	130	142	155	169	184	201	219	239	261
89.0	97.1	106	116	126	138	150	164	179	195	213	232	254	277	302
100	109	119	130	142	155	169	184	201	219	239	261	285	311	339

2.9 Pulling tensions shall be calculated from both ends as if the cable were pulled from either end and the worst case shall be used as the reference. However installers should pull from the end with the lower tension.

2.10 Maintenance holes shall have the following characteristics:

- Precast
- Minimum interior dimensions of 3.6m (12ft) long x 1.8m (6ft) wide x 2.1m (7ft) high
- Equipped with a built-in sump
- Minimum entrance opening of 762 mm (30") interior diameter
- Equipped with a corrosion-resistant pulling iron at either end
- Grounding system
- Cable racks on both side
- Fixed or movable ladder
- Capable of supporting the heaviest anticipated weight, based on the following table:

Rating	Heaviest anticipated weight
Light duty	Pedestrian traffic only
H-5 (5,000 Kg)	Sidewalk applications and occasional non-deliberate traffic
H-10 (10,000 Kg)	Driveways, parking lots, and off-road applications subject to non-deliberate heavy traffic
H-20 (20,000 Kg)	Deliberate heavy traffic

- 2.11 Maintenance holes shall be located based on the following:
- Out of the roadway (when possible)
 - Away from locations where water is likely to pool
 - Allow for adequate traffic control when the MH is open
 - Not jeopardize vehicular or pedestrian traffic flow.
 - Not in or near an intersection or near a point where a curve occurs in a road.
- 2.12 Duct systems shall have the following clearances:
- Below the frost line
 - 150 mm (6 in) when crossing pipes
 - 300 mm (12 in) when parallel to pipes
 - 75 mm (3 in) from power run in concrete
 - 300 mm (12 in) from power direct buried
- 2.13 All duct runs and maintenance holes shall be clearly shown on as built drawings indicating number and size of ducts and the cable size in fibre strands and copper pairs contained within.
- 3 **MATERIALS**
- 3.1 NIL
- 4 **FIELD QUALITY CONTROL**
- 4.1 NIL

IDENTIFICATION FOR COMMUNICATION SYSTEMS

1 SCOPE OF WORK

- 1.2 Include detailed identification and administration of communication system as described in these performance specifications and summarized in the following elements of the work:
- .3 The scope of work included within the section includes identification and administration of an end-to-end structured cabling system and its pathways and spaces.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Inspection, testing and administration of identification and administration shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
 - TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI - Customer Owner Outside Plant Design Manual
- 2.2 Labelling shall be in accordance with the following:
- .1 All labelling shall be mechanically printed and follow the TIA/EIA-606-A guidelines and be in accordance with the requirements of this specification. Hand written labels are not permitted.
- .2 Cable labels shall be Vinyl construction with a white printing area and a clear tail that self-laminate the printed area when wrapped around the cable. The clear area should be of sufficient length to wrap around the cable at least 1.5 times.

-
- .3 Vinyl identification labels shall appear on the following locations with the designations indicated on the cable schedule and drawings:
- Port identification on both ends of every cable
 - Port identification on the front of all faceplates
 - Port identification on the front of all patch panels
 - Panel identification on the front top right hand corner of all patch panels
 - Pair identification on the front of termination fields
 - Wireless identification on the front of all wireless access points
- .4 Lamicoid identification labels shall appear on the following locations with the designations indicated on the cable schedule and drawings:
- Cabinet identification on the top right hand side of the cabinet
- .5 All firestops shall be labelled stating "WARNING FIRESTOP SEAL DO NOT DISTURB" and also the contractors name, address and phone number, date installed, fire rating.
- .6 Horizontal cabling systems (faceplate ports, cable, patch panel ports) shall use the following labelling scheme: (DO NOT USE **X** IN THE LABELING USE LAN ROOM LETTER)
- 1st Data = **X**-001A where '**X**' = '**LAN ROOM LETTER**', '001' = 'port number' and 'A' = 1st data port
 - 2nd Data = **X**-001B where '**X**' = '**LAN ROOM LETTER**', '001' = 'port number' and 'B' = 2nd data port
- .7 Backbone cabling shall use the following labelling scheme (DO NOT USE **X** IN THE LABELING USE LAN ROOM LETTER):
- **TCX-2**-001-200 where '**TCX**' = 'Telecommunication **X**', '2' = '2 floor communication room' and '001-200' = 'port 1-200'
- 8 Cabinets shall use the following labelling scheme:
- **TCX-1A** where 'TCA' = 'Telecommunication LAN Letter', "Cabinet Number"
- .9 Wireless access points shall use the following labelling scheme: *(See Appendix for Cable and Jack Colours)*
- **X-W-01** where WL = 'WIRELESS', 01 = 'wireless port number' increasing by 1 for each extra wireless access point. W-02, W-03 etc. **(Where X is the LAN room Letter this drop terminates to)**
- .10 Elevator drops shall use the following labelling scheme: *(See Appendix for Cable and Jack Colours)* X = Lan room Letter
- **X-EL-01** where EL = 'Elevator', 01 = 'port number' . **(Where X is the LAN room Letter this drop terminates to)**

.11 Fire control panels shall use the following labelling scheme: *(See Appendix for Cable and Jack Colours)* X = Lan room Letter

- **X-FR-01** where FR = 'Fire', 01 = 'port number' **(Where X is the LAN room Letter this drop terminates to)**

.12 Bonding and grounding systems shall use the following labelling scheme:

- TMGB where 'TMGB' = 'Telecommunication Main Grounding Busbar'
- TGB-4B where 'TGB' = 'Telecommunication Grounding Busbar' and '4B' = '4th floor communication room B' and
- ESBC where 'ESBC' = 'Electrical Service Bonding Conductor'
- TBB-4B where 'TBB' = 'Telecommunication Bonding Backbone' and '4B' = '4th floor communication room B' and
- EBC-TCA where 'EBC' = 'Equipment Bonding Conductor', 'TCA' = 'Telecommunication Cabinet A'
- CBC-TCA-4B-001-200 where 'CBC' = 'Cable Bonding Conductor', 'TCA' = 'Telecommunication Cabinet A', '4B' = '4th floor communication room B' and '001-200' = 'port 1-200'

2.3 As-built drawings shall include, but are not limited to, the following:

- Work area port designations
- Main routing of pathways
- Cabinet elevations
- Backboard elevations
- Communication room layouts
- Riser routing and cable counts

2.4 A full-size copy of the as-built drawings shall be placed in every communication room.

3 **MATERIALS**
NIL

4 **FIELD QUALITY CONTROL**
NIL

FIRESTOPPING

NOTE TO SPECIFIER: in the design using EZ-Path - do not take tray through wall: Coordinate drawings to show tray terminating at wall or floor and resuming on other side.

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes Labor, materials and equipment necessary to complete the installation required for the items specified under this Section, including but not limited to:
 - 1. Firestopping of Through Penetrations in Fire Rated Assemblies.

1.2 RELATED SECTIONS

- A. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
- B. This Specification should be considered as an augmentation to Section 07 84 00 Firestopping and any or all sub sections of Section 07 84 00.
- C. This Section addresses those unique elements that affect the Firestopping of Information Technology cabling systems which may not be addressed in 07 85 00 or any of its sub-sections.

1.3 REFERENCES

- A. CAN4-S115-M, "Standard Method of Fire Tests of Firestop Systems".
- B. CAN/ULC-S115, "Standard Method of Fire Tests of Firestop Systems".
- C. Underwriters Laboratories Canada Inc. (ULC) – Fire Resistance Directory
- D. Underwriters Laboratories, Inc. (cUL) – Fire Resistance Directory of Products Certified for use in Canada.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire rated cable pathway devices shall be used for ALL low-voltage, video, data and voice cabling, optical fibre raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:
 - 1. Meet the hourly fire-rating of fire rated wall and or floor penetrated.
 - 2. Be tested for the surrounding construction and cable types involved.
 - 3. Have ULC, cUL or cULus Systems permitting cable loads from; "Zero to 100% Visual Fill." This requirement eliminates need for fill-ratio calculations to be made

-
- by cable technicians to ensure cable load is within maximum allowed by ULC, cUL or cULus System.
4. Not have a constrictive inner liner that tightens around or compresses cables tightly together encouraging potential cross-talk or interference.
 5. Be "Zero-Maintenance", zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
 - a. Opening or closing of doors.
 - b. Spinning rings to open or close fabric liner.
 - c. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
 - d. Furnish letter from manufacturer certifying compliance with this definition of "Zero-Maintenance".
 6. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
 7. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
 8. Cable Pathway Devices passing vertically through floors shall have equal FT Rating. (See UL System # F-A-3037, Item #4 "EZ-PATH Grid T-Rating Kit" Part # TRK444)
 9. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
- B. Where non-mechanical pathways must be utilized, such as sealing (caulking) around single or grouped conduits, 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. Provide letter from manufacturer certifying compliance with this section.
- C. Cable pathway shall replace conduit sleeves in walls and floors, and;
 - a. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
 - b. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.
 - c. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates.
 - d. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.
- D. Cable tray shall terminate at each fire barrier and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of fire barrier.

Note to Specifier: Coordinate drawings to show tray terminating at wall or floor and resuming on other side.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. 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.
- C. Schedule of ULC, cUL or cULus System Drawings: Submit schedule of all expected opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings. If engineering recommendations are necessary, list these in the schedule too.
- D. ULC, cUL or cULus System Drawings: Furnish copies of all ULC, cUL or cULus Systems identified in schedule above. Include any engineering recommendations.
- E. Certificates: Product Certificate of Compliance from the firestop system manufacturer certifying material compliance with applicable code and specified performance characteristics.
- F. Installation Instructions: Submit manufacturer's printed installation instructions.

1.6 QUALITY ASSURANCE

- A. 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 ULC, cUL or cULus, 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.
- B. 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.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. 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 multi-component 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.
- B. Storage and Protection:

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

1.8 PROJECT CONDITIONS

- A. Do not install firestopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- B. Do not install firestopping products when substrates are wet due to rain, frost, condensation, or other causes.
- C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- D. Do not use materials that contain flammable solvents.
- E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Specified Technologies Inc., or Approved Alternative.
- B. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

2.2 MATERIALS

- A. 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.
- B. Firestop Sealants: STI SpecSeal® Brand or Approved Alternate single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
 1. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant or Approved Alternate.
 2. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant or Approved Alternate.

- C. Firestop Putty: STI SpecSeal® Brand or Approved Alternate intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty or Approved Alternate
- D. Firestop Pillows: STI SpecSeal® Brand or Approved Alternate re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame retardant poly bag, the following products are acceptable:
 - 1. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows or Approved Alternate.
- E. Fire Rated Cable Pathways: STI EZ-PATH™ Brand or Approved Alternate device modules comprised of 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™ or Approved Alternate Fire Rated Pathway
 - a. Series 22 or Approved Alternate
 - b. Series 33 or Approved Alternate
 - c. Series 44 or Approved Alternate

Note to Specifier: Coordinate drawings to show size device desired to accommodate future cabel capacity. If no size is specified, contractors will use smallest size. Labor to install all three sizes is approximately the same.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. 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.
- B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to protect adjacent surfaces.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. 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.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.

3.3 FIELD QUALITY CONTROL

- A. Inspections: Owner shall engage qualified independent inspection agency to inspect through-penetration firestop systems.
- B. Keep areas of work accessible until inspection by authorities having jurisdiction.
- C. Where deficiencies are found, repair firestopping products so they comply with requirements.

3.4 ADJUSTING AND CLEANING

- A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- B. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

3.5 SCHEDULES:

Review this list and update as required, Contact STI for assistance

Penetrant Type	Concrete Floor	Concrete Wall	Gypsum Board Wall
Blank Opening	C-AJ-0100, C-AJ-0101	C-AJ-0100, C-AJ-101	
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Conduits/ Raceways	C-AJ-2140, C-AJ-2292	W-J-2018, W-J-2076	W-L-2093, W-L-2241
Cables	C-AJ-3214, C-AJ-3231, F-A-3015	C-AJ-3214, C-AJ-3231, W-J-3098, W-J-3099	W-L-3218, W-L-3219
Cable Trays	C-AJ-4029	W-J-4021, W-J-4022, W-J-4033	W-L-4008, W-L-4029, W-L-4043

3.6 DOCUMENTATION

- A. Place system stickers on each side of wall penetrations.
- B. Place a reproduction (photo copy) of the UL System description in a document protector and mount to the wall next to the wall penetration
 - 1. Highlight the section of the system description that lists the allowed cable types.

COMMUNICATION EQUIPMENT ROOMS

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply, installation, inspection and testing of communication rooms and items contained within as described in these performance specifications and summarized in the following elements of the work:
- .2 The scope of work included within the section includes architectural requirements, electrical systems, environmental requirements, cable management and pathways, and cabinets.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of communication rooms and related items shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
 - TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
 - BICSI – Customer-Owner Outside Plant Design Manual
 - Cisca – Ceiling and Interior Systems Construction Association

-
- 2.2 Locate communication rooms in accordance with the following:
- .1 As close to the centre of, and on the same floor as the area it is intended to serve.
 - .2 Accessible to hallways or common areas and access for delivery of large equipment.
 - .3 In multifloored buildings the communication rooms shall be stacked vertically.
 - .4 Avoid locations that may be subject to water infiltration, steam infiltration, humidity exceeding 55%, sources of heat such as direct sunlight, corrosive or adverse environmental conditions and sources of excessive EMI such as machinery.
 - .5 Avoid spaces in or adjacent to mechanical rooms, boiler rooms, washrooms, janitor closets, storage rooms, and loading docks.
- 2.3 Size communication rooms in accordance with the following:
- .1 If the serving area is 500 m² (5000 ft²) or less the room shall be 3.0 m x 2.4 m (10 ft. x 8 ft.).
 - .2 If the serving area is larger than 500 m² (5000 ft²) and less than or equal to 800 m² (8000 ft²) the room shall be 3.0 m x 2.7 m (10 ft. x 9 ft.).
 - .3 If the serving area is larger than 800 m² (8000 ft²) and less than or equal to 1000 m² (10,000 ft²) the room shall be 3.0 m x 3.4 m (10 ft. x 11 ft.).
 - .4 If the serving area exceeds 1000 m² (10,000 ft²) a second communication room shall be required on the same floor.
- 2.4 A separate room shall be provided for the entrance facility. The room shall be located next to or directly below the main equipment room. A space of at least 1.2 m x 1.8 m (4 ft. x 6 ft.) shall be provided for each Access Provider.
- 2.5 A separate room shall be provided for the main equipment room. A space of at least 3 m x 4.6 m (10 ft. x 15 ft.) is required.
- 2.6 Design communication rooms to have fully outward opening, lockable doors that are a minimum of 0.91 m (3 ft.) wide and 2 m (80 in) tall. Access Provider rooms sized at 1.2 m x 1.8 m (4 ft. x 6 ft.) shall have two outward opening 0.91 m (3 ft.) wide and 2 m (6.7 ft.) tall doors.
- 2.7 False ceilings are not permitted.
- 2.8 Ceiling height shall be a minimum of 3 m (10 ft).
- 2.9 Communication room walls shall extend to the structural ceiling, install high-pressure laminate tile and treat walls and ceiling. Walls shall be 2-hour fire rated.
- 2.10 All walls, floors and ceiling surfaces shall be white in color.
- 2.11 Design access floors in accordance with the following:
- .1 Shall meet the requirements of Cisca.
 - .2 Shall be covered in high-pressure laminate or other durable tile.

-
- .3 Have a uniform load capacity of 12 kPa (250 lbs/ft²).
 - .4 Have a concentrated load capacity of 8.8 kN (2000 lbs.).
 - .5 All metal parts of the access floor shall be bonded to ground in accordance with CEC Rule 10-406. A minimum of every fourth pedestal shall be bonded to ground with a 6 AWG wire.
- 2.12 Access floors shall only be installed in data centre applications.
- 2.13 In a multifloored building vertically interconnect communication rooms with a minimum of four 103 mm (4 in) sleeves or conduits. All conduits and sleeves shall be installed with bushing and appropriately rated firestop. Sleeves and conduits entering the communication room shall extend above the floor by 78 mm (3 in) AFF or extend down below the ceiling to 2.4 m (8 ft.) AFF.
- 2.14 Horizontally interconnect multiple rooms on a floor with conduit sized to 40% fill or cable tray that provides equivalent capacity. Regardless of cable counts there shall always be a minimum of two 53 mm (2") conduits or cable tray that provides equivalent capacity between rooms. All conduits shall be installed with bushing and appropriately rated firestop. Conduits entering the communication room shall extend down below the ceiling to 2.4 m (8 ft.) AFF.
- 2.15 Provide a minimum of three 103mm (4") conduits from the property line (location to be recommended by the utility) to the entrance facility designated for Access Provider use. Do not include more than two 90-degree bends in the conduit run between pull points. Never exceed a 90-degree bend. Conduits entering the room shall extend above the floor by 103 mm (4 in) AFF or extend down below the ceiling to 2.4 m (8 ft) AFF. All conduits entering the building shall be sealed with a rubber plug or water plug.
- 2.16 Design communication rooms to have the following power requirements:
- .1 Provide a 15 amp 120-volt duplex convenience receptacle on standard power every 1.8 m (6 ft) around the perimeter walls.
 - .2 In rooms containing active equipment, provide a dedicated communication power panel with Transient Voltage Surge Suppression (TVSS). Identify the panel on the front door with a lamicoid label stating "Communication Panel" and panel designation. If a main UPS is installed in a data centre, all communication power panels shall be powered from that UPS.
 - .3 Provide one 20 amp 120 volt duplex receptacle (5-20RA) and one 20 amp 120 volt duplex twist lock receptacle (L5-20), both black in colour, for each cabinet and rack installed, mounted on the side of the cable tray or below the raised floor where applicable. These receptacles must be fed from the dedicated communication power panel.
 - .4 Provide two 20 amp 120 volt duplex receptacles (5-20RA), black in colour, for every 4ft wide section of backboard installed. These receptacles must be fed from the dedicated communication power panel.

-
- 2.17 Design communication room to have the following lighting requirements:
- .1 Minimum of 500 lux (50 fc) measured 0.91 m (3 ft.) above finished floor, in front and behind cabinets installed. Position fixtures to minimize shadows.
 - .2 Do not use dimmer switches.
 - .3 Locate fixtures a minimum of 2.6 m (8.5 ft.) above finished floor.
 - .4 Power for lighting shall not come from the dedicated power panel in the communication room but from standard power.
 - .5 A minimum of 50% the fixtures shall be on emergency power, if available.
- 2.18 Design communication rooms to have a grounding and bonding system as per Specification Section 270526 'Grounding and Bonding for Communication Systems'.
- 2.19 Line a minimum of two walls within the communication room with AC grade or better, void-free plywood, 2.4 m (8 ft) high with a thickness of 19 mm (¾ in). The plywood shall be installed with the 'C' grade facing the wall. Plywood shall be pressure impregnated with fire-retardant chemicals in conformance with CAN/CSA-O80 Series-M and have a flame-spread rating not more than 25. A plywood backboard shall always appear where backbone sleeves enter and leave the communication room, in order to support backbone cables.
- 2.20 Design communication rooms containing active equipment to have the following environmental conditions and controls:
- .1 Maintain continuous and dedicated environmental control (24 hours per day, 365 days per year). Connect HVAC system to emergency power where available.
 - .2 Maintain positive pressure with a minimum of one air change per hour.
 - .3 Dissipate the heat generated by active equipment. Coordinate with the City of Brampton IT department for equipment lists. Regardless of heat loads the cooling provided shall never be less than 0.5 tons/hr (6,000 Btu/hr) in general communication rooms and never less than 1 ton/hr (12,000 Btu/hr) in the main communication room. To include model #?
 - .4 Maintain a temperature of 18 °C to 22 °C.
 - .5 Maintain a relative humidity of 30% to 55%.
- 2.21 Design cabinet installations to be run side by side, with a minimum clearance of 0.91 m (3 ft) in the front and rear of the cabinets. Provide two vertical cable managers in each cabinet. Provide a solid side panel at both ends of a cabinet run, but never between cabinets.
- 2.22 Provide 2 vertical power bars in each floor standing cabinet.
- 2.23 Each cabinet shall have an UPS installed at the bottom of the cabinet. UPS shall be supplied and installed by the City of Brampton. *(See Appendix A for Part Numbers).*

3 **MATERIALS**

3.1 Acceptable manufacturer of all cabinets and associated accessories shall be RF Mote or equivalent.

3.2 Floor standing cabinets shall have the following characteristics:

- .1 Model of cabinet shall be *(See Appendix A for Part Numbers)*
- .2 CSA and UL approved.
- .3 Standard EIA 19" mounting with 44U unit capacity.
- .4 Dimensions: 762 mm (30 in) W x 914 mm (36 in) D x 2109 mm (83 in) H
- .5 #10-32 EIA universal mounting hole spacing.
- .6 Constructed from 11 gauge steel, textured black colour.
- .7 Side panel shall be solid.
- .8 Front door shall be smoked acrylic, with lockable recessed handles.
- .9 Rear door shall be mesh, with lockable recessed handles.
- .10 Cable management shall be a vertical internal ladder style.
- .11 Exhaust fans shall exhaust a minimum of 200 CFM.
- .12 Rear mounting rails shall be installed.

3.3 Vertical power bars shall have the following characteristics:

- .1 CSA and UL approved.
- .2 Rating: 20 amps, 120 volts.
- .3 10 outlets, 20 amps, 120 volts (5-20RA).
- .4 10 ft power cord, with a 20 amp plug (5-20P).
- .5 Built in surge and spike protection.
- .6 Power to the bar shall be switch disabled.

-
- 3.4 Wall mounted cabinet shall have the following characteristics:
- .1 Model of cabinet shall *(See Appendix A for Part Numbers)*
 - .2 Standard EIA 19" hinged cabinet with 12U, 20U, and 26U unit capacity.
 - .3 Dimensions shall be at minimum: 762 mm (30 in) W x 477 mm (18.75 in) D x 565 mm (22.25 in) H.
 - .4 Extender brackets for cabinets shall be installed *(See Appendix A for Part Numbers)*, to increase depth by 152mm (6 in).
 - .5 Constructed from 11 gauge steel, textured black colour.
 - .6 CSA and UL approved.
 - .7 #10-32 EIA universal mounting hole spacing.
 - .8 Built-in vertical cable management.
 - .9 Provision for two exhaust fans.

4 **FIELD QUALITY CONTROL**

NIL

COPPER BACKBONE CATEGORY 3

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:

- .1 The scope of work included within the section includes voice end-to-end structured cabling between communication rooms.
- .2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI – Customer Owned Outside Plant Design Manual

-
- 2.2 For every horizontal cable intended for voice, provide two (2) pairs plus 25% spare pairs in the backbone cable between the general communication room and the main communication room or data centre.
- 2.3 No means of splicing shall be used.
- 2.4 Provide 3 m (10 ft) of cable slack within the communication room. All cable slack shall be stored in a neat extended loop or figure of eight within the cable tray or on the backboard. Cable shall not be stored in a bundled loop.
- 2.5 All pairs shall be directly cabled back to a backboard mounted wiring block located within the communication room.
- 2.6 Backbone cable channel link shall not exceed 800 m (2624 ft); this length shall include the cable slack.
- 2.7 Maintain minimum bend radii of four times the cable diameter for twisted pair cable.
- 2.8 Do not exceed the maximum cable pulling force of 110 N (25 lbs) for twisted pair cable.
- 2.9 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable. Where tie-wraps are used in a plenum space, only UL listed plenum rated tie-wraps shall be used.
- 2.10 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.
- 2.11 The twist of the individual pairs shall be maintained up to the point of termination. The maximum amount of untwisting in a pair as a result of termination shall be no greater than 13 mm (0.5 in).
- 2.12 All twisted pair terminations shall use a T568A wire map.
- 2.13 Cables shall be properly supported and protected from damage always and shall be installed in such a way as to ensure that cable will not deform over time.
- 2.14 Where cables are exposed to potential damage, split loom tubing shall be used.
- 2.15 Allow no rough handling, kinking, denting or abrasion of the cable.
- 2.16 Where cables are run in cable tray, neatly bundle and tie-wrap all cables. Separate voice, data and fibre cables into individual bundles.
- 2.17 Vertical riser cable shall be supported a minimum of three (3) times per floor. Supports shall be placed 1 m (3 ft) apart.
- 2.18 Bix Block to be cross connected to 24 Port patch panel in LAN closet with all pairs terminated to Patch Panel.

3 MATERIALS

-
- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Voice Backbone cabling shall have the following characteristics:
- .1 Model of cable shall be **(See Appendix A for Part Numbers).**
 - .2 Cable shall meet or exceed Category 3 requirements per TIA/EIA-568-B.
 - .3 Conductors: Multipair 24 AWG solid copper
 - .4 UL and CSA rated as CMP/FT6.
 - .6 Insulation: colour coding as per TIA/EIA-568-B
 - .7 Jacket: printed at intervals stating cable code, AWG, manufacturer and length markings, grey in colour.
- 3.4 Wiring Block shall have the following characteristics:
- .1 Model of wiring block shall be BIX System Kit
 - .2 25 pair capacity
 - .
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATIONS FIBRE BACKBONE MULTIMODE 550

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes data end-to-end structured cabling between communication rooms.
 - .2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated.
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
 - TIA/EIA-568-B.3-1 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard – Addendum 1 – Additional Transmission Performance Specifications for 50/125 um Optical Fibre Cables
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - TIA/EIA-492AAAB Detail Specification for 50-um Core Diameter/ 125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibre
 - TIA/EIA-492AAAC-A Detail Specification for 850-nm Laser Optimized, 50-um Core Diameter/ 125-um Cladding Diameter Class Ia Grade-Index Optical Fibre
 - BICSI – Telecommunication Distribution Methods Manual

-
- BICSI – Information Transport Systems Installation Manual
 - BICSI - Customer Owner Outside Plant Design Manual

- 2.2 In a new building, each general communication room shall be connected to the main communication room or data centre with a fibre backbone cable.
- 2.3 In the case of an extension to an existing building each general communication room shall be connected to the existing main communication room or data centre with a fibre backbone cable, unless stated otherwise by the City of Brampton.
- 2.4 For every forty eight (48) horizontal cables being run to a communication room, provide two (2) multimode strands in the backbone, with a minimum of a twenty four (24) strand cable.
- 2.5 Provide 3 m (10 ft) of cable slack within the communication room. All cable slack shall be stored in a neat extended loop or figure of eight within the cabinet cable management. Cable shall not be stored in a bundled loop.
- 2.6 Maintain a bend radius during installation of fibre cable of 20 times the cable diameter and 10 times the cable diameter after installation.
- 2.7 Do not exceed the maximum cable pulling force of 222 N (50 lbs.) for fibre cable.
- 2.8 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable.
- 2.9 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.
- 2.10 Cables shall be properly supported and protected from damage always and shall be installed in such a way as to ensure that cable will not deform over time.
- 2.11 Vertical riser cable shall be supported a minimum of three (3) times per floor. Supports shall be placed 1 m (3 ft) apart.
- 2.12 Allow no rough handling, kinking, denting or abrasion of the cable.

3 MATERIALS

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.

-
- 3.3 Fibre Backbone Cabling shall have the following characteristics:
- .1 Model of cable shall be (See Appendix A for Part Numbers).
 - .2 Meet or exceed 50/125um requirements per TIA/EIA-568-B.
 - .3 UL and CSA rated as OFNR/FT4, on condition the cable is run within plenum rated corrugated loom tubing at all times.
 - .4 Capable of supporting up to 1 Gigabit fibre channel up to 900 m (1804 ft) at 850 nm.
 - .5 Capable of supporting up to 10 Gigabit fibre channel up to 550 m (1804 ft) at 850 nm.
 - .6 Minimum fibre strand count of 24.
 - .7 Fibre sub-units: colour coding as per TIA/EIA-568-B
 - .8 Jacket: printed at intervals stating cable code, manufacturer and length markings, aqua in colour.
- 3.4 Communication Room Fibre Patch Cords shall have the following characteristics:
- .1 Model of cord shall (See Appendix A for Part Numbers). LC/LC only.
 - .2 Cable characteristics shall match or exceed those of the backbone cable the cord is patching.
 - .3 UL and CSA rated as OFNR/FT4.
 - .4 Jacket: printed at intervals stating cable code, manufacturer, aqua in colour.
 - .5 Factory terminated LC (simplex) connector on both ends.
 - .6 Durability: 500 insertions.
- 3.5 Data Centre Fibre Patch Cords shall have the following characteristics:
- .1 Model of cord shall be (See Appendix A for Part Numbers). LC / LC only.
 - .2 Cable characteristics shall match or exceed those of the backbone cable the cord is patching.
 - .3 UL and CSA rated as OFNR/FT4.
 - .4 Jacket: printed at intervals stating cable code, manufacturer, aqua in colour.
 - .5 Factory terminated LC (simplex) connector on both ends.
 - .6 Durability: 500 insertions.

-
- 3.6 Fibre Patch Panels shall have the following characteristics:
- .1 Models of patch panels shall be *(See Appendix A for Part Numbers)*.
 - .2 Shelves: *(See Appendix A for Part Numbers)*- (houses up to 4 modules), *(See Appendix A for Part Numbers)*- (houses up to 8 modules), *(See Appendix A for Part Numbers)*- (houses up to 12 modules),
 - .1 Compatible with standard 19" rack.
 - .2 All plastic materials shall be fire-retardant, UL94V-0 rated.
 - .3 Black in color.
 - .4 Hinged front door
 - .5 Comes with trough cable manager.
 - .6 Top cover panel
 - .3 Modules: *(See Appendix A for Part Numbers)* for communication rooms and for data centres.
 - .1 6 front mounted LC duplex adapters or 24 front mounted LC duplex adapters.
 - .2 Transmission performance characteristics shall match those of LazrSPEED 550.
 - .4 Splices: *(See Appendix A for Part Numbers)*. (for up to 32 splices), *(See Appendix A for Part Numbers)*. (for up to 64 splices), *(See Appendix A for Part Numbers)*. (for up to 96 splices),
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION HORIZONTAL CABLING CAT 6

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply and installation of communication cabling as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes data and voice end-to-end structured cabling between the communication room and the work are
 - .2 **Supply an End-to-End Certified Structured Cabling System installed by a Systimax Value Added Reseller for the systems described in these specifications.**

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of communication cabling shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-2 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 2 – Grounding and Bonding Requirements for Screened Balanced Twisted-Pair Horizontal Cabling
 - TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling

-
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 - TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
 - TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
 - TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
- 2.2 All work area jacks shall be housed in wall recessed outlets specifically dedicated to a particular work area, unless a 'MUTOA' section is included in the specification package. When a 'MUTOA' section is included, they shall only be used in open office concepts using modular furniture, unless stated otherwise.
- 2.3 Voice and Data outlet requirements shall be as follows:
- .1 Each workstation shall consist of two data ports, all within one outlet.
 - .2 Each meeting room and conference room shall consist of two data ports, all within one outlet, located on each of the walls within the room.
 - .3 Each office large enough to house a separate meeting table shall contain a second outlet containing two data ports. Located local to the meeting table.
 - .4 Each fax machine, printer station and photocopier station shall consist of two data ports, all within one outlet.
- 2.4 Data ports contained within one outlet shall be arranged as follows:
- 1st data at the top
 - 2nd data on the bottom
- 2.5 No data outlets shall be required for wireless access points, unless a 'wireless access point' section is included in the specification package.
- 2.6 Each jack shall require a dedicated horizontal cable. The splitting of pairs within a cable between different jacks is not permitted.

-
- 2.7 All ports shall be directly cabled back to a cabinet mounted patch panel located within the local communication room on the same floor, unless a 'consolidation point' section is included in the specification package.
- 2.8 Provide 1.5 m (5 ft) of horizontal cable slack within the communication room and 3 m (10 ft) of horizontal cable slack within the ceiling space above the work area outlet. All cable slack shall be stored in a neat tie wrapped extended loop or figure of eight. Cable shall not be stored in a bundled loop.
- 2.9 Horizontal cable permanent link shall not exceed 90 m (295 ft.); this length shall include the cable slack. This length is based on a patch cord length not exceeding 5 m (16 ft.). Should the patch cord length exceed 5 m (16 ft.), then the permanent link shall be reduce to match the following equation result:
- Permanent cable length = $102 - (\text{Total combined length of patch cords} * 1.2)$
- 2.10 Outlet may be re-located up to 3 m (10 ft.) at the cost of the contractor if notified prior to installation. This shall not affect the cable slack lengths.
- 2.11 Maintain minimum bend radii of four times the cable diameter for twisted pair cable.
- 2.12 Do not exceed the maximum cable pulling force of 110 N (25 lbs.) for twisted pair cable.
- 2.13 Neatly bundle cable in logical bundles with minimum 3/4" Velcro or hoop & loop cable tie. Secure cable bundles to horizontal supports and plywood backboard. Plastic tie wraps are not acceptable. Where tie-wraps are used in a plenum space, only UL listed plenum rated tie-wraps shall be used.
- 2.14 Do not deform the cable jacket when using fasteners. Test to see that the fastener is loose enough to rotate easily around the cable when pressed with medium finger pressure.
- 2.15 The twist of the individual pairs shall be maintained up to the point of termination. The maximum amount of untwisting in a pair as a result of termination shall be no greater than 13 mm (0.5 in).
- 2.16 The maximum amount of cable jacket that shall be removed as a result of termination shall be no greater than 25 mm (1 in).
- 2.17 All twisted pair terminations shall use a T568A wire map.
- 2.18 Cables shall be properly supported and protected from damaged always and shall be installed in such a way as to ensure that cable will not deform over time.
- 2.19 Where cables are exposed to potential damage, split loom tubing shall be used.
- 2.20 Allow no rough handling, kinking, denting or abrasion of the cable.
- 2.21 Where there are unused port positions in a faceplate, a blank insert shall be provided.
- 2.22 Where cables are run in cable tray, neatly bundle and tie-wrap all cables. Separate voice, data and fibre cables into individual bundles.
- 2.23 Patch cord lengths and counts shall be as follows:

-
- .1 Each patch cord length used within a communication room shall be either 0.6 m (2 ft.) or 1.2 m (4ft) or 2.1 m (7ft) long, the appropriate length shall be based on the specific cabinet layout.
 - .2 Each patch cord length used within a work area shall be either 4.2 m (14 ft.) or 7.6 m (25 ft.) long, the appropriate length shall be based on the specific furniture layout.
 - .3 Patch cords shall always be sized to provide a neat and professional installation and include adequate slack for routing through vertical and horizontal cable management.
 - .4 Patch cord counts shall include 10% spare of each length.

3 MATERIALS

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Voice and Data Horizontal cabling shall have the following characteristics
 - .1 Model of cable shall be (See Appendix A for Part Numbers).
 - .2 Cable shall meet or exceed Category 6 requirements per TIA/EIA-568-B.
 - .3 Conductors: 4-pair 23 AWG solid copper
 - .4 UL and CSA rated as CMP/FT6.
 - .5 Capable of supporting up to 1 Gigabit Ethernet.
 - .6 Insulation: colour coding as per TIA/EIA-568-B
 - .7 Jacket: printed at intervals stating cable code, AWG, manufacturer and length markings, blue in colour for data and white in color for voice.
- 3.4 Data and Voice Work Area Jacks shall have the following characteristics:
 - .1 Model of jack shall be (See Appendix A for Part Numbers).
 - .2 Meet or exceed Category 6 requirements per TIA/EIA-568-B.
 - .3 8-pin, RJ45
 - .4 All plastic materials shall be fire-retardant, UL94V-0 rated.
 - .5 Data jacks shall be blue in color and voice jacks shall be slate grey.
 - .6 Durability: 750 insertions

-
- 3.5 Data and Voice Patch Cords shall have the following characteristics:
- .1 Model of cord shall be *(See Appendix A for Part Numbers)*.
 - .2 Meet or exceed Category 6 requirements per TIA/EIA-568-B.
 - .3 Conductors: 4-pair 24 AWG stranded copper
 - .4 UL and CSA rated as CMR/FT4.
 - .5 Insulation: colour coding as per TIA/EIA-568-B
 - .6 Jacket: printed at intervals stating cable code, AWG, manufacturer, grey in colour for voice and blue in colour for data.
 - .7 Factory terminated RJ45 connector on both ends.
 - .8 Durability: 750 insertions.
- 3.6 Copper Data and Voice Patch Panels shall have the following characteristics:
- .1 Model of patch panel shall be *(See Appendix A for Part Numbers)*.
 - .2 48-port, 2U or 24-port, 1U
 - .3 Compatible with standard 19" rack.
 - .4 Jacks shall meet or exceed Category 6 requirements per TIA/EIA-568-B. Category 6A for wireless.
 - .5 Jacks shall be 8-pin, RJ45.
 - .6 All plastic materials shall be fire-retardant, UL94V-0 rated.
 - .7 Jacks shall be (See Appendix in C for colours).
 - .8 Durability: 750 insertions.
- 3.7 Wall faceplates shall be *(See Appendix A for Part Numbers)*, 2, 4-port, white in colour.
- 3.8 Furniture faceplate shall be *(See Appendix A for Part Numbers)*, 2, 4-port, white in colour.
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION CONSOLIDATION POINTS

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply, installation and inspection of consolidation points as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes consolidation point configurations within a horizontal cable run.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of consolidation points and related items shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
 - TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 - TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware

-
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
 - TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
 - TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
 - TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
 - CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
 - BICSI – Telecommunication Distribution Methods Manual
 - BICSI – Information Transport Systems Installation Manual
 - CISCA – Ceiling and Interior Systems Construction Association
- 2.2 Consolidation points shall be located in fully accessible and permanent locations. Consolidation point must not be located in an obstructed area.
- 2.3 The consolidation point shall be sized to have a minimum of 40% spare capacity for future additions.
- 2.4 The consolidation point shall be located at least 15 m (50 ft) from the local communication room and horizontal cross-connect.
- 2.5 A consolidation point located within the ceiling space or raised access floor shall follow the following rules:
- .1 All items installed within a plenum space shall be UL listed as plenum rated or be completely enclosed within a plenum rated container.
 - .2 Ceiling space or raised access floor space must be fully accessible without moving building fixtures, equipment, or heavy furniture or disturbing building occupants. Heavy furniture is defined as 45 kg (100 lb) or more as per TIA/EIA-569-B.
 - .3 The ceiling or floor tile shall be clearly and permanently labelled as concealing a consolidation point.
 - .4 Shall not contain any active equipment.
 - .5 Shall be bonded to the nearest communication grounding busbar with a minimum 6 AWG.
 - .6 Cable entering and exiting the consolidation point shall pass through plenum rated fire foam.
 - .7 Shall be located along side a main communication pathway such as a cable tray.

-
- 2.6 When consolidation points are located within the office space they shall be mounted to a permanent building structure.
- 2.7 A consolidation point shall only be used for making direct connections to communication outlets. A consolidation point shall never be used as a cross-connect location, for patching, or for direct connections to active equipment with patch cords.
- 3 **MATERIALS**
- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Consolidation points shall have the following characteristics:
- .1 Model of consolidation point shall be M48 Zone Wiring Box only.
 - .2 Accommodates up to 48 M-series jacks.
 - .3 UL listed for plenums spaces
 - .4 Twelve 19 mm (0.75 inch) knockouts for use with conduits.
 - .5 Removable cover.
- 4 **FIELD QUALITY CONTROL**
- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION WIRELESS ACCESS POINT OUTLETS CAT6A

1 SCOPE OF WORK

- 1.1 Include detailed design, manufacturer, supply, installation and inspection of wireless systems as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes wireless access point outlet configurations.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Design, manufacturer, supply and installation of wireless access point outlet and related items shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
 - TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
 - TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
 - TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5

- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- Cisca – Ceiling and Interior Systems Construction Association

- 2.2 All horizontal and backbone cabling related to wireless access points shall confirm to the appropriate specification section included in this package.
- 2.3 Horizontal cable permanent link shall not exceed 80 m (262 ft), this is due to the extended length of the access point patch cord.
- 2.4 Two data outlets shall be installed per wireless access point.
- 2.5 Data outlets in 2.4 shall be terminated to a SYSTIMAX 24-port patch panel in the local LAN room, used specifically for wireless outlet data drops. (W-01, W-02, etc)
- 2.6 No power outlet shall be required; all power to the access point shall be via Power over Ethernet (PoE) – (by others).
- 2.7 Each outlet shall be located above the T-bar ceiling mounted to the structural ceiling and consist of two data jacks housed in a two-port metallic faceplate mounted to a metallic single gang surface mount box. One 19 mm (0.75 in) grommet lined hole shall be used for all cables.
- 2.8 Every effort shall be made to enclose all non-plenum rated items within the metallic box.
- 2.9 Two outlets in a single assembly shall be placed in a cell like pattern to cover the entire usable area of the building (usable area does not include washrooms, changing rooms, stairs, electrical or mechanical rooms). Spacing of these outlets shall be based on the following table:

	Cell diameter of a 54 Mbps access point
Open space (warehouse)	46 m (151 ft)
Semi Open area (cubicle area)	32 m (105 ft)
Closed Office	22 m (72 ft)

- 2.10 One 4.2 m (14 ft) or 7.6 m (25 ft) plenum rated patch cord shall be included for every outlet. The appropriate length shall be based on the specific location of the access point, and as dictated by the City of Brampton IT division.

3 **MATERIALS**

- 3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.
- 3.2 Obtain components through one source from a single manufacturer.
- 3.3 Data horizontal cabling shall be **CAT6A** all other horizontal cable specified in other sections.
- 3.4 Patch cord shall match performance characteristics specified in other sections, with the following physical differences:
 - .1 Two (2) 4.2 m (14 ft) or 7.6 m (25 ft) in length
 - .2 UL and CSA rated as CMP/FT6.
 - .3 Red in color

4 **FIELD QUALITY CONTROL**

- 4.1 Refer to 'Testing of Communications Systems' section.

COMMUNICATION MUTOA OUTLETS

1 SCOPE OF WORK

1.1 Include detailed design, manufacturer, supply, installation and inspection of Multi-User Telecommunications Outlet Assembly (MUTOA) as described in these performance specifications and summarized in the following elements of the work:

.1 The scope of work included within the section includes MUTOA configurations within a work area.

2 DESIGN AND PERFORMANCE REQUIREMENTS

2.1 Design, manufacturer, supply and installation of MUTOAs and related items shall comply with the following standards, unless otherwise stated:

- Canadian Electric Code
- Ontario Building Code
- TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
- TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
- TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
- TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
- TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
- TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
- TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
- TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination
- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5

- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-606-A Administration Standard for Commercial Telecommunication Infrastructure
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual

2.2 MUTOA's shall be used in open office concepts, for modular furniture designs only, unless stated otherwise.

2.3 MUTOA's shall be located in fully accessible locations on building columns or permanent walls. MUTOA's shall never be installed in ceiling spaces, under access floors or in obstructed areas.

2.4 The MUTOA shall be sized to have a minimum of 40% spare capacity for future additions.

2.5 A MUTOA shall only be used for making direct connections to work area equipment. A MUTOA shall never be used as a cross-connect location.

2.6 Patch cords connected to a MUTOA shall never exceed 22 m (72 ft) in length; this is based on a horizontal cable length not exceeding 70 m (230 ft). Refer to the horizontal cable section of the specification for specifics.

3 MATERIALS

3.1 Acceptable manufacturer of all end-to-end structured cabling systems shall be Systimax only.

3.2 Obtain components through one source from a single manufacturer.

3.3 MUTOA shall have the following characteristics:

- .1 Model of MUTOA shall be M224 Zone Wiring Box only.
- .2 Accommodates up to 24 M-series jacks.
- .3 Removable cover.
- .4 White in colour.

4 FIELD QUALITY CONTROL

4.1 Refer to 'Testing of Communications Systems' section.

TESTING OF COMMUNICATIONS SYSTEMS

1 SCOPE OF WORK

- 1.1 Include detailed inspection, testing and administration of communication system as described in these performance specifications and summarized in the following elements of the work:
- .1 The scope of work included within the section includes testing, identification and administration of an end-to-end structured cabling system and its pathways and spaces.

2 DESIGN AND PERFORMANCE REQUIREMENTS

- 2.1 Inspection, testing and administration of communication system shall comply with the following standards, unless otherwise stated:
- Canadian Electric Code
 - Ontario Building Code
 - TIA/EIA-568-B.1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements
 - TIA/EIA-568-B.1-1 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 1 – Minimum 4-pair UTP and 4-pair ScTP Patch Cable Bend Radius
 - TIA/EIA-568-B.1-2 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 2 – Grounding and Bonding Requirements for Screened Balanced Twisted-Pair Horizontal Cabling
 - TIA/EIA-568-B.1-3 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 3 – Supportable Distances and Channel Attenuation for Optical Fibre Applications by Fibre Type
 - TIA/EIA-568-B.1-4 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 4 – Recognition of Category 6 and 850 nm Laser-Optimized 50/125 um Multimode Optical Fibre Cabling
 - TIA/EIA-568-B.1-5 Commercial Building Telecommunication Cabling Standard – Part 1: General Requirements – Addendum 5 – Telecommunications Cabling for Telecommunications Enclosures
 - TIA/EIA-568-B.2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components
 - TIA/EIA-568-B.2-1 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 1 – Transmission Performance Specifications for 4-pair 100 Ohm Category 6 Cabling
 - TIA/EIA-568-B.2-2 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 2
 - TIA/EIA-568-B.2-3 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 3 – Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination

- TIA/EIA-568-B.2-4 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 4 – Solderless Connection Reliability Requirements for Copper Connecting Hardware
- TIA/EIA-568-B.2-5 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 5
- TIA/EIA-568-B.2-6 Commercial Building Telecommunication Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components – Addendum 6 – Category 6 Related Component Test Procedures
- TIA/EIA-568-B.3 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard
- TIA/EIA-568-B.3-1 Commercial Building Telecommunication Cabling Standard – Part 3: Optical Fibre Cabling Components Standard – Addendum 1 – Additional Transmission Performance Specifications for 50/125 um Optical Fibre Cables
- TIA/EIA-569-B Commercial Building Standard for Telecommunication Pathways and Spaces
- TIA/EIA-758-A Customer-Owner Outside Plant Telecommunications Infrastructure Standard
- TIA/EIA-942 Telecommunications Infrastructure Standard for Data Centres
- CSA-T527 Grounding and Bonding for Telecommunications in Commercial Buildings
- BICSI – Telecommunication Distribution Methods Manual
- BICSI – Information Transport Systems Installation Manual
- BICSI - Customer Owner Outside Plant Design Manual

3 **MATERIALS**

NIL

4 **FIELD QUALITY CONTROL**

- 4.1 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- 4.2 Test procedures and test equipment shall comply with the following standards (in their latest draft including all addendums):
 - .1 TIA/EIA-568-B
 - .2 TIA/EIA TSB-140
 - .3 TIA/EIA-526-14-A
 - .4 TIA/EIA-526-7-A

-
- 4.3 The copper test equipment testing Category 5e cable shall comply with the accuracy requirements for Level III field testers and Category 5e cabling as defined in the above standards. All software shall be the latest versions, and licensed.
- 4.4 The copper test equipment testing Category 6 cable shall comply with the accuracy requirements for Level III field testers and Category 6 cabling as defined in the above standards. All software shall be the latest versions, and licensed.
- 4.5 The copper test equipment testing Category 6A cable shall comply with the accuracy requirements for Level IIIe field testers and Category 6A cabling as defined in the above standards. All software shall be the latest versions, and licensed.
- 4.6 The optical fibre test equipment shall comply with the accuracy requirements for field testers and fibre optic cabling as defined in the above standards. The OTDR shall operate within the range of 850 nm +/- 30 nm and 1300 nm +/- 20 nm for multimode fibre and 1310 nm +/- 10 nm and 1550 nm +/- 20 nm for singlemode fibre testing.
- 4.7 All installed cable runs shall be tested and must pass the requirements of the standards defined above. Any failing link shall be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The passing result of the tests for all links shall be provided in the test results documentation.
- 4.8 All Category 5e, 6 and 6A cable links shall be tested for channel link performance and the following parameters:
- T568A wire map for continuity on all pairs
 - Length – using an accurate NVP value, the pair with the longest electrical delay shall be used for the maximum length.
 - Insertion Loss
 - NEXT Loss must be tested from both ends of the cabling
 - ELFEXT must be tested from both ends of the cabling
 - Propagation delay and delay skew
 - Return Loss must be tested from both ends of the cabling
 - PSNEXT must be tested from both ends of the cabling
 - Power Sum ELFEXT must be tested from both ends of the cabling
 - ANEXT must be tested from both ends of the cabling (for Cat 6A only)
- 4.9 All fibre cable shall be tested before installation while still on the reel for attenuation at both 850 nm and 1300 nm for multimode and 1310 nm and 1550 nm for singlemode to ensure that it meets or exceeds the manufacturer stated performance. The contractor shall provide a soft copy of the test results to the Communications Consultant. The Communications Consultant must approve this report prior to any installation activity.
- 4.10 All fibre cable links shall be tested for channel link performance for the following parameters:
- End-to-end attenuation tested at both 850 nm and 1300 nm for multimode to ensure predicted system performance.
 - A-B Polarity where duplex connectors are used
 - OTDR signature trace documentation for as-built records
- 4.11 Testing will be considered completed once records show that all installations meet the 100% pass rate.

SYSTIMAX STANDARDS SPECIFICATION GUIDELINES

1.0 TEST RESULTS

- 1.1.1 Cabling Contractor is required to submit test results in native tester format to the City of Brampton. Cabling Contractor is to provide the software required to view the results.
- 1.1.2 The report should be divided into sections by building floors
- 1.1.3 The report should indicate for each cable when it was tested successfully, the result, and the length.
- 1.1.4 The entire report must be signed by an authorized person for the Communications Cabling Contractor and a Registered Communication Distribution Designer (RCDD) at the end of the project.
- 1.1.5 The test result documentation is to be submitted to the City of Brampton for review no later than 5 working days following the completion of the installation.

2.0 AS-BUILT DRAWINGS

- 2.1.1 Communications Cabling Contractor is required to provide as-built drawings of the cable installation for all cabling included in this specification. All drawings to be provided to City of Brampton at the end of the project for any changes due to on-site conditions.
- 2.1.2 The as-built drawings are to include, but are not limited to, the following:
 - 1. Cable numbers on the floor plans.
 - 2. Changes on the floor plans.
 - 3. Cable routing on the floor plans.
 - 4. Rack Elevation drawings and changes.
 - 5. Backboard Elevation drawing and changes.
 - 6. Riser Routing Drawing.
- 2.1.3 Communications Cabling Contractor to provide one (1) soft copy in AutoCAD 2014 format and six (6) plotted copies for the City of Brampton after the City of Brampton 's final review and acceptance of the drawings.
- 2.1.4 Within 30 working days after approval, the Communications Cabling Contractor is to distribute one copy of the plotted copies to each of the telecommunications closets

3.0 CHANGE NOTICES

- 3.1.1 All change notice pricing will include, by line item, a detailed breakdown including :
 - 1. Part number
 - 2. Unit cost
 - 3. Labour Units
 - 4. Labour Cost as per this document.
 - 5. HST
 - 6. Mark-ups for overhead and profit
 - 7. Total Price for the change notice
- 3.1.2 Labour cost and mark-ups will apply for the duration of the project.
- 3.1.3 Change Notices are to reference the City of Brampton Change Notice Number or Site Instruction. Work is not to proceed without prior approval.

4.0 MANDATORY REQUIREMENTS

- 4.1.1 Cabling contractor must be registered as CommScope SYSTIMAX Value Added Re-Seller (VAR) (Prestige, Authorized, Authorized Installer) as of the date of the Tender closing.
- 4.1.2 Provide a proof of company's CommScope's SYSTIMAX Solutions VAR Certification including expiry date and duration of experience.

-
- 4.1.3 Provide a copy of SYSTIMAX SCS Design & Engineering Certification including expiry date for each Project Manager designated to work on the City of Brampton sites.
 - 4.1.4 Provide a copy of SYSTIMAX SCS Installation and Maintenance including expiry date for each installer designated to work on the City of Brampton sites.
 - 4.1.5 Provide a copy of RCDD's Certification including expiry date for each designer designated to work on the City of Brampton site. Must be able to sign off on as-built documentation.
 - 4.1.6 A 20 Year Systimax Certification Warranty on cabling shall be provided to the City of Brampton no later than 30 working days following the completion of the installation.

APPENDIX A – APPROVED MATERIALS LIST

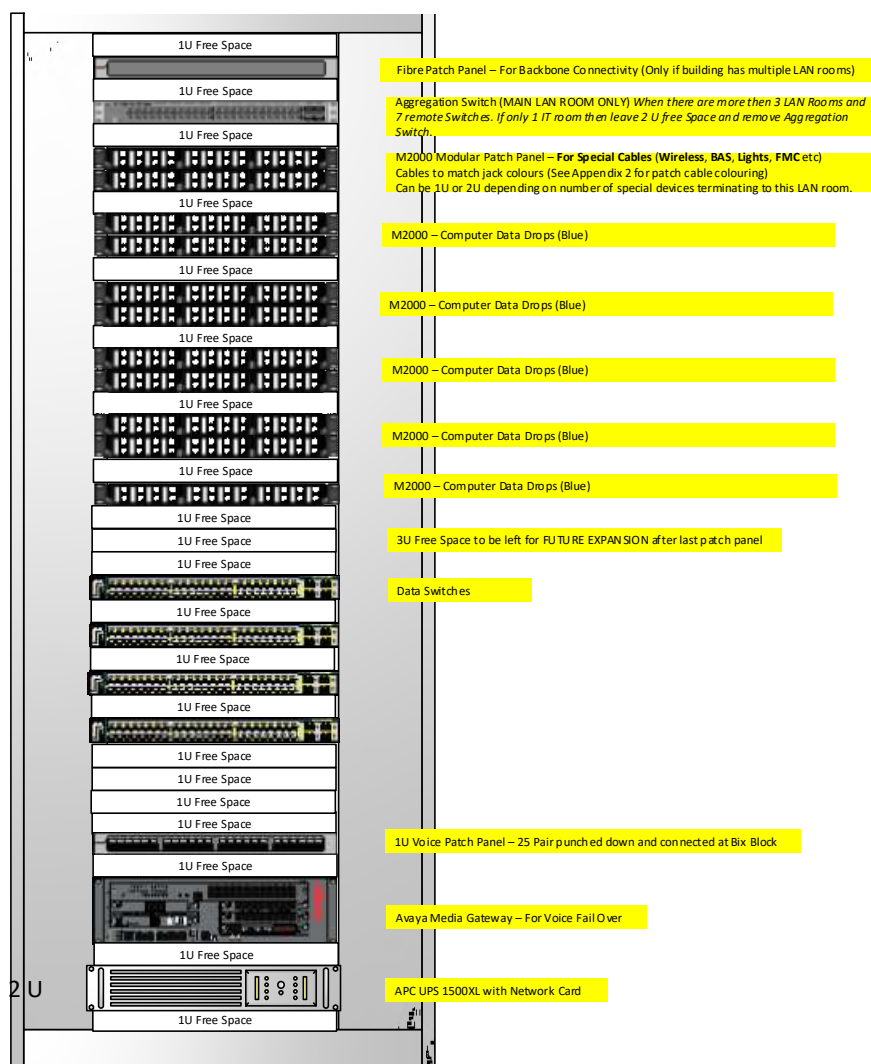
Section	Material	Manufacture	Model
270528			
	Cable Tray	Flextray	
	Cable Tray	Cablofil	
	Sling Support System	Erico Caddy Cablecat	
271100			
	Floor standing cabinets	RF Mote	RFM-303083
	Floor standing cabinets	RF Mote	RFM-303059
	Wall mounted cabinet	RF Mote	RFM-3022-WM
	Wall mounted cabinet	RF Mote	RFM-3036-WM
	Wall mounted cabinet	RF Mote	RFM-3048-WM
	6" Extender Brackets	RF Mote	RFM-6X-WM
	6" Extender Brackets	RF Mote	RFM-6X-WM-36
	6" Extender Brackets	RF Mote	RFM-6X-WM-48
	UPS	APC	SMX1500RM2UNC (City Supplied and Installed)
271313			
	Voice Backbone Cable	Systimax	Plenum 2010
	Wiring Block	Belden	BIX
271323			
	Fibre BackBone Cable	Systimax	LazrSPEED 550 - Plenum rated
	Fibre Patch Panel	Systimax	600G2-1U-MOD-SD-360
	Fibre Patch Cords	Systimax	FEXLCLC42-MXF0XX
	Shelves	Systimax	360G2-1U-MOD-SD
	Shelves	Systimax	360G2-2U-MOD-SD
	Shelves	Systimax	360G2-4U-MOD-SD
	Modules	Systimax	360DP-12LC-LS
	Modules	Systimax	360DP-24LC-LS
	Splices	Systimax	RS-2AF-16SF
	Splices	Systimax	RS-4AF-16SF
	Splices	Systimax	SW-6AF-16SF
271513			
	Horizontal Cable (Data)	Systimax	GigaSPEED XL 2071E
	Horizontal Cable (WIRELESS)	Systimax	GigaSPEED XL 2091B / Alternate 2091SD
	Jack (Data) / Jack (Wireless)	Systimax	MGS400 (DATA) / MGS600-XXX (WIRELESS)
	Patch Cords Floor Racks for wireless see 271544	Systimax	CPC3312-0xFyyy
	Patch Cords Wall Mounts for wireless see 271544	Systimax	MINO6-XX
	Patch Panel	Systimax	CPP-UDDM-M-1U-24 / CPP-UDDM-M-2U-48
	Data Jacks for M2000	Systimax	MGS400-XXX

Section	Material	Manufacture	Model
271513	Wall faceplates	Systimax	M12LE-266
cont.	Wall faceplates	Systimax	M13LE-266
	Wall faceplates	Systimax	M16LE-266
	Wall faceplates	Systimax	M13SP
	Wall faceplates	Systimax	M16SP
	Furniture faceplate	Systimax	M13C-262
271520			
	Consolidation point	Systimax	M48 Zone Wiring Box
271544			
	Dual Port Surface Box	Systimax	M202 Plenum SMB-262
	Patch Cable for Ceiling	Systimax	CPCSSY2-07F015 (Plenum Rated)
	Patch Cable for Ceiling	Systimax	CPCSSY2-07F025 (Plenum Rated)
	Patch Cable for Ceiling	Systimax	CCA-CAT6A-PLENUM (Plenum Rated)
	Patch Cords Floor Racks	Systimax	CPCSSX2- (Red)
	Patch Cords Wall Mounts	Systimax	CO199K2- (Red)
271545			
	MUTOA	Systimax	M224 Zone Wiring Box
OTHER	Wire Mold	Wire Mold	V750 (Colour to match wall being installed on)



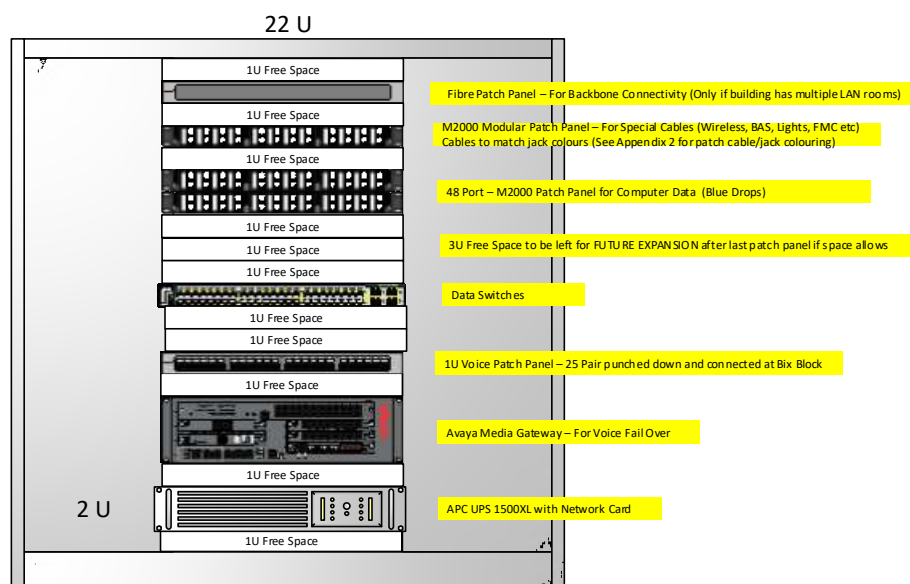
Main LAN Room A with Aggregation Switch

Part Number for Cabinet: Refer to Appendix A for approved Materials





Part Number for Cabinet: Refer to Appendix A for approved Materials



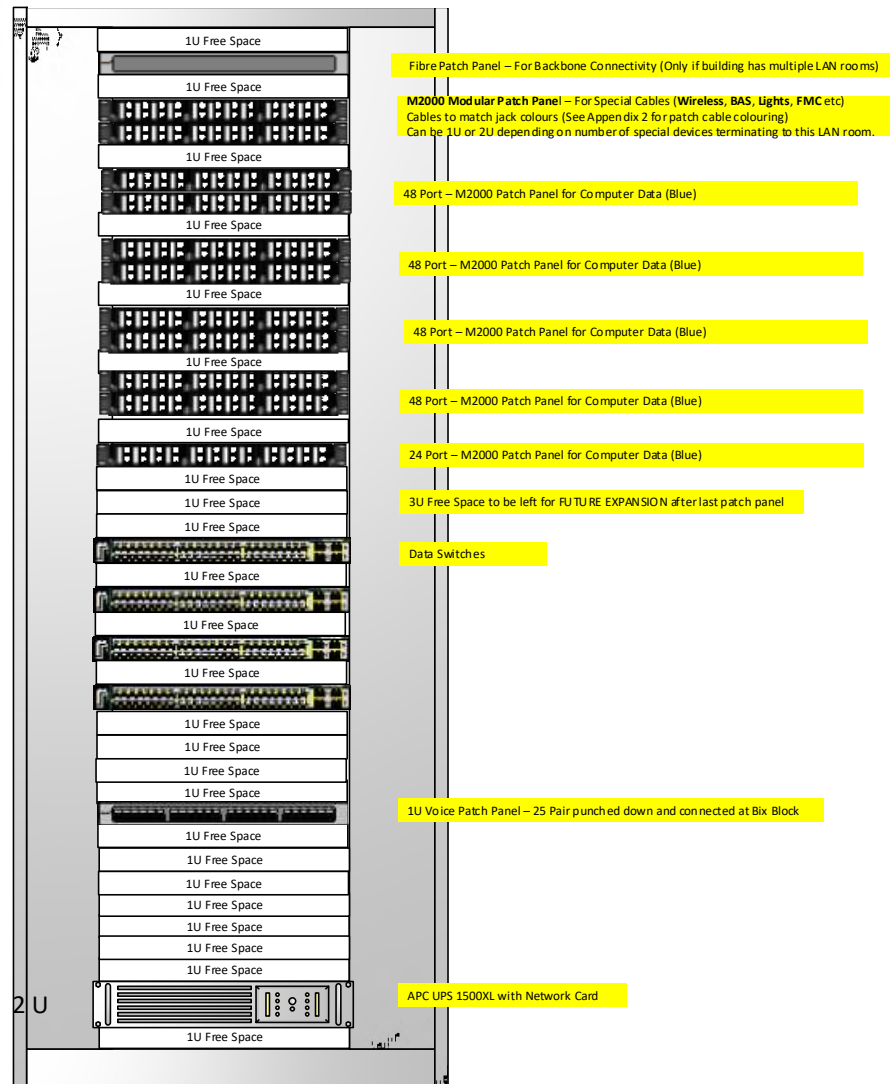
Please note: When designing wall mount cabinets, the patch cables used in these cabinets will be a different part number, please pay attention.



City of Brampton IT Cabinet Design

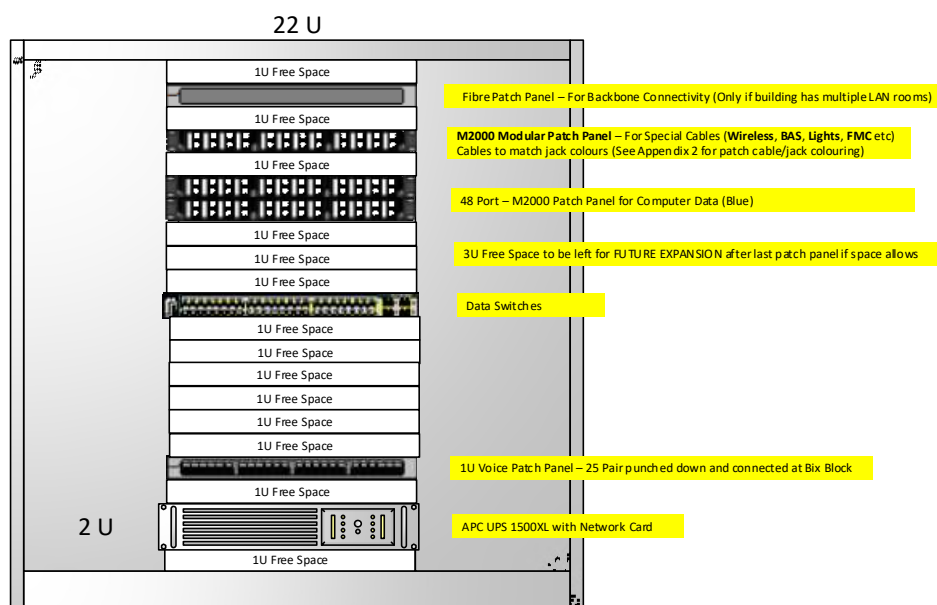
Remote LAN Room (B,C,D etc)

Part Number for Cabinet: Refer to Appendix A for approved Materials





Part Number for Cabinet: Refer to Appendix A for approved Materials



Please note: When designing wall mount cabinets, the patch cables used in these cabinets will be a different part number, please pay attention.

APPENDIX C – OUTLET MOUNTING HEIGHTS AND PATCH CABLE COLOURS

Data and Electrical Plates should be installed on the walls at the heights shown

Modular Furniture

Rackway

Typical Data and Electrical Height for Modular Furniture

Data and Electrical Plates should be installed on the walls at the heights shown

Typical Data and Electrical Height for Meeting Rooms

All Cables terminating into patch panels are to be Blue in Colour with the exception of security cabling.

	<p>Red Patch Cables will be used for: Wireless and UPS (Red Jacks in M2000 Patch Panel)</p>
	<p>Green Riser/Patch Cables will be used for: Security ONLY</p>
	<p>Blue Patch Cables will be used for: All Data Drops (Computers)</p>
	<p>Grey Patch Cables will be used for: All Voice related Devices including Avaya Gateway</p>
	<p>Orange Patch Cables will be used for: All Monitoring Devices BAS, FMC, Brine, Fuel, Electric Charging, People Counter etc. (Orange Jacks in M2000 Patch Panel)</p>
	<p>Purple Patch Cables will be used for: AV Devices (Purple Jacks in M2000 Patch Panel)</p>

IT Network Services Department - MF	Typical Cable Runs / Patch Cable Colouring	Jan 2019 V1.1	
--	---	------------------	--

1 General

1.1 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.
- .5 Coordinate with the Division 26 contractor (hereafter referred to as the "electrical contractor").

1.2 RELATED DIVISIONS

- .1 Division 25 – Integrated Automation.
- .2 Division 26 – Electrical.
- .3 Division 28 – Electronic Safety and Security.

1.3 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. It shall be your responsibility to ensure that the systems specified hereafter are complete and operative.

1.4 CODES AND 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 Cabling Installation Manual
 - .3 Outside Plant Manual
- .3 Canadian Standards Association (CSA)
 - .1 CSA C22.1 – Canadian Electrical Code, Part 1
 - .2 CSA T529 – Commercial Building Telecommunications Cabling Standard (ANSI/EIA/TIA-568-B).
 - .3 CSA T530 – Commercial Building Standard For Telecommunications Pathways And Spaces (TIA/EIA 569-A).
 - .4 CSA T528 – Administration Standard For The Telecommunications Infrastructure Of Commercial Buildings (ANSI/EIA/TIA-606).
 - .5 CSA T527 – Commercial Building Grounding And Bonding Requirements For Telecommunications (ANSI/EIA/TIA-607).
 - .6 CSA C22.2 No. 214 – Communications Cables.
 - .7 CSA C22.2 No. 232-M – Fibre Optic Cables.
 - .8 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.
- .14 The Corporation of the City of Brampton
 - .1 IT Performance Specification Division 27, Communications New Build, Version 1.5.

1.5 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.

1.6 INSPECTIONS

- .1 The Engineer and/or the Project Manager will carry out inspections and prepare deficiency list for action by the Contractor, during and on completion of project.

1.7 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.

1.8 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.

1.9 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 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.

1.10 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.

1.11 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.

1.12 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

2.1 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.

2.2 SHOP DRAWINGS

- .1 Before delivery to site of any item of equipment, the electrical contractor shall submit 6 copies of shop drawings c/w all data, pre-checked and stamped accordingly, for approval to the Engineer. Indicate project name on each brochure or sheet. Submit shop drawings within 1 week after award of contract, for the following:
 - .1 Copper Cabling
 - .2 Fibre Optic Cabling
 - .3 Fabric Innerduct
 - .4 Racks, managers
 - .5 Patch Panels
 - .6 Telecommunications Outlets, Faceplates
 - .7 Fibre Optic Routing System
 - .8 Rack Power Distribution Units

2.3 AS-BUILT DRAWINGS

- .1 To Section 01 78 00.
- .2 Red lines, mark-ups by this contractor.

2.4 OPERATION AND MAINTENANCE MANUALS

- .1 Refer to Division 01.

3 Execution

3.1 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.

3.2 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.

3.3 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.

3.4 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.

3.5 LABELS AND SIGNS

- .1 Labelling shall be as per TIA/EIA-606.

3.6 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.

3.7 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

1.1 SECTION INCLUDES

- .1 Provide a complete system of empty conduits, pull boxes, outlets, and sleeves for enclosure of wiring by general contractor. Refer to General Requirements.

1.2 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 21.11 – Addressable Fire Alarm Systems.

1.3 REFERENCES

- .1 BICSI Telecommunications Distribution Methods Manual, 13th Edition (2014).

2 Products

2.1 OUTLETS

- .1 Wall outlets shall be 115 mm square boxes with plaster rings to suit single gang devices unless otherwise noted.

2.2 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 two coats of fire retardant light grey enamel.
.6 Provide a minimum of two duplex receptacles on separate circuits at each backboard.
.7 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

3.1 INSTALLATION

- .1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.
.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8" nylon pull cord continuously from outlet to outlet, through conduit and fasten at each box.
.3 Conduit bends 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 Cash Allowance installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.1 SUMMARY

- .1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlets for enclosure of wiring by Security Contractor.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
.2 Section 26 05 33.16 – Boxes for Electrical Systems.

2 Products

2.1 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. Coordinate with Security Contractor.

2.2 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

3.1 INSTALLATION

- .1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.
.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8" nylon pull cord 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 Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.1 SUMMARY

- .1 Provide a complete system of empty conduits, terminal cabinets, plywood backboards, pull boxes and outlet boxes for enclosure of cabling by Owner under a separate contract.

1.2 RELATED REQUIREMENTS

- .1 Section 26 05 33.13 – Conduit for Electrical Systems.
.2 Section 26 05 33.16 – Boxes for Electrical Systems.

2 Products

2.1 VIDEO SURVEILLANCE EQUIPMENT (BY OWNER)

- .1 Video Surveillance equipment shall be based on IP cameras. Size conduits based on industry practices based on Category 6 communications cabling.

2.2 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. Coordinate with Owner's video surveillance contractor.

2.3 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 mm by 2400 mm, 19 mm thick, painted with 2 coats of fire retardant light grey enamel.
.6 Provide a minimum of two duplex receptacles on separate circuits at each backboard.

3 Execution

3.1 INSTALLATION

- .1 Vertically mount outlet boxes, unless noted otherwise, 300 mm to centre above floor, or 150 mm above counter top where shown at counters or benches.
.2 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install No. 12 gauge galvanized soft iron pull wire, or 1/8 inch 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 Security installer to facilitate wiring and equipment installation. Include above noted information on final record drawings at project completion.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Cabling requirements for IP based CCTV cameras.

1.2 RELATED REQUIREMENTS

- .1 Division 27 – Communications.

2 Products

2.1 OWNER-FURNISHED PRODUCTS

- .1 New IP cameras, and associated equipment shall be supplied and installed by others under a separate contract.
- .2 This contractor shall be responsible for coordinating rough-in requirements.

2.2 CABLING

- .1 Plenum rated Category 6 cabling in accordance with Division 27.

3 Execution

3.1 INSTALLATION

- .1 In accordance with sections of Division 27.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Communications conductors and cables for fire detection, suppression, and alarm systems.
- .2 Conduit for fire detection, suppression, and alarm systems.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 11 - Fire Sensors and Detectors.
- .2 Section 28 46 21.31 - Fire Detection, Suppression, and Preaction Releasing Panels.
- .3 Section 28 46 21.33 - Fire Detection, Suppression, and Preaction Releasing Panel Sequences of Operation.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 01 61 00.

1.4 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

2.1 CONDUIT AND WIRE FOR FIRE ALARM SYSTEM

- .1 Conduit:
 - .1 In accordance with Section 26 05 33.13.
 - .2 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.
 - .3 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.
- .3 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 Conductors: 300V rated multiconductor, insulated, colour coded, copper conductor, minimum size to be #16 AWG for device loops and 14 AWG for signal circuits.
 - .4 Certified by CSA as fire alarm and signal cable type FAS 105 to CSA C22.2 No. 208.
 - .5 Non-Fire rated cable:
 - .1 Insulation: 105 degrees C flame retardant PVC
 - .2 Outer Jacket: 105 degrees C flame retardant PVC Red.
 - .3 Armour: Interlocking aluminum without overall Jacket. For drops to devices in suspended ceilings from conduit system.
 - .6 Fire rated 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 Alternates such as "Lifeline" installed in conduit may only be considered if listed by ULC under ULC Category Code 'FHJRC' after October 2014.
- .3 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code 'FHJRC', dated 19 May 2015).

3 Execution

3.1 **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 "A" wiring for signalling circuits.
- .8 Fire rated conductors:
 - .1 Install 1 hour fire rated cables for fire alarm circuits as required by the building code where transponders (data gathering panels) or annunciators are installed in a separate fire compartments from the main FACP CPU.
 - .2 Install 1 hour fire rated 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.
 - .3 In lieu of fire rated 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 1 hour.
- .9 End-of-line resistors shall be furnished as required for mounting as directed by the manufacturer on Class B circuits.
 - .1 Install EOL resistors maximum 1800 mm above finished floor in interior spaces.

3.2 **TESTING AND INSPECTION**

- .1 The manufacturer's representative shall make 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

1.1 SECTION INCLUDES

- .1 Wireless Access Points for WiFi network communications.

2 Products

2.1 OWNER-SUPPLIED PRODUCTS

- .1 WAP (Wireless Access Points).
 - .1 Free issued by Owner to this Contractor for installation at locations as indicated on the drawings.
 - .2 Power Over Ethernet (PoE) powered.

3 Execution

3.1 INSTALLATION

- .1 Allow for site wireless survey for the final locations of WAPs
- .2 Allow for 5 m cable slack at WAP outlets end for final location adjustment.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 A fully functional master clock system including time reference source, master timer unit, clock displays, programming software, network interface, SNTP and NTP network interfaces.
- .2 Conduits, cables, connectors, connections, equipment mounting hardware and cabinets, display unit mounting hardware required to install and make the master clock system fully functional and operational.
- .3 Power limited transformers for step down from 120 V to 24 V for Class 2 wiring distribution to a maximum of 100 VA per circuit.
- .4 Field adjustments to installed display units to ensure clearance from obstructions so as to permit unobstructed viewing as far as reasonable and practicable. Make field changes after mechanical systems have been installed. Make field changes to elevation and orientation of display units to accommodate and be clear from operational machinery installed in this contract or by others under separate contract as far as reasonably possible and within practicable limitations.
- .5 Radio controlled wireless synchronization of displays using a radio signal operating in a licensed band.

1.2 MANUFACTURER QUALIFICATIONS

- .1 Supply products and systems produced by manufacturers with a minimum of 5 years of continuous production and with established national service representation.

2 Products

2.1 MANUFACTURERS

- .1 ATS Clocks.
- .2 BRG Precision.
- .3 Franklin Instruments.
- .4 Inova Solutions.
- .5 Lathem Time.
- .6 National Time and Signal.
- .7 Primex.
- .8 Simplex.
- .9 Spectracom.

2.2 WIRELESS CLOCK SYSTEM

- .1 Time reference source
 - .1 GPS derived time source as primary reference
 - .1 GPS off-air derived time using self-contained GPS signal receiver, window mounted or roof mounted antenna, antenna mounting brackets and weather protection, with time code signal output.
 - .2 NTP or SNTP as secondary source of time reference.
 - .1 Networked time based reference signal using self-contained, internet derived, reference time signal and using SNTP (Simple Network Time protocol or Network Time Protocol) to decode and distribute time reference signals.
 - .3 System internal clock as default.

- .1 Substitute a primary signal with a secondary signal if the one is absent for 4 consecutive hours.
Restore signals when sources return for uninterrupted period of 1 hour or more.

2.3 PROGRAMMABLE SEQUENCE AND TIMING CONTROLLER

- .1 Provide a master controller of solid state design and construction suitable for surface, rack or semi-flush mounting, equipped with an LED display, displaying hours, minutes, seconds and day of the week, and keyboard for programming, and editing; self-contained memory, so that in the event of a total power failure, including battery removal for servicing, programme and stored data will not be lost; of "fail-safe" design so that on replacement of failed part, synchronization of system and display devices can occur without manual intervention or device reset.
- .2 Master controller using external time reference source or in event of external source signal failure internal clock as default. Internal clock accuracy better than 1 second error in any 24 hour period, not synchronized to electrical supply. Visual indication of absence of external reference and/or operation on default time source.
- .3 Master system capable of seven day, twenty-four hour programming and equipped with a 4 year, 365/366 day calendar with ability to record 31 preset exceptions including holidays.
- .4 Master system with auto recognition and indication of Daylight Saving Time.
- .5 Master system able to transmit time information to run and synchronize secondary clocks. Communications protocol to ensure accurate and reliable synchronization.
- .6 Self-contained battery supply to maintain 24 hours of autonomous operation.
- .7 Equipment supplier to furnish all software and programming of master clock system features and provide any software enhancements necessary to accommodate specified functions.
- .8 Time signal distribution systems
 - .1 Radio transmitter operating in licenced frequency Range, at maximum radiated power 1 watt (30 dBm) adjustable, operating temperature 0 degrees C. to 70 degrees C
 - .2 Transmitter antenna vertical polarized dipole, gain less than 2.2 dB.
 - .3 Operator set controls including local time zone over-ride, saving time override, 12/24 hour presentation over-ride.
 - .4 Operation from 120 V ac with internal or external backup battery to permit 24 hours autonomy.
 - .5 Internal memory protection against loss of configuration.

2.4 DIGITAL DISPLAY CLOCKS

- .1 Wall, surface, flush or pendant mounted wireless units, 7 segment LED display, polycarbonate frame and polycarbonate lens with display character heights:
 - .1 63.5mm (2.5 inch) for admin office area
 - .2 100mm (4 inch) for garage area
- .2 Single or double sided display, 6 digit LED digits, Red only, or Green only, or selectable red or green or red and green (orange), to be confirmed with Owner.
- .3 Digital clocks synchronized to master time reference, able to operate in absence of signal, to accuracy of 1 second error in any 24 hours.

3 Execution

3.1 INSTALLATION

- .1 GPS Wireless Clock system head-end equipment to be installed in IT room.
- .2 Digital display clocks to be installed
 - .1 Repair garage area

- .2 Dispatch Office (inside and outside)
- .3 Any other area assigned by the owner
- .4 Allow for total of 12 - 4 inch and 12 - 2.5 inch display clocks.
- .5 Provide unit price for add or delete one 4 inch or one 2.5 inch display clock, including cost for labour and electrical power supply.

End of Section

1 General

1.1 REFERENCES

- .1 CAN/ULC-S1001-11 – Integrated Systems Testing of Fire Protection and Life Safety Systems.

1.2 PURPOSE

- .1 To verify that installations are in accordance with project requirements.
- .2 To ensure proper system operation.

1.3 COMMISSIONING ORGANIZATIONS

- .1 Certified member of Electrical Contractors Association of Ontario (ECAO) or Canadian Fire Alarm Association (CFAA).

2 Products – Not Used

3 Execution

3.1 SITE TESTS AND INSPECTIONS

- .1 Perform Commissioning of integrated systems in accordance with CAN/ULC-S1001.
- .2 Follow manufacturer's recommendations for testing.
- .3 Inspect wiring connections to all devices comprising the system.
- .4 Verify supervision of wiring at every device connection to a supervised circuit.
- .5 Test operation of every device on a system to verify its function.
- .6 Examine equipment for any apparent damage or tampering that may interfere with its intended operation.
- .7 Test equipment with capabilities for field adjustment to establish that it functions as intended under the conditions prevailing at its point of installation.
- .8 Examine devices for evidence of damage or obstructions which may interfere with their operating mechanisms.
- .9 Test automatic devices by simulating an operating condition.
- .10 Wiring:
 - .1 Inspect every device and test to demonstrate that disconnection of the device from the circuit or malfunction of the equipment or wiring activates the required supervisory signals. Inspection shall include verification that:
 - .1 Supervisory signals operate in response to open circuits, short circuits, ground faults and disconnection of plug-in components;
 - .2 Terminations of conductors entering and leaving equipment have been made;
 - .3 Circuit polarities are in accordance with the system design, where applicable.
 - .2 In addition, test to establish that the power supplied to any device is within its recommended operating range and that the required voltage levels are maintained and that the fusing is correct.
- .11 Initiating Devices - Manual:
 - .1 Inspect manual alarm stations in consideration of the following:
 - .1 The device shall be mounted with sufficient clearance to facilitate ease of access and proper operation;
 - .2 Operate each manual alarm station, toggle switch and key switch to verify proper functions.
- .12 Automatic heat detectors:

- .1 Use a heat source reproducible in its intensity, as recommended by the manufacturer of the device, to initiate an alarm.
- .2 Test equipment - Heat lamp or Air heater. DO NOT USE AN OPEN FLAME HEAT SOURCE.
- .3 Apply heat source as to not damage or operate fusible disc parts.
- .13 Automatic smoke detectors - area type:
 - .1 Test by introducing smoke into its detecting chamber. This may consist of actual smoke from burning materials or artificially generated smoke aerosol spray as recommended by the manufacturer. The sensitivity should be noted and adjusted if necessary.
- .14 Automatic smoke detectors:
 - .1 Examine the air sampling arrangements of the detectors under actual conditions of balanced air circulation by conducting a check of the field sensitivity and a check of the air velocity in accordance with the manufacturers' recommendations.
 - .2 Test gas to be used similar to Automatic Smoke Detector.
- .15 Alarm signals - audible:
 - .1 Test on main power supply and standby power supply with the maximum expected load on the system.
 - .2 The audible signalling appliances shall function as intended and shall be audible throughout the building over the background noise present.
 - .3 Decibel recordings in each area covering 100 sq. metres shall be taken.
 - .4 The level of sound should usually be 15 dB above ambient noise level.
- .16 Alarm signals - visual:
 - .1 The visual signal appliances shall function as intended and shall be clearly visible.
- .17 Fire suppression supervision:
 - .1 Coordinate with the requirements of Section 21 12 00, and Section 21 13 00.
 - .2 Sprinkler and standpipe trade to active each sprinkler and standpipe supervisory and alarm device by operating valves and producing flows as required in conjunction with fire alarm technician to observe activation of flow switches, pressure switches, supervised valves, etc.
- .18 Annunciators, printers and workstations:
 - .1 Inspect and operate to establish that their operation in conjunction with the control equipment and other system components, is as intended. The equipment shall be inspected to ensure:
 - .1 The zone of each alarm initiating device is properly indicated;
 - .2 The legend is clearly visible;
 - .3 Adequate voltage under local conditions is present;
 - .4 Wiring connections have been made in a workmanlike manner.
 - .5 Proper care must be taken to establish that each item is complete and satisfactory.
- .19 Standby power supplies - batteries:
 - .1 Examine batteries for possible damage and consideration of the following:
 - .1 The charging system functions as intended;
 - .2 The installation has not resulted in the bypassing of a fuse or a similar protective device;
 - .3 The installation protects the batteries from accidental or mechanical damage.

- .4 The batteries must be able to operate the fire alarm system with the charger input disconnected for one rated load cycle.
- .20 Control equipment and transponders:
 - .1 Test to establish that they function as intended. The following examinations and tests shall be performed:
 - .1 A visual and physical inspection of all cables, plug interconnections, plug-in circuit components, lamps, sockets and controls to establish that their mechanical and electrical connections and mounting are as required for intended function and, where applicable, to confirm electrical supervision;
 - .2 Verification that all field wiring is terminated in a workman-like manner;
 - .3 All lamps and indicators shall be tested for operation and intended function;
 - .4 All keypad functions shall be tested for operation and intended function;
 - .5 All control unit functions shall be operated to verify appropriate response including all software routines and programme functions are simulated;
 - .6 Simulation of open circuits, short circuits and ground faults on all relevant internal circuits in order to confirm the appropriate supervisory response;
 - .2 Commissioning Report:
 - .1 Provide in accordance with requirements of Section 01 91 13, supplemented as specified herein.
 - .2 Report to include relevant information of the system including:
 - .3 Each system part described.
 - .4 How the system is operated.
 - .5 What functions the system performs.
 - .6 Requirements for tests and service.
 - .7 Itemization of all devices connected on the system, their general location.
 - .8 The date of the performed tests.
 - .9 All pertinent details of the report sheets requested.
 - .3 Verification:
 - .1 The Commissioning Report to be submitted to the Commissioning Manager upon completion of commissioning and will be subject to verification by the Commissioning Manager.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Single stage addressable fire alarm systems.
- .2 System testing and verification.
- .3 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing, and putting into proper operation a complete Fire Alarm System as shown, as specified, and as otherwise required. Complete system shall be left ready for continuous and efficient satisfactory operation.

1.2 RELATED REQUIREMENTS

- .1 Section 21 10 00 – Water-Based Fire-Suppression Systems.
- .2 Section 26 05 00 – Common Work Results for Electrical.

1.3 REFERENCES

- .1 Definitions
 - .1 FACP: Fire Alarm Control Panel. This is the central component of a fire alarm/detection/communication system and consists of a control panel(s) and contains the system power supply, system CPU, circuit terminations, and system annunciation functions.
 - .2 INITIATION DEVICE: Examples are smoke detectors, heat detectors, water flow switches, valve tamper switches, and manual pull stations. These are devices which initiate a signal and send it to the FACP telling it that an abnormal event has taken place. Data Centre extinguishing systems, kitchen hood extinguishing systems, and other special extinguishing system control panels are additional examples of initiating devices.
 - .3 NOTIFICATION DEVICE: Examples are alarm horns, alarm speakers, and strobe lights. These devices are used to indicate through visual and audible means the existence of an abnormal event throughout all areas of the protected premises.
 - .4 CONTROL DEVICE: Examples are electronic relays or solenoids. These devices allow the FACP to automatically take certain actions during an abnormal event. For example, the FACP may energize a relay which, in turn, shuts down an air handling unit.
 - .5 CENTRAL PROCESSING UNIT (CPU): The central computer of a multiplex fire alarm system.
 - .6 CONCEALED: Where used in connection with installation of piping or conduit and accessories shall mean "hidden from sight" as in shafts, furred spaces, soffits or above suspended ceilings.
 - .7 EXPOSED: Where used in connection with installation of piping or conduit and accessories shall mean "visible" or "not concealed."
 - .8 AHJ: Authority Having Jurisdiction.
 - .9 LISTED: Materials or equipment included in a list published by a nationally recognized laboratory that maintains periodic inspection of production of listed equipment and materials, and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.
 - .10 NFPA: National Fire Protection Association.
 - .11 CLASS A: Applies to wiring from transponder to central processing unit. The CPU will detect circuit trouble and transponder will retain the ability to transmit alarm upon a single fault condition.
 - .12 CLASS B: Applies to wiring from initiating device to transponder. A trouble signal will be transmitted to the panel upon a single fault condition.
 - .13 TRANSPONDER: Single or multiple zone/point data collection panel used within a multiplex system.

- .14 UL and ULC: Underwriters Laboratories, Inc., and Underwriters Laboratories of Canada, Inc.
- .15 ULC Listed: Materials or equipment listed by Underwriters Laboratories of Canada and included in the most recent edition of the UL and ULC Fire Protection Equipment Directory.
- .16 AHU: Air Handling Unit.
- .17 FM: Factory Mutual Research Corporation/Factory Mutual Engineering Association.
- .2 Reference Standards
 - .1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. The equipment and installation shall comply with the latest edition/amendment referenced code, standard, or publication.
 - .1 Canadian Standards Association
 - .1 CSA C22.1-18, Canadian Electrical Code, Part 1 (24th edition), Safety Standard for Electrical Installations.
 - .2 Ontario Electrical Safety Code (OESC), 27th Edition, 2018.
 - .3 CSA C22.2 No. 208-14 - Fire Alarm and Signal Cable.
 - .2 Ontario Regulations
 - .1 2012 Ontario Building Code.
 - .2 2007 Ontario Fire Code.
 - .3 Underwriters Laboratories of Canada Standards
 - .1 CAN/ULC-S524-14 – Standard for Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525 – Audible Signal Appliances for Fire Alarm Systems.
 - .3 CAN/ULC-S526 – Visual Signal Appliances for Fire Alarm Systems.
 - .4 CAN/ULC-S527 – Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528 – Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529 – Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530 – Heat Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S533 – Egress Door Securing and Releasing Devices.
 - .9 CAN/ULC-S536 – Inspection and Testing of Fire Alarm Systems.
 - .10 CAN/ULC-S537 – Verification of Fire Alarm Systems.
 - .11 CAN/ULC-S548 – Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems.
 - .12 CAN/ULC-S561-13 – Standard for Installation and Services for Fire Signal Receiving Centres and Systems.
 - .13 CAN/ULC-S1001-11 (R2018) - Integrated Systems Testing of Fire Protection and Life Safety Systems.
 - .4 All requirements of the Authority Having Jurisdiction (AHJ).
 - .2 In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, the installed Fire Alarm / Life Safety System shall comply with the most stringent requirement.
- 1.4 ACTION SUBMITTALS
 - .1 In accordance with Section 26 05 00.
 - .2 Shop Drawings: Provide annunciator layout and system wiring diagram showing each device and wiring connection required.

- .3 Product Data: Provide electrical characteristics and connection requirements.
- .4 Test Reports: Indicate satisfactory completion of required tests and inspections.
- .5 Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of products.
- .6 Submit drawings to municipal Fire Department, showing annunciation devices, manual pull stations, complete wiring diagrams and annunciator details and obtain their approval.
- .7 Shop Drawings:
 - .1 Sufficient information, clearly presented, shall be included 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 passive graphic to be included with submittal package.

1.5 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data
 - .1 Operation Data: Operating instructions.
 - .2 Maintenance Data: Maintenance and repair procedures.
- .2 Record Documentation
 - .1 Record actual locations of initiating devices, signaling appliances, and end-of-line devices.
 - .2 Electrical Safety Authority (ESA) inspection certificate.
 - .3 Fire alarm verification report.
 - .4 Audibility test.
- .3 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 shall indicate 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.

1.6 SPARE PARTS

- .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply six keys of each type.
 - .2 Supply three of each type of addressable detector base, smoke detector, heat detector, and fire alarm pull station.
 - .3 Supply three of each type of other installed initiating, notification, or controlling devices.

- .4 Supply three of each type of any special tools required for system use and maintenance.
- .5 Supply three of each type of signalling device used on the project.
- .2 Provide (supply and install) an additional three of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:
 - .1 Section 28 46 11:
 - .1 Smoke detectors.
 - .2 Duct smoke detectors.
 - .2 Section 28 46.23.11:
 - .1 Fire alarm horns.
 - .2 Combination Horn/Strobes.
 - .3 Section 28 46 41:
 - .1 Fire alarm speakers.
 - .2 Combination speaker/strobes.

1.7 QUALITY ASSURANCE

- .1 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.
- .2 Each and all items of the fire alarm system shall be listed as the products of a single manufacturer under the appropriate category by Underwriters Laboratories of Canada and shall bear the "ULC" label.
- .3 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.
- .4 Each and all items of the fire alarm system shall be covered by a one-year parts and labour warranty covering defects resulting from faulty workmanship and materials. The warranty shall be deemed to begin on the date the system is accepted by the Project Manager on issuance of the substantial performance certificate for the project.
- .5 Regulatory Requirements
 - .1 Provide products listed and classified by ULC as suitable for purpose specified and indicated.
- .6 Qualifications of Manufacturer
 - .1 Equipment and materials shall be provided by an experienced reputable manufacturer to ensure proper specification adherence, final connection, test, turnover, warranty compliance, and service.
 - .2 The manufacturer is required to have been in the fire alarm industry (service and installation) for a minimum of ten years.
 - .3 The manufacturer shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and remote control equipment.
 - .4 International Standards Organization. The system and all components will be manufactured to ISO 9001 international Quality Management and Quality Assurance Standards.
 - .5 Manufacturer must have service facilities within a 50 km radius of the installation location.
- .7 Qualifications of Installers
 - .1 All work performed to comply with this specification shall be carried out by and/or managed by a competent firm regularly engaged in the installation and testing of fire alarm systems for commercial buildings. All subcontractors of the contractor including the chosen fire alarm equipment distributor shall also be competent firms which are regularly engaged in the design, installation, testing, and servicing of fire alarm systems for commercial buildings.

- .2 Review of cut-sheets, shop drawings, calculations and other materials submitted by the contractor shall not relieve the contractor's responsibility for full compliance with the design drawings and specification unless written approval is requested by the contractor and obtained from the Consultant for each non-complying feature. Finalized agreements for all equipment deviations from the drawings and specification shall be completed prior to award of the installation contract.
- .3 For those instances where the contractor cannot conform to the drawings and specification, a proposed variance shall be submitted in writing to the Consultant at least five working days prior to the bidding date. The Consultant will respond to all proposed variances within two working days of receipt.
- .4 All questions concerning interpretation of the design drawings and specification shall be submitted to the Owner's purchasing division in writing no later than five working days prior to the bidding date. Requests for interpretations received after this date will not be answered. The Owner's purchasing division will respond to all requests for interpretations in writing and will provide a summary of each request and the response to all bidding contractors.
- .5 The contractor shall utilize the services of a fire alarm equipment distributor who is a factory authorized representative and a full line stocking distributor of the equipment manufacturer and shall maintain a constant inventory of the parts typical of those used in the system installation covered under this specification.
- .6 The contractor, installation subcontractor, and the fire alarm equipment manufacturer or distributor shall each have a minimum of 7 years of continuous experience in the design and/or installation of fire alarm systems and shall have completed a minimum of five projects of similar scope and complexity which were completed using addressable/analog systems. It is intended that these projects incorporated the same equipment, manufacturer and model number, as is being proposed for this project. To verify the qualifications, the contractor, installing subcontractor, and the fire alarm equipment distributor shall submit a brief design narrative which covers at least five fire alarm systems selected for references. This narrative shall indicate the project location, approximate contract value, system size by device counts, and a functional overview. These narratives shall provide an end-user contact name and telephone number for each referenced system. Where a fire alarm equipment distributor is a branch office of a fire alarm manufacturer, the references shall be chosen from projects in which the branch office completed both the design implementation and the installation.
- .7 The Owner reserves the right to request documentation from the contractor with respect to any pending litigation against the contractor or any subcontractor. Further, the Owner reserves the right to review an audited financial statement of the contractor or any subcontractor for the most recently completed fiscal year.
- .8 The Owner reserves the right to disqualify any contractor who does not comply with all requirements of the Contractor Performance Standard of this specification.
- .9 Installer must be certified by the Province of Ontario as a fire alarm installer.

1.1 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 26 05 00.

1.2 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

2.1 MANUFACTURERS

- .1 All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.
 - .1 Notifier by Honeywell; Onyx NFS2-3030 series (as per City of Brampton standard).
- .2 All equipment and components shall be the manufacturer's current model.
- .3 The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system.
- .4 The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
- .5 The contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications.
- .6 Manufacturer is to support a 20 year product.

2.2 CONDUIT AND WIRE FOR FIRE ALARM SYSTEM

- .1 Conduit:
 - .1 In accordance with Section 26 05 33.13.
 - .2 Conduit shall be in accordance with the Electrical Safety Authority (ESA), local and provincial requirements.
 - .3 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.
- .3 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 Conductors: 300 V rated multiconductor, insulated, colour coded, copper conductor, minimum size to be #16 AWG for device loops and 14 AWG for signal circuits.
 - .4 Certified by CSA as fire alarm and signal cable type FAS 105 to CSA C22.2 No. 208.
 - .5 Non-Fire rated cable:
 - .1 Insulation: 105 degrees C flame retardant PVC
 - .2 Outer Jacket: 105 degrees C flame retardant PVC Red.
 - .3 Armour: Interlocking aluminum without overall Jacket. For drops to devices in suspended ceilings from conduit system.
 - .6 Fire rated fire alarm cable:
 - .1 Pentair Pyrotenax 1850 series mineral insulated (MI) cable with 2 hour fire rating to ULC S139 and to meet 2012 Ontario Building Code rule 3.2.7.10.

- .2 Alternates such as "Lifeline" installed in conduit may only be considered if listed by ULC under ULC Category Code 'FHJRC' after October 2014.
- .3 Acceptable alternate: VITALink MC Brand Type MC, manufactured by Marmon Wire & Cable Inc. (listed by ULC under ULC category code 'FHJRC', dated 19 May 2015).

2.3 ADDRESSABLE FIRE ALARM SYSTEM

- .1 The system to be electrically supervised, non-coded, annunciated, single-stage, addressable fire alarm system using addressable devices.

2.4 FIRE ALARM ANNUNCIATOR PANEL (FAAP) AND GRAPHIC

- .1 To Section 28 46 21.22.

2.5 ULC MONITORING TRANSMITTER

- .1 To Section 28 46 21.24.

2.6 FIRE ALARM SYSTEM ACCESSORIES

- .1 To Section 28 46 25.

2.7 FIRE ALARM INITIATION DEVICES

- .1 Automatic Initiating Devices to Section 28 46 31.
- .2 Manual Pull Stations to Section 28 46 31 31.
- .3 Supervisory Signal devices and Sprinkler Flow Switch alarms to Section 28 46 31.41.

2.8 FIRE-ALARM SUPERVISED INTERFACE HARDWARE

- .1 Door Hardware Fire Alarm Integration to Section 28 46 51.08.
- .2 HVAC Integration to Section 28 46 51.23.

2.9 SIGNALLING DEVICES

- .1 Horns and visual signal devices (strobes) to Section
- .2 Horns and Strobes: to Section 28 46 41.
 - .1 Strobe Frequency
 - .1 Strobe frequency shall have a maximum of 5 Hz.
- .3 Programmable Electronic Sounders:
 - .1 Shall be flush mounted as required.
- .4 Audible/Visual Combination Devices:
 - .1 Shall meet the applicable requirements listed above for audibility.
 - .2 Shall have a built in strobe, 75 candela.
- .5 Strobe Synchronizing Modules:
 - .1 Synchronize strobes at 1 Hz and horns at temporal over single wire pan.

2.10 OPERATION SEQUENCE

- .1 To Section 28 46 15.

3 Execution

3.1 INSTALLATION

- .1 The entire system shall be installed in accordance with the edition of CAN/ULC-S524 as adopted by the applicable legislation, and the manufacturer's manuals and wiring diagrams.
- .2 The contractor shall furnish all labour, conduit, wiring, outlet boxes, junction boxes, cabinets and similar devices necessary for a complete, functional life safety fire alarm system.
- .3 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 Canadian Electrical Code and the Inspection Authority.
- .4 All penetration of floor slabs and fire walls shall be fire stopped in accordance with all local fire codes.
- .5 Power supply:
 - .1 Connect fire alarm system power supply to a dedicated circuit.
 - .2 Circuit breaker(s) feeding fire alarm system to be coloured red, clearly labelled, and be locked in the ON position.
- .6 Wiring:
 - .1 Install all wiring in metal raceways.
 - .2 Provide wiring suitable for fire alarm circuits.
 - .1 Class "A" wiring for initiating circuits.
 - .2 Class "A" wiring for signalling circuits unless noted otherwise.
 - .3 Provide fire rated cables for fire alarm circuits as required by applicable codes and standards.
 - .4 Provide separate signalling circuits for audible and visual devices.
 - .5 End-of-line resistors shall be furnished as required for mounting as directed by the manufacturer on Class B circuits.
 - .1 Install EOL resistors maximum 1800 mm above finished floor in interior spaces.
- .7 Install manual pull stations at 1200 mm above finished floor.
- .8 Identification
 - .1 Provide lamacoid label (white text on red background) for all supporting field devices indicating function of the device.

3.2 FIELD QUALITY CONTROL

- .1 The installing contractor shall provide a qualified project superintendent for the overall management and supervision of the work.
- .2 The project superintendent shall assure that adequate supervision is provided during all periods of installation of the fire alarm system. The project superintendent and all job site supervisors shall have a minimum of five years of continuous experience in the installation of fire alarm systems of similar scope and complexity.
- .3 Upon completion of the installation, the installing contractor shall test all alarm initiating devices, supervisory devices, control devices and notification devices for proper response and effectiveness. Operation of all annunciating devices including the FACP, printer and remote LCD panel shall be verified. Testing shall include thorough sound level measurements of audible notification devices. These tests shall be fully documented. All testing up to the point of conducting the final acceptance tests shall be recorded using a temporary printer. The permanent printer of the system, where such has been provided, shall not be installed prior to the final acceptance tests.

- .4 All smoke detectors shall be suitably protected against contamination up to the time of the final acceptance tests.
- .5 An itemized test report in accordance with CAN/ULC-S524, CAN/ULC-S536, and CAN/ULC-S537 shall be submitted to the Consultant. This report shall provide complete details of the testing completed for all devices as well as circuit testing parameters. Data shall be submitted indicating the sensitivity level of all system smoke detectors.
- .6 Following completion of a 100 per cent system functional test, the contractor shall perform a thorough acceptance test of the system at the direction of and to the satisfaction of the Owner and Consultant. This test shall not be carried out until at least 15 days after completion of all contractor's testing, modification and repairs following the original contractor's functional test and submittal of the functional testing documentation to the Consultant. The 15 day interval is also intended to be a system "burn-in" period. Any false activations of the system which occur within the burn-in period which are determined to be the result of a system fault shall result in the restart of the 15 day period.
- .7 In the event that the acceptance test of the system results in the need for system repair or modification, the contractor shall demonstrate the operability of the system to the full satisfaction of the Owner and Consultant following the completion of repairs or modification.
- .8 In the event that the AHJ requires a separate demonstration of the operability of the system for acceptance purposes, these additional tests shall be carried out by the Contractor without expense to the Owner.
- .9 The contractor shall conduct an independent quality assurance review of all developed "record" drawings to assure accuracy and completeness of these drawings. Any discrepancies shall be brought to the attention of the Consultant prior to construction start.
- .10 Only directly prior to verification, remove smoke detector protectors, and clean smoke detectors thoroughly.
- .11 Inspect and check each individual device in entire system for proper connection, supervision and function in accordance with CAN/ULC-S537. Identify detectors, manual pull stations and signal appliances not installed within requirements of CAN/ULC-S524 in remarks column of verification report.
- .12 Obtain verification certificate and verification report from manufacturer showing each device checked, and that work has been carried out. Utilize standard verification forms similar to Canadian Fire Alarm Association (CFAA) forms.

3.3 ADJUSTING

- .1 Contractor to verify programming of room names prior to fire alarm system programming, and allow for a revision to the fire alarm system programming should the Owner or AHJ wish to revise the room names.

3.4 MONITORING

- .1 Fire alarm control panel to be located as indicated. Coordinate third party CUL Listed monitoring with Owner.

3.5 MANUFACTURER SERVICES

- .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 The manufacturer's representative shall make an inspection of the fire alarm equipment, including those components necessary to the direct operation of the system such as manual stations, thermal and smoke actuated detectors and controls, whether or not manufactured by the manufacturer. The inspection shall comprise an examination and test of such equipment for the following:
 - .1 That the type of equipment installed is that designated by the specifications.
 - .2 That the wiring connections to all equipment components show that the installer undertook to have observed ULC requirements. That all products of combustion (smoke) detectors have been properly calibrated and adjustments set correctly.

- .3 That the representative's equipment has been installed in accordance with the manufacturer's recommendations.
- .4 That the supervisory wiring of all devices connected to a supervised circuit is operating and that the wiring, having been met to the satisfaction of the inspecting officials.
- .3 Testing to be done in the presence of the local building inspector, and the local fire inspector.
- .4 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 pull 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 pin-point 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 replacing 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.

3.6 SITE TESTS AND INSPECTIONS

- .1 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.
- .2 All initial testing shall be in accordance with the latest issue of ULC-S537 Verification of Fire Alarm Systems standard.
- .3 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.
- .4 The verification report shall be submitted for approval to the Consultant.
- .5 On completion of the inspection 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 operate in accordance with Article "System Verification".
- .6 Audibility Test:

- .1 Provide audibility test of signalling devices after other systems have been commissioned to verify operation at ambient sound levels.
- .2 Provide audibility test report to the Consultant.
- .3 Implement varied tone to suit audibility requirements.

3.7 CLOSEOUT ACTIVITIES

- .1 The System Supplier shall schedule and present documented formalized instruction for the building owner, detailing the proper operation and maintenance of the installed System.
- .2 The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.
- .3 The instruction shall cover the schedule of maintenance required by ULC and any additional maintenance recommended by the system manufacturer.
- .4 Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.
- .5 The contractor shall provide for a minimum of three training sessions of two hours in length. At least one of these training sessions shall be carried out for key personnel prior to the system being initially placed on-line for the beginning of the burn-in period.
- .6 Three bound copies which summarize the training instruction shall be submitted to the Owner for future reference.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Single stage addressable fire alarm system Sequence of Operation.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.

1.3 CLOSEOUT SUBMITTALS

- .1 Manuals
 - .1 Provide a clear and concise description of operation which gives, in detail, the information required to properly operate the equipment.

2 Products

2.1 OPERATION SEQUENCES

- .1 An alarm is caused by actuation of any one of the following devices:
 - .1 Pulling 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 The activation of a manual pull station, automatic fire detector, automatic smoke detector, or sprinkler flow switch shall initiate the following sequence of operation:
 - .1 Sound an alarm signal throughout building.
 - .2 Control panel and remote annunciators shall indicate exact location of alarm via a zoned RED LED.
 - .3 Fans shall be automatically turned off.
 - .4 Initiate alarm origin on CPU and at graphic annunciator.
 - .5 Display the alarm event on all annunciator panels.
 - .6 Actuate CPU causes evacuation signal to sound and strobes to operate.
 - .7 The internal audible device shall sound at the control panel.
 - .8 Signal transmission to external systems:
 - .1 Transmit signal to monitoring station.
 - .2 Central station shall be automatically alerted via telephone lines connected for fire alarm system.
 - .3 Transmit signal to Building Automation System.
 - .4 Transmit signal to Access Control System.
 - .9 Door Releases:
 - .1 All stairwell/exit doors shall unlock throughout the building.
 - .2 All self-closing fire/smoke doors held open shall be released.

- .3 Site entrance and exit gates open.
 - .10 HVAC Shutdowns:
 - .1 Shut down air supply and return air fans.
 - .2 Activate smoke dampers.
 - .11 CPU indicates trouble when any fault occurs within the system
 - .4 Alarm
 - .1 Actuate CPU causes evacuation signal to sound and strobes to operate.
 - .2 The internal audible device shall sound at the control panel.
 - .3 Signal transmission to external systems:
 - .1 Transmit signal to monitoring station.
 - .2 Transmit signal to Building Automation System.
 - .3 Transmit signal to Access Control System.
 - .4 Door Releases:
 - .1 All stairwell/exit doors shall unlock throughout the building.
 - .2 All self-closing fire/smoke doors held open shall be released.
 - .3 Site entrance and exit gates open.
 - .5 HVAC Shutdowns:
 - .1 Shut down air supply and return air fans.
 - .2 Activate smoke dampers.
 - .5 Supervisory
 - .1 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.
 - .2 The activation of a sprinkler supervised valve or pressure switch shall initiate the following sequence of operation:
 - .1 The control panel and remote annunciator shall indicate exact location of activity via a zoned AMBER LED
 - .2 Activate an audible tone on the control panel and remote annunciator
 - .3 The signals in the building shall not be sounded.
 - .6 Trouble
 - .1 A short, ground fault or open circuit to any fire alarm conductor, the tamper or removal of any field device or the loss of primary or standby power to any control equipment will result in the following trouble sequence of operation:
 - .1 The control panel and remote annunciator shall indicate exact location of activity via a zoned YELLOW LED.
 - .2 Activate an audible tone on the control panel and remote annunciator.
 - .3 The signals in the building shall not be sounded.
- 3 Execution – Not Used

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Fire alarm annunciator panels.
 - .1 Main annunciator panel and remote LCD annunciator panels.
- .2 Firefighter entrances.
- .3 Passive graphics.

1.2 RELATED REQUIREMENTS

- .1 Section 21 10 00 – Water-Based Fire-Suppression Systems.
- .2 Section 26 05 00 – Common Work Results for Electrical.
- .3 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCE STANDARDS

- .1 The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only. Comply with the latest edition/amendment referenced code, standard, or publication.
 - .1 Ontario Regulations
 - .1 Ontario Building Code.
 - .2 Ontario Fire Code.
 - .2 Underwriters Laboratories of Canada
 - .1 CAN/ULC-S524 – Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S525 – Audible Signal Appliances for Fire Alarm Systems.
 - .3 CAN/ULC-S526 – Visual Signal Appliances for Fire Alarm Systems.
 - .4 CAN/ULC-S527 – Control Units for Fire Alarm Systems.
 - .5 CAN/ULC-S528 – Manual Pull Stations for Fire Alarm Systems.
 - .6 CAN/ULC-S529 – Smoke Detectors for Fire Alarm Systems.
 - .7 CAN/ULC-S530 – Heat Detectors for Fire Alarm Systems.
 - .8 CAN/ULC-S533 – Egress Door Securing and Releasing Devices.
 - .9 CAN/ULC-S536 – Inspection and Testing of Fire Alarm Systems.
 - .10 CAN/ULC-S537 – Verification of Fire Alarm Systems.
 - .11 CAN/ULC-S548 – Alarm Initiating and Supervisory Devices for Water Type Extinguishing Systems.
 - .12 ULC/ORD 693 – Central Station Fire Protective Signaling.
 - .3 All requirements of the Authority Having Jurisdiction (AHJ).
- .2 In the case of any discrepancy between these specifications, the project drawings, and any applicable local codes, comply with the most stringent requirement.

1.4 COORDINATION

- .1 Coordinate between all trades for inclusion of information to be included on passive graphic.

1.5 ACTION SUBMITTALS

- .1 In accordance with Section 28 46 13.
- .2 Shop Drawings:
 - .1 Annunciator:

- .1 Provide annunciator layout and system wiring diagram showing each device and wiring connection required.
- .2 Show annunciator layout and main control panel module layout, configurations and terminations.
- .2 Passive Graphic:
 - .1 Prepare a complete zoning schedule and artwork layout for each passive graphic to be included with submittal package.
 - .2 Submit colour PDF (electronic submittal) using the identical colours as will be used in a temporary graphic for use during occupancy review by municipal fire inspector.
 - .3 After occupancy review, incorporate comments from municipal fire inspector, and submit colour PDF (electronic submittal) using the identical colours as will be used in the final production graphic.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 26 05 00.

1.7 WARRANTY

- .1 All work performed and all material and equipment furnished to be warranted as free from defects and for a period of at least one year from the date of acceptance.

2 Products

2.1 MANUFACTURERS

- .1 In accordance with Section 28 46 13.

2.2 FIRE ALARM ANNUNCIATOR PANEL (FAAP)

- .1 Annunciator panels will have an alphanumeric display for each detection device, and will identify the detection device initiating an alarm.
- .2 Annunciator panel located at the firefighter's entrance will have separate zone indication for each zone.
- .3 Install panel in a recessed enclosure with brushed aluminum finish [to suit the construction of the vestibule]. Coordinate exact location and dimensions with Architectural drawings.
- .4 Identify emergency exit door numbers/identifiers, and on the control panel/annunciator panel LED labels in order to identify the manual pull stations adjacent to said doors when being activated when cross referenced with the passive graphic.
 - .1 Coordinate with architectural plans indicating door IDs.

2.3 PASSIVE GRAPHIC DISPLAYS

- .1 Provide passive colour graphic display to be mounted adjacent to the fire alarm control panel and each annunciator panel as indicated on the drawings.
 - .1 Provides building and zone layout while defining zone boundaries.
 - .2 Visual reference of user's location within the building.
- .2 Multicoloured Passive Graphics:
 - .1 Plastic laminate type, on white background, framed and under glass, 600 mm by 600 mm (24 inch by 24 inch) minimum size.
 - .2 Different brilliant colours used to distinguish the various fire alarm zones and building outline from one another, silk-screened with durable acrylic-based inks on a white matte 3 mm (1/8 inch) thick acrylic sheet. Use UV protected inks to protect against fading or colour changes for life.

- .3 Provide a minimum of six different colours.
- .4 Uppercase text, minimum height of 4 mm (0.15 inches).
- .5 Graphical display will indicate the following at minimum. Coordinate between all trades for inclusion of this information.
 - .1 "YOU ARE HERE" indicated in red (unique to each passive graphic location), and properly oriented to the viewer when standing in front of the graphic.
 - .2 Zone colours to clearly indicate the extents of all fire alarm zones.
 - .1 Define all egress corridors in a distinctive (dot) black hatch pattern.
 - .2 All enclosed stairs and elevators to be coloured yellow.
 - .3 Indicate the extents of zones served by air handling units with shut downs.
 - .4 Indicate the location of the fire alarm control panel, all annunciators, and network panels/nodes.
 - .5 Indicate the location and designation of sprinkler and standpipe monitoring devices.
 - .6 Indicate the location of Sprinkler Room(s), and all supervised fire protection devices. Coordinate with the fire protection trade(s) for exact locations of devices.
 - .7 Emergency exit doors with door numbers shown. These will be needed to cross reference with the annunciator panel labels for pull stations that are activated next to these doors.
 - .8 Label all Stair Letters. Designations to match Architectural drawings.
 - .9 Main gas shut off location.
- .3 Frame
 - .1 Stainless steel frame with concealed mounting hardware and concealed screws
 - .2 Brushed silver finish.
 - .3 Concealed security mounting hardware.
 - .4 Frame to permit future replacement of graphic if the building or zone layouts change in future.
- .4 Allow for other requirements per the Authorities Having Jurisdiction, including the Municipal Building Inspector, and Municipal Fire Inspector.

3 Execution

3.1 INSTALLATION

- .1 Installation in accordance with Section 28 46 13.
- .2 Install annunciators and passive graphics with the top no greater than 1800 mm (70 in) above finished floor.
- .3 Install main annunciators with temporary passive graphics in the following locations:
 - .1 Ground floor main entrance (firefighter's entrance).
- .4 Install temporary passive graphic at fire alarm control panel.

3.2 SITE TESTS AND INSPECTIONS

- .1 Review passive graphics and annunciators with municipal fire inspector on site during occupancy review. Incorporate any comments and resubmit to Consultant for review.
- .2 Include reprogramming of zone nomenclature by system manufacturer to suit municipal review comments.
- .3 After review by Consultant, fabricate final passive graphics, and replace temporary graphics on site.

End of Section

1 General

1.1 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.

1.2 REFERENCES

- .1 CAN/ULC-S561:2020 – Installation and Services for Fire Signal Receiving Centres and Systems.

1.3 COORDINATION

- .1 Coordinate if the Owner has identified a ULC monitoring company to be used.
.2 Coordinate the installation of the fire alarm monitoring panel with the fire alarm system supplier.

1.4 CLOSEOUT SUBMITTALS

- .1 ULC “Fire Protective Signaling Certificate” certificate indicating the monitoring company is in compliance with CAN/ULC-S561.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 In accordance with Section 26 05 00.

2 Products

2.1 ULC FIRE ALARM MONITORING PROVIDER

- .1 Provide ULC monitoring transmitter and connect to a monitoring station listed to CAN/ULC-S561.

2.2 TRANSMITTER PANEL

- .1 The Fire alarm system shall be provided with a fire alarm monitoring panel that meets ULC-S561 requirements. DSC Fire Alarm Monitoring System or approved equivalent.
.2 The Monitoring System shall be fully redundant cellular / dual internet alarm communication.
.3 Monitoring panel shall be certified for active or passive ULC monitoring and operate on the local cellular 3G networks. System must automatically switch to 2G service should the 3G service fail.
.4 Monitoring Panel shall have an LCD back lit display keypad with AC status indicator. Provide battery back-up for the monitoring panel and energize from a dedicated branch circuit. Provide a red lock-on device for the breaker.
.5 Monitoring shall be provided in a passive configuration to meet ULC S561 requirements. System shall have a dedicated primary telephone line and shall not be shared with any other system in the facility. Provide Cat5 in EMT conduit to the telephone demark in [the telecommunications entrance facility]. Fire alarm system supplier shall be responsible to include a complete system with monitoring for two (2) years after substantial performance.
.6 As part of the fire alarm system shop drawing submission provide information on the monitoring company and confirmation that the monitoring company meets ULC-S561 requirements.
.7 The Monitoring System shall include cellular booster complete with lightning surge protector. Wilson Pro1050 or approved equivalent.
.8 The Contractor is responsible for all wiring from the fire alarm panel to the monitoring panel and from the monitoring panel to the [telecommunications entrance facility]. Cabling shall be as per manufacturer’s requirements. All cabling shall be run in conduit.

3 Execution

3.1 INSTALLATION

- .1 Provide one dedicated 15A/120 volt circuit for monitoring transmitter at communications entrance facility for use by Monitoring Transmitter and connect fire alarm system outputs to ULC monitoring transmitter.

- .2 Post a copy of the ULC certificate at the location of the transmitter.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 End-of-Line Devices.
- .2 Fault Isolators.
- .3 Wire Guards.
- .4 Illuminated Signs.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.
- .2 Section 28 46 31.31 – Fire Alarm Manual Initiating Devices: manual pull station covers.

1.3 REFERENCES

- .1 CAN/ULC-S524-14 – Installation Standard for Fire Alarm Systems.

1.4 UNIT PRICES

- .1 Unit price to supply and install wire guard for any fire alarm device.

1.5 CLOSEOUT DOCUMENTS

- .1 As-Built Drawings: include location and zone of all End-of-Line devices.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials
 - .1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:
 - .1 Fault Isolators.
 - .2 End-of-Line devices.
 - .3 Wire guard.
- .2 Spare Parts
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of other installed initiating, notification, or controlling devices.
- .3 Tools
 - .1 Supply three of each type of any special tools required for system use and maintenance.

2 Products

2.1 END OF LINE DEVICES

- .1 One watt type resistors mounted within outlet boxes separate from those for other devices at the locations indicated. Provide on the cover plate for each such device on approved nameplate, engraved "END-OF-LINE RESISTOR" or with an approved symbol. Provide red lamacoid plate with white 6 mm letters identifying zone.

2.2 FAULT ISOLATORS

- .1 Module shall detect and isolate a short-circuited segment of a fault-tolerant loop whilst allowing the rest of the addressing circuit to function normally.

2.3 DEVICE GUARDS

- .1 Description: Welded wire mesh of size and shape for the initiation, signaling, or other device requiring protection.
 - .1 Factory fabricated and furnished by manufacturer of device.
 - .2 Finish: Paint of color to match the protected device.
- .2 Pull station covers: as described in Section 28 46 31.31.

2.4 ILLUMINATED "FIRE DO NOT ENTER" SIGNS

- .1 Internally illuminated sign with red LED illuminating text.
- .2 Lettering within the sign not visible unless the sign is illuminated.
- .3 Display text:
 - .1 FIRE DO NOT ENTER
 - .2 Other custom text where specified on drawing.
- .4 Designed for 24 VAC/DC with integrated supervisory function.
- .5 Manufacturers:
 - .1 Geographics
 - .1 GEO-LIS series (indoor use).
 - .2 GEO-LIS-WP series (outdoor use).
 - .2 Fire alarm system manufacturer.

3 Execution

3.1 INSTALLATION

- .1 Installation to Section 28 46 13 and CAN/ULC-S524.
- .2 End-of-Line devices:

ULC-S524-14, Provide End-of-Line devices as directed by the manufacturer. Install 1800 mm above finished floor and provide a label indicating the zone service.

- .2 Installation of End-of-Line devices within other field devices: not permitted.
- .3 Provide a permanent mark to identify the zone or circuit served by the End-of-Line device.
- .3 Fault Isolators:
 - .1 Provide fault isolators in accordance with CAN/ULC-S524.
- .4 Illuminated "Fire Do Not Enter" Signs
 - .1 Feed illuminated signs from the fire alarm system and provide electrically supervised output circuits.

3.2 FIELD TESTS AND INSPECTIONS

- .1 Testing and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Sensors for the detection of Carbon Monoxide (CO) gas.

1.2 RELATED REQUIREMENTS

- .1 Section 28 46 13 – Fire-Alarm Systems.
- .2 Section 28 46 31.26 – Residential Smoke and Carbon Monoxide Alarms.

1.3 REFERENCES

- .1 CSA 6.19-17 – Residential Carbon Monoxide Alarming Devices.
- .2 Ontario Building Code.
- .3 Underwriter’s Laboratories of Canada
 - .1 CAN/ULC-S529-09 – Smoke Detectors for Fire Alarm Systems.

1.4 CERTIFICATIONS

- .1 The CO detector shall be ULC-S529 and CSA 6.19 as Carbon Monoxide alarm device.

2 Products

2.1 MANUFACTURERS

- .1 Edwards signature series “SIGA2” devices.
- .2 S-Tech.
- .3 CO detectors shall be compatible with the system in Section 28 46 13.

2.2 CARBON MONOXIDE SENSORS

- .1 The CO element shall be modular and can be replaced when the CO detector reaches end of life, so that the whole detector does not need to be replaced. Detectors that require the complete device to be replaced are not be acceptable.
- .2 The CO detector element shall have an integral count-down timer that counts down from 6 years (expected life span of the CO detector component). The detector’s processor shall monitor the CO detector component to ensure that if the CO device is out of tolerance before the 6-year time frame, the device will register a trouble condition and identify itself to the control panel.
- .3 Devices include, SIGA2-COS, carbon monoxide detector, SIGA2-PCOS, combination Photoelectric/CO detector, SIGA2-PHCOS combination Photo/Thermal/ CO detector as well as SIGA2-HCOS combination Heat/CO detector. The combination devices shall only utilize one detector address and have the ability to separate the device types to a maximum of two different inputs from each addressable detector. It shall be possible to have the smoke detector activate the sounder base only like a smoke alarm and have the heat detector activate the general alarm condition. And if the CO sensor activates, the sounder base must sound the ISO Temporal 4 CO alarm code.
- .4 The CO sensor in a sounder base shall be listed as a Carbon Monoxide Alarm to CSA-6.19. Addressable Carbon Monoxide (CO) Detector, EST model SIGA2-COS with audible sounder base. Provide intelligent addressable Carbon Monoxide Detector with Temporal 4 Audible Base.
- .5 The CO detection element shall indicate a trouble condition at the FACP signaling end of life and the CO element of the detector shall be field replaceable. It shall be programmed at the main control panel as a supervisory indication and transmit a separate supervisory signal to the central station.
- .6 Alternate product for mechanical rooms: S-Tech STCH-1000HW (hard wired alarm, wall mount), and STCH-100HWR (hard wired alarm with relay).

3 Execution

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.
- .2 Install CO detectors in accordance with 2012 Ontario Building Code, section 6.2.12, and as indicated on the drawings.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

End of Section

1 General

1.1 SECTION INCLUDES

- .1 Intelligent Modules.
- .2 Fire Alarm Pull Stations for Single Stage Fire Alarm Systems.

1.2 RELATED REQUIREMENTS

- .1 Section 21 05 23 - General-Duty Valves for Water-Based Fire Suppression.
- .2 Section 26 05 00 – Common Work Results for Electrical.
- .3 Section 28 46 13 – Fire-Alarm Systems.

1.3 REFERENCES

- .1 CAN/ULC-S528, Manual Stations for Fire Alarm Systems.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials
 - .1 Provide (supply and install) an additional [five] of each manual pull station to be used as directed on site during construction.
 - .2 Turn over unused surplus in addition to those devices listed below.
- .2 Spare Parts
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply 6 keys of each type.
 - .2 Supply 3 of each type of fire alarm pull station.
 - .3 Supply 10 manual pull station break-glass rods.
- .3 Tools:
 - .1 Supply three of each type of any special tools required for system use and maintenance.

2 Products

2.1 MICROPROCESSOR BASED INTELLIGENT MODULES

- .1 General
 - .1 Zone Addressable Modules (ZAM) shall be used for the monitoring of water flow, valve tamper, fire suppression control panels, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.
 - .2 Monitor ZAM's shall monitor any N/O contact device and be capable of powering 2-wire smoke detectors. The ZAM will communicate the zone's status (normal, alarm, trouble) to the transponder. The ZAM's zone address shall be set at the time of installation via a dip switch package.
 - .3 Control ZAM's shall be able to provide supervised or non-supervised control of any control function. The ZAM will communicate the zone's status (normal, trouble) to the transponder. Each control ZAM shall provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of the relay shall be equipped with a replaceable 2 Amp fuse. The ZAM's zone address shall be set at the time of installation via a dip switch package.
 - .4 Fire Alarm / Life Safety System shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2-wire electronic communications

loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. All addressing of the Microprocessor-based Addressable Modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. All field wiring to the Microprocessor-based Addressable Modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Modules to assist in troubleshooting system faults. Each module shall be suitable for operation in the following environment:

- .1 Temperature: 0°C to 49°C (32°F to 120°F)
- .2 Humidity: 0-93% RH, non-condensing
- .2 Single Input Module:
 - .1 Microprocessor-based Addressable Modules shall be used to provide one (1) supervised Class A input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.
- .3 Dual Input Module:
 - .1 Microprocessor-based Addressable Modules shall be used to provide two (2) independent supervised Class A input circuits capable of operation with contact devices. Both of the input circuits shall be terminated to, and operated from, the same microprocessor-based addressable module.
 - .2 Modules configured for water flow operation shall have an automatic delay of 15 seconds before reporting the water flow alarm condition to the Fire Alarm Control Panel. The module shall monitor sprinkler supervisory switches and shall automatically report the supervisory function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .4 Monitor Module:
 - .1 The Microprocessor-based Addressable Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open Active Non-Latching Monitor circuit. The module shall automatically report the monitor function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .5 Control Relay Module:
 - .1 Microprocessor-based Addressable Control Relay Modules shall provide one form "C" dry relay contact rated at 2 amps at 24 VDC or 0.5 amps at 120 VAC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications. The position of the relay contact shall be confirmed by the system firmware.

2.2 MICROPROCESSOR BASED ADDRESSABLE MANUAL PULL STATIONS

- .1 Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
- .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 All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
- .4 Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 44 mm (1.75 in) or larger.

- .5 All addressing of the Manual Pull Stations shall be done electronically, and the electrical location of each station shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the Manual Pull Station will not be dependent on their electrical location on the circuit.
- .6 The manual station shall be suitable for mounting on a North American 38 mm (1-1/2 inch) deep, 100 mm (4 inch) square electrical box with 13 mm (1/2 inch) raised cover.
- .7 All Manual Fire Alarm station shall be suitable for operation in the following environment:
 - .1 Temperature: 0 degrees C to 49 degrees C (32 degrees F to 120 degrees F)
 - .2 Humidity: 0-93 per cent RH, non-condensing.
- .8 Pull Station Cover
 - .1 All Manual Fire Alarm pull stations shall be provided with a clear, tamperproof, polycarbonate shield and frame that fits over manual pull stations. When lifted to gain access to the actual alarm, it shall sound a 95 dB or 105 dB warning horn.
 - .2 The cover is connected to the frame by a cable. When the cover is lifted, it hangs off of the frame and the horn will sound until the cover is snapped back onto the frame (or for the life of the battery).
 - .3 Battery shall be provided for each cover.
 - .1 Tamper or protecting covers for manual stations shall comply with CAN/ULC-S528, Including Accessories.
- .9 Pull stations shall be addressable, single action, non-coded, single stage, semi-flush mounted type.
- .10 Provide contacts for connection to magnetic locking devices power supply such that upon activation of the local pull station or first stage fire alarm signal the magnetic locks release.
- .11 The approximate location of all initiating devices is shown on the drawings. All existing initiating devices shall not be disturbed unless absolutely necessary to facilitate installation of a new device. No existing devices are to be disturbed without specific authorization by the Project Manager

3 Execution

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.
- .2 Install manual pull stations at 1200 mm above finished floor.
- .3 Where possible, install the manual station on the latch side of a single door at a maximum lateral distance of 1500 mm (59 in) from the door opening.
- .4 Install manual pull stations on both sides of a series of doors exceeding 12 m (39 feet) in total width, and within 1500 mm (59 in) of each side of the opening.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

End of Section

-
- 1 General
 - 1.1 **SECTION INCLUDES**
 - .1 Intelligent Modules.
 - 1.2 **RELATED REQUIREMENTS**
 - .1 Section 21 05 13 – Heat Tracing for Fire Suppression Piping.
 - .2 Section 21 05 23 – General-Duty Valves for Water-Based Fire Suppression.
 - .3 Section 21 31 00 – Centrifugal Fire Pumps.
 - .4 Section 23 38 13 – Commercial-Kitchen Hoods.
 - .5 Section 26 05 00 – Common Work Results for Electrical.
 - .6 Section 28 46 13 – Fire-Alarm Systems.
 - 1.3 **UNIT PRICES**
 - .1 To Section 28 46 13.
 - 1.4 **MAINTENANCE MATERIAL SUBMITTALS**
 - .1 Extra Stock Materials
 - .1 Provide (supply and install) an additional [five] of each of the following fire alarm devices as directed during construction. Turn over unused surplus in addition to those devices listed below:
 - .1 Zone Addressable Modules (ZAMs).
 - .2 Spare Parts
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of other installed initiating, notification, or controlling devices.
 - .3 Tools
 - .1 Supply three of each type of any special tools required for system use and maintenance.
 - 2 Products
 - 2.1 **MICROPROCESSOR BASED INTELLIGENT MODULES**
 - .1 General
 - .1 Zone Addressable Modules (ZAM) shall be used for the monitoring of water flow, valve tamper, fire suppression control panels, non-addressable detectors, and for control of fans or dampers that require shutdown or manual control in an alarm condition.
 - .2 Monitor ZAM's shall monitor any N/O contact device and be capable of powering 2-wire smoke detectors. The ZAM will communicate the zone's status (normal, alarm, trouble) to the transponder. The ZAM's zone address shall be set at the time of installation via a dip switch package.
 - .3 Control ZAM's shall be able to provide supervised or non-supervised control of any control function. The ZAM will communicate the zone's status (normal, trouble) to the transponder. Each control ZAM shall provide a double pole double throw relay for switching loads of up to 120 VAC. Each common leg of the relay shall be equipped with a replaceable 2 Amp fuse. The ZAM's zone address shall be set at the time of installation via a dip switch package.
 - .4 Fire Alarm / Life Safety System shall incorporate microprocessor-based addressable modules for the monitoring and control of system Input and Output functions over a 2 wire electronic communications

loop, using both broadcast and serial polling protocols. All modules shall display communications and alarm status via LED indicators. The function of each connected module shall be determined by the module type, and shall be defined in the system software through the application of a personality code. All addressing of the Microprocessor-based Addressable Modules shall be done electronically, and the electrical location of each module shall be automatically reported to the Fire Alarm Control Panel, where it may be downloaded into a PC, or printed out. The addressing of the modules will not be dependent on their electrical location on the circuit. All field wiring to the Microprocessor-based Addressable Modules shall be supervised for opens and ground faults and shall be location identified to the module of incidence. Diagnostic circuitry, and their associated indicators, with reviewable Trouble Codes, shall be integral to the Microprocessor-based Addressable Modules to assist in troubleshooting system faults. Each module shall be suitable for operation in the following environment:

- .1 Temperature: 0°C to 49°C (32°F to 120°F)
- .2 Humidity: 0-93% RH, non-condensing
- .2 Single Input Module:
 - .1 Microprocessor-based Addressable Modules shall be used to provide one (1) supervised Class A input circuit capable of latching operation for use with contact devices, non-damped Waterflow Switches, non-latching supervisory sprinkler switches.
- .3 Dual Input Module:
 - .1 Microprocessor-based Addressable Modules shall be used to provide two (2) independent supervised Class A input circuits capable of operation with contact devices. Both of the input circuits shall be terminated to, and operated from, the same microprocessor-based addressable module.
 - .2 Modules configured for water flow operation shall have an automatic delay of 15 seconds before reporting the water flow alarm condition to the Fire Alarm Control Panel. The module shall monitor sprinkler supervisory switches and shall automatically report the supervisory function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .4 Monitor Module:
 - .1 The Microprocessor-based Addressable Monitor Module shall be factory set to support one (1) supervised Class A Normally-Open Active Non-Latching Monitor circuit. The module shall automatically report the monitor function to the Fire Alarm Control Panel each time the associated dry contact closes.
- .5 Control Relay Module:
 - .1 Microprocessor-based Addressable Control Relay Modules shall provide one form "C" dry relay contact rated at 2 amps @ 24 V DC or 0.5 amps at 120 V AC to, control external appliances or equipment processes. The control relay module shall be rated for pilot duty applications. The position of the relay contact shall be confirmed by the system firmware.

3 Execution

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46 13.
- .2 Verification to Section 28 46 13.

End of Section

-
- 1 General
- 1.1 SECTION INCLUDES**
- .1 Fire Alarm Horns.
 - .2 Fire Alarm Strobes.
 - .3 Combination Horn/Strobes.
- 1.2 RELATED REQUIREMENTS**
- .1 Section 26 05 00 – Common Work Results for Electrical.
 - .2 Section 28 46 13 – Fire-Alarm Systems.
- 1.3 MAINTENANCE MATERIAL SUBMITTALS**
- .1 Extra Stock Materials
 - .1 Supply the following additional equipment as spare parts in a proper metal enclosure sized to accept the equipment as listed herein. Label the enclosure fire alarm spare parts. Enclosure shall be placed in the same room as the FACP.
 - .1 Supply three of each type of signalling device used on the project.
 - .2 Spare Parts
 - .1 Provide (supply and install) an additional [five] of each of the following devices as directed during construction. Turn over unused surplus in addition to those devices listed above:
 - .1 Fire alarm horn.
 - .2 Fire alarm strobes.
 - .3 Combination horn/strobes.
 - .3 Tools
 - .1 Supply three of each type of any special tools required for system use and maintenance.
- 1.4 CERTIFICATIONS**
- .1 All appliances which are supplied for the requirements of this specification shall be ULC Listed.
 - .2 All appliances of the same manufacturer as the Fire Alarm Control Panel specified to ensure absolute compatibility between the appliances and the control panels, and to ensure that the application of the appliances are done in accordance with the single manufacturer's instructions.
 - .3 Any appliances that do not meet the above requirements, and are submitted for use must show written proof of their compatibility for the purpose intended. Such proof shall be in the form of documentation from all manufacturers that clearly states that their equipment (as submitted) is 100% compatible with each other for the purpose intended.
- 2 Products
- 2.1 HORNS**
- .1 Vibrating horn: semi-flush mounted, 24 VDC, selectable 94 dBA or 98 dBA, suitable for installation in a standard electrical box.
 - .2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.
- 2.2 HORN-STROBES**
- .1 Vibrating horn: semi-flush mounted, 24 VDC, selectable 94 dBA or 98 dBA, suitable for installation in a standard electrical box.
 - .2 Red enamel typical, or white enamel as indicated on the drawings, and as confirmed by the Owner.

- .3 Provide horn-strobes where shown on plans and drawings. Strobe output shall be determined as required by its specific location and application from a family of 15/75 cd, 30 cd, and 110 cd devices. Strobes shall provide a synchronized flash.
- .4 Strobes shall be 24 VDC and ULC listed.
- .5 Strobe circuits shall be coordinated with audible circuits such that activation of an audible circuit results in activation of the companion strobe circuit. The strobe circuits shall be capable of being arranged such that they continue to operate in the event that the audible circuits have been silenced and remain operating until the FACP has been reset. Strobe circuits should also be coordinated with the audible circuits such that they are zoned in the same manner as the audible circuits
- .6 All strobes and combination horn strobes shall be mounted such that the bottom of the device is mounted 80 inches above the finished floor or 6 inches below the ceiling, whichever is lower.

2.3 STROBES

- .1 Strobes shall be supplied where shown on plans and drawings. Strobe output shall be determined as required by its specific location and application from a family of 15/75 cd, 30 cd, and 110 cd devices. Strobes shall provide a synchronized flash.
- .2 Size strobe power supplies based on all strobes set at 75 cd with exact setting determined in the field to provide adequate visual signals in accordance with CAN/ULC-S524.

3 Execution

3.1 INSTALLATION

- .1 Installation to Section 28 46 13.

3.2 SITE TESTS AND INSPECTIONS

- .1 Testing, and inspection to Section 28 46.21 11.
- .2 Verification to Section 28 46 13.

End of Section