

"ISSUED FOR TENDER"

ELECTRICAL SPECIFICATION

FOR

COMMUNITY URBAN SPACE PROJECT

PHASE 3 – NEWMARKET COMMUNITY CENTRE
ADDITION AND RENOVATION

NEWMARKET, ONTARIO

MMM GROUP NO.: 1810061-000
OCTOBER 5, 2010



MMM Group Limited
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END OF DOCUMENT

SECTION 16002 - FORM OF SUPPLEMENTARY ELECTRICAL TENDER

NAME OF BIDDING SUBCONTRACTOR: _____

DATE: _____

PROJECT: **Newmarket Community Centre Addition and Renovation**
MMM No. 1810061-000

To: MMM Group Limited
100 Commerce Valley Drive West
Thornhill, Ontario
L3T 0A1

Attn: Mr. Tara Ali
Email: alit@mmm.ca

Submit document in accordance with the Instructions to Bidders and submit a copy directly to MMM Group Limited, by means of email addressed as above within twenty-four (24) hours after the Electrical Tender closing.

Note: Specifications shall govern over this list. Where names are added/deleted by addenda, it shall be understood that this list will reflect the respective changes. Failure to complete and submit this document as directed may result in your Bid being ruled informal.

DIVISION 16 LIST OF MANUFACTURERS/SUPPLIERS

We submit, herein, typed or neatly printed, the names of the manufacturers upon whose products our Bid Price is based and which we will supply. If no name is indicated, or if name identified is not listed in issued documents, or if more than one name is indicated for a particular product, we will if requested, provide the base specified manufacturer's product. Where products are named in the specifications with only one (1) manufacturer/supplier, or are not listed herein, we are also prepared to provide the base specified named product. We will provide Canadian manufactured products if costs and quality are similar.

We understand that the first manufacturer specified for any product is the manufacturer upon whose product the design is based, and that the other manufacturers specified for a particular product are manufacturers acceptable to the Owner and whose product produces equivalent quality, performance and size. We further understand if we indicate a manufacturer other than the manufacturer whose product is the basis of the design, we are responsible for ensuring that the product supplied is equivalent in quality, performance and size to the base design product, and that any additional costs incurred as a result of use of such products will be borne by us. Acceptance of non base specified manufacturers with respect to their equivalency shall be at sole discretion of Consultant.

CONTRACTOR'S AUTHORIZED SIGNATURE _____

PROJECT NO. 0910

05/10/2010
MMM GROUP NO.: 1810061-000

16002-1

SECTION 16002 - FORM OF SUPPLEMENTARY ELECTRICAL TENDER

SECTION	PRODUCT/WORK	MANUFACTURER/SUPPLIER & CATALOGUE NUMBER/COMPANY
16050	Switches & Receptacles	
16050	Firestopping & Smoke Seal Materials	
16050	Cable Tray	
16400	Switchboard	
16400	Transformers	
16400	Panelboards and Distribution Panels	
16400	Distribution System Testing & Coordination	
16500	Fluorescent Luminaries	
16500	Exterior Luminaries – Wall Mounted	
16500	Exit Lights	
16500	Emergency Lighting	
16500	Fluorescent Lamp Ballasts	
16500	HID Lamp Ballasts	
16700	Fire Alarm System	
16700	Fire Alarm Testing and Verification Company	
16850	Cabinet Heaters	
16850	Base Board Heaters	

END OF SECTION

CONTRACTOR'S AUTHORIZED SIGNATURE _____

PROJECT NO. 0910

05/10/2010
MMM GROUP NO.: 1810061-000

16002-2

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

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NIL

PART 3 - EXECUTION

NIL

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

PART 1 - GENERAL

1.1 REFERENCES

- .1 The "General Conditions", Documents and all Sections of Division 1 apply to and are a part of this Section.

1.2 APPLICATION

- .1 This Section applies to and is an integral part of all Sections of Division 16.

1.3 DEFINITIONS

- .1 The following are definitions of words found in Sections of Division 16 of the Specification and on associated drawings:
 - .1 "concealed" means hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions;
 - .2 "exposed" means work normally visible, including work in equipment rooms, tunnels, and similar spaces;
 - .3 "provide" (and tenses of "provide") means supply and install complete;
 - .4 "install" (and tenses of "install") means secure in position, connect complete, test and verify;
 - .5 "supply" means to procure, arrange for delivery to site, inspect, accept delivery and administer the supply of manufacturer's products and/or systems, and includes manufacturer's supply of any special cables, standard on site testing, initial start-up, programming, basic commissioning, warranties and assistance to Contractor;
 - .6 "governing authority" and/or "authority having jurisdiction" and/or "regulatory authority" and/or "Municipal authority" – means government departments, agencies, standards, rules and regulations that apply to and govern the work and to which the work must adhere;
 - .7 "BAS" – means Building Automation System; reference to "BAS", "BMS" – Building Management System; and "FMS" – Facilities Management System, shall generally mean the same.
- .2 Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the specification or on the drawings they are understood, unless otherwise defined, to mean that work or product referred to is "approved by", "inspected by", etc., the Consultant.

1.4 EXAMINATION OF SITE

- .1 Carefully examine all conditions at the site that will or may affect electrical work, and become familiar with site conditions and work associated with electrical work in order that your tender price includes for everything necessary for completion of the electrical work.
- .2 Ensure that materials and equipment are delivered to the site at the proper time and in such assemblies and sizes so as to enter into the building and to be moved into spaces where they are to be located without difficulty.

1.5 PHASING

- .1 Phasing and scheduling of the Work may be required. Include in Bid Price all costs (including costs for "off hours" work) for scheduling, coordination and construction phasing to suit this project if specified in Division 1 and/or on the drawings.

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

1.6 PLANNING

- .1 The exact locations and routing of mechanical and electrical services shall be properly planned, coordinated and established with all affected trades prior to installation such that the services will clear each other as well as any obstructions. Generally, give the right of way to piping requiring uniform pitch and locate and arrange other services to suit.
- .2 Prepare working detail drawings, supplementary to the contract drawings, when deemed necessary by the Consultant, for all areas where a multiplicity of services and/or equipment occur, or where the work due to architectural and structural considerations involves special study and treatment. Submit working detail drawings to the Consultant in shop drawing form for review before the affected work is installed.
- .3 Carry out all alterations in the arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with the contract documents, in order to conceal the work behind finishes, 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.
- .4 The Owner and the Consultant reserve the right to relocate electrical components such as receptacles, switches, communication system, outlets, hard wired outlet boxes and luminaries at a later date, but prior to installation, without additional cost to Owner, assuming that the relocation per components do not exceed 10' (3m) from the original location. No credits will be anticipated where relocation per components of up to and including 10' (3m) reduces materials, products and labour. Should relocations per components exceed 10' (3m) from the original location the Contract Price will be adjusted for that portion beyond 10' (3m) in accordance with the provisions for changes in the Contract Documents.
- .5 Make necessary changes, due to lack of coordination, as required and when approved, at no additional cost, to accommodate structural and building conditions.
- .6 Whether shown on drawings or not, leave adequate space and provision for servicing of equipment and removal and re-installation of replaceable items. Comply also with code requirements with regards to space provision around electrical equipment.

1.7 SYSTEMS CO-ORDINATION

- .1 Be responsible for and perform specific coordination of various low voltage systems supplied by Division 16 and also with systems supplied by other Divisions of the Work. Include for but not be limited to provision of the following, as applicable:
 - .1 coordinate with General Contractor and other Subcontractors, the various systems of all trades which in any way are interfaced with or monitored by or integrated to, or need to be coordinated with;
 - .2 prepare systems coordination drawings detailing related system coordination and integration points being monitored and/or controlled; submit coordination drawings as part of shop drawing submission;
 - .3 coordinate security system requirements with successful door hardware supplier and prepare detailed coordination drawings of component installations, wiring and conduit layouts, division of responsibility between various trades, etc.; review security system requirements with associated door hardware (electromagnetic locks, electric strikes, etc., to ensure proper sequence of operation and door functionality is provided to suit each door configuration); prepare detailed door functionality of each door configuration and submit for review by Consultant and Owner;
 - .4 review specifications of all trades/Divisions, i.e. BAS points, elevator requirements, electrical devices in headwalls/articulating arms, etc., to ensure proper communications and power requirements;
 - .5 review with manufacturers the coordination and integration requirements of their systems;
 - .6 review each systems communication protocols to ensure they are compatible and can communicate with each other as required;

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

- .7 review all system shop drawings prior to submission to Consultant, to verify that each system has been coordinated with other systems and that required options and features are selected to meet coordination requirements;
- .8 be present at all testing and commissioning functions of each system and provide technical assistance with regards to system operations;
- .9 be the "on-site" coordinator of respective system trades with regards to respective system coordination of installation and testing;
- .10 liaise with Consultant with regards to ensuring that systems coordinate and integrate properly to satisfaction of Owner;
- .11 document all coordination and integration requirements and maintain records for submission as part of shop drawings;
- .12 respond to all coordination and integration requirements and be fully responsible for such work;
- .13 where a system integrator has been included for, coordinate integration requirements with system integrator.

1.8 DOCUMENTS

- .1 In the case of discrepancies or conflicts between the Drawings and Specifications, the Documents will govern in order specified in the "General Conditions", however, when the scale and date of the Drawings are the same, or when the discrepancy exists within the Documents, include the most costly arrangement.
- .2 The Specification is arranged in accordance with the CSI/CSC 16 Division Format with supplemental Controls Section of Division 17. Sections of Division 16 are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and the Sections are to be read as a whole.
- .3 The electrical drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. The drawings are intended to convey the scope of work and do not show architectural and structural details. The locations of materials and equipment shown may be altered, when reviewed by the Consultant, to meet requirements of the material and/or equipment, other equipment and systems being installed, and of the building. Provide all fittings, offsets, transformations, and similar items required as a result of obstructions and other architectural or structural details but not shown on the electrical drawings.
- .4 The Specification does not generally indicate the specific number of items or amounts of material required. The Specification is intended to provide product data and installation requirements. It is necessary to refer to schedules, drawings (layouts, riser diagrams, schematics, details) and the Specification to provide correct quantities. Singular may be read as plural and vice versa in the Specification.
- .5 Starter schedule drawings are both mechanical and electrical drawings and apply to the work of Division 15/17 and Division 16.
- .6 The drawings and Specifications are prepared solely for use by the party with whom the Consultant has entered into a contract and there are no representations of any kind made by the Consultant to any party with whom the Consultant has not entered into a contract.
- .7 Bidders finding discrepancies in, or omissions from the Bid documents, or having doubt as to the meaning or intent thereof, shall at once notify the Consultant, in writing. If a response is required at the discretion of the Consultant, a written instruction in the form of addendum shall be sent to all Bidders. All such addenda shall become part of the Contract Documents. Neither Owner nor Consultant will be responsible for verbal instructions.

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

1.9 EQUIPMENT LOADS

- .1 All equipment loads (self weight, operating weight, house keeping pad, inertia pads, etc.) must be supplied by Electrical Contractor to the Consultant, via shop drawing submissions, prior to construction.
- .2 When the choice of specific equipment is made by the Contractor, the actual weight, location and method of support of the equipment may differ from those initially given to the Consultants and thus from those assumed for design. Consequently, it is necessary to back-check all equipment loads, location and supports.
- .3 Where the supporting structure consists of structural steel framing, it is imperative that the equipment loads, location and method of support be confirmed prior to the fabrication of the structural steel. Be responsible for confirming the locations of all equipment with the Consultant prior to construction.

1.10 OPENINGS

- .1 All opening sizes and locations must be supplied to the Consultant to allow verification of their affect on the design, and for inclusion on the structural drawings where appropriate.
- .2 No openings will be permitted through the completed structure without written approval of the Consultant. Any openings which are required through the completed structure must be clearly and accurately shown on a copy of the structural drawings. Exact locations, elevations and size of the proposed opening must be identified and submitted to the Consultant for review, well in advance of doing the work.

1.11 SHOP DRAWINGS

- .1 Submit for review, properly identified and dimensioned shop drawings showing in detail the design, construction and performance of equipment and materials as requested in Sections of the Specification. Include dimension drawings, system block diagrams and wiring schematic drawings. The shop drawings must be submitted to the Consultant for review prior to ordering and installation of equipment.
- .2 Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS", include your company name, the submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned for resubmittal. The number of copies of shop drawings will be as later directed.
- .3 The Consultant will review shop drawings and will indicate his review status by stamping shop drawing copies as follows:
 - .1 "REVIEWED" or "REVIEWED AS NOTED" - If the Consultant's review of shop drawing is final, the Consultant will stamp the shop drawing "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked).
 - .2 "RETURNED FOR CORRECTION" If the Consultant's review of shop drawing is not final, the Consultant will stamp the shop drawing "RETURNED FOR CORRECTION", mark the submission with his comments, and return the submission. Revise the shop drawing in accordance with the Consultant's notations and resubmit.

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

- .4 It is understood that the following is to be read in conjunction with the wording on the Consultant's shop drawing review stamp applied to each and every shop drawing submitted:

"THIS REVIEW BY THE CONSULTANT IS FOR THE SOLE PURPOSE OF ASCERTAINING CONFORMANCE WITH THE GENERAL DESIGN CONCEPT. THIS REVIEW DOES NOT MEAN THAT THE CONSULTANT APPROVES THE DETAIL DESIGN INHERENT IN THE SHOP DRAWINGS, RESPONSIBILITY FOR WHICH REMAINS WITH THE CONTRACTOR, AND SUCH REVIEW DOES NOT RELIEVE THE CONTRACTOR OF THE RESPONSIBILITY FOR ERRORS OR OMISSIONS IN THE SHOP DRAWINGS OR OF HIS 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 COORDINATION OF THE WORK OF ALL SUBTRADES".

- .5 Each system (i.e.: fire alarm system, security system, etc.) and each major component (i.e.: switchboard, transformer etc.) shall each be separate shop drawing submissions. Shop drawings for common devices such as devices of each system or all luminaires, shall be submitted together.
- .6 Shop drawings for submission shall be obtained from product manufacturer's authorized representatives and supplemented with additional specified requirements.

1.12 WORK STANDARDS

- .1 Where regulatory codes, standards and regulations are at variance with the Drawings and Specification, the more stringent requirement will apply.
- .2 Where any code, regulation, by law or standard is quoted it means, unless otherwise specifically noted, the current edition including all revisions or amendments at the time of the Contract. Where references are made to printed instructions, it means the current edition of such instructions.
- .3 Supplementary mandatory Specifications and requirements to be used in conjunction with the project shall include the following:
- .1 Ontario Electrical Safety Code (OESC);
 - .2 Electrical Safety Authority (ESA);
 - .3 Electrical and Electronic Manufacturers Association of Canada (EEMAC);
 - .4 Ontario Building Code (OBC);
 - .5 Canadian Standards Association (CSA);
 - .6 Underwriters' Laboratories of Canada (ULC);
 - .7 National Building Code of Canada (NBC);
 - .8 Illuminating Engineering Society (IES);
 - .9 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE);
 - .10 Hydro inspection permits;
 - .11 Local Codes of governing authorities;
 - .12 Owner's standards.
- .4 Coordinate work inspection reviews and approvals with governing inspection department to ensure that construction schedule is not delayed. Be responsible for prompt notification of deficiencies to Consultant and submission of reports and certificates to Consultant.

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

1.13 PERMITS, CERTIFICATES AND FEES

- .1 Obtain and pay for all permits, certificates and inspections required to complete electrical work.
- .2 Be responsible for ensuring that authorities having jurisdiction which require on-site inspection of the work, have ample notification to perform inspection, with sufficient lead time to correct deficiencies in a manner that will not impede schedule of completion of the Work. Include costs for ESA inspections and certifications of approvals, as required.
- .3 Include in each copy of operating and maintenance instruction manuals, copies of inspection certificates issued by regulatory authorities to certify that the completed work is in accordance with the regulations of the regulatory authorities and is acceptable to them.
- .4 Where electromagnetic locks are provided whether by this Division or by others, be responsible for obtaining and paying for required certificates of work with regards to such electromagnetic lock work.

1.14 CHANGES OR REVISIONS TO THE WORK

- .1 Wherever the Consultant proposes in writing to make a change or revision to the design, arrangement, quantity or type of any work from that called for on or in the contract documents, submit to the Consultant for approval, a detailed, itemized, estimate breakdown of the cost of all equipment, materials and labour entering into each change or revision.
- .2 Do not execute any changes or revisions until written authorization for such changes or revisions has been issued by the Consultant.
- .3 Note: For any revision which includes deleted work as well as additional work, the total cost of the deleted work must be subtracted from the cost of the additional work before adding percentages for overhead and profit.

1.15 CLEANING UP

- .1 During construction, keep the site reasonably clear of rubbish and waste material resulting from electrical work on a daily basis to the satisfaction of the Consultant. Before applying for a Certificate of Substantial Performance of the Work, remove all of your rubbish and debris, and arrange for and pay for the repair of any damage caused as a result of electrical work.
- .2 At time of final cleaning, clean luminaire reflectors, lenses, and other luminaire surfaces that have been exposed to construction dust and dirt, including the top surface, whether exposed or in the ceiling space.
- .3 Clean switch, receptacle, and communications outlets, coverplates, and exposed surfaces.
- .4 Clean all other electrical equipment and devices installed as part of this project.
- .5 For electrical equipment rooms, electrical closets and communication closets, perform the following:
 - .1 using HEPA type vacuum cleaner, thoroughly vacuum and clean interiors and buswork of all switchboards, panels, cabinets and other electrical equipment of all construction debris and dust prior to energization.
 - .2 HEPA vacuum the top of all switchboards, panels, cabinets, bus ducts, cable trays and conduits, and all mechanical duct work in room, followed by a thorough HEP vacuuming of the floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
 - .3 thoroughly re-clean as necessary prior to final turn over to Owner.
 - .4 do not lay permanent switchboard matting in electrical rooms until rooms are thoroughly re-cleaned, and floors wet mopped and dried, immediately prior to final turn over to Owner.

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1.16 FINAL INSPECTION

- .1 Submit to Consultant, written request for final inspection of system. Include with this submission written certification that:
 - .1 deficiencies noted during job inspections have been completed.
 - .2 field quality control procedures have been completed.
 - .3 systems have been tested and verified, and are ready for operation.
 - .4 completed maintenance and operating data have been submitted and approved.
 - .5 tags are in place and equipment identification have been completed.
 - .6 cleaning up is complete.
 - .7 spare parts and replacement parts specified have been provided and receipt acknowledged by Consultants.
 - .8 As-built and Record drawings have been completed and approved.
 - .9 owner's staff have instructed in operation and maintenance of systems.
 - .10 fire alarm verification has been 100% completed and Verification Certificate has been submitted and accepted.
 - .11 commissioning procedures have been completed.

1.17 PROTECTION OF EQUIPMENT AND MATERIALS

- .1 Properly protect all electrical equipment and materials on site from damage due to the elements, the electrical work and the work of other trades, to the satisfaction of the Consultant. All equipment and materials must be in new condition when the work is substantially performed.
- .2 Wherever possible, coordinate equipment deliveries with manufacturers and/or suppliers so that equipment is delivered to the site when it is required, or so that it can be stored within the building and protected from the elements.

1.18 NOTICE FOR REQUIRED FIELD REVIEWS

- .1 Whenever there is a requirement for the Consultant to perform a field review prior to concealment of any work, give minimum five (5) working days notice in writing to the Consultant.
- .2 If the Consultant is unable to attend a field review when requested, arrange an alternative date and time.
- .3 Do not conceal work until the Consultant advises that it may be concealed.

1.19 SCAFFOLDING, RIGGING, AND HOISTING

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

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1.20 RECORD "AS BUILT" DRAWINGS

- .1 The drawings for this project have been prepared on a CAD system using AutoCAD Release 2004 software. For the purpose of producing record "as built" drawings, copies of contract drawings shall be purchased from the Engineer, at the Contractor's expense of \$25.00 CDN plus GST, per drawing, up to first ten (10) drawings, and \$5.00 CDN per any additional drawings thereafter.
- .2 When work begins at the site, clearly and accurately mark on a bound set of white prints of the Contract Drawings, on a daily basis, all changes and deviations from the routing of main service and system feeders and locations of equipment shown on the Contract Drawings. Changes and deviations include those made by addenda, change orders, and site instructions, and changes and deviations indicated on supplemental drawings issued with addenda, change orders, and site instructions. Maintain the "As built" white prints at the site for periodic inspection by the Consultant throughout the duration of the work.
- .3 Pay particular attention to accurately dimensioning the location of all concealed services terminated for future extension, and work concealed within the building in inaccessible locations.
- .4 Before applying for a Certificate of Substantial Performance of the Work, update a clean copy of the Contract Document drawing set in accordance with the marked up set of "as built" white prints including all deviations from original Contract Document drawings, thus forming an "as built" drawing set. Submit the "as built" site drawing prints to the Consultant for review. Make necessary revisions to drawings as per Consultant's comments, to satisfaction of Consultant.
- .5 Use the final reviewed "as built" drawing set to provide CAD files of the drawings, thus forming true "as built" set of contract drawings. Load drawing files onto compact discs (CD's). Provide two (2) complete sets of "as-built" drawings on separate CD's. Submit the "as built" sets of white prints, and discs to Consultant.
- .6 Prepare and submit for review with record drawings, a neat, clear, properly identified, "As built" electrical riser diagram record drawing (in AutoCAD 2004 format) of the entire electrical distribution system up to and including line side connections to panelboards. The diagram shall include feeder types and sizes, conduit sizes, breaker, switchboard and distribution panel sizes, etc., and must be approved by the Consultant. The diagram shall be as same size as the issued full size project drawings. Riser diagrams shall be mounted on 3/8" (10mm) thick foam core complete with mylar finish cover, and hardware suitable for wall mounting in the main electrical room.
- .7 All submitted drawings shall be of the same quality as original contract document drawings. The CAD drawing files shall be of form compatible with the Consultant's existing AutoCAD software.

1.21 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

- .1 For each item of equipment for which a shop drawing is required (except for simple equipment), supply three (3), project specific, indexed copies of equipment manufacturer's operating and maintenance instruction data manuals. Consolidate each copy of the data in an identified hard cover three ring binder. Each binder shall include:
 - .1 front cover with project name clearly labelled;
 - .2 detailed list of contents;
 - .3 contact names and telephone numbers for major pieces of equipment and systems;
 - .4 a copy of each "reviewed" shop drawing;
 - .5 complete explanation of operation principles and sequences;
 - .6 complete part lists with numbers;
 - .7 recommended maintenance practices and precautions;
 - .8 copies of all inspection certificates issued by regulatory authorities;
 - .9 complete wiring and connection diagrams;

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- .10 copies of all test reports and commissioning reports;
 - .11 copies of warranties;
 - .12 photocopies of panelboard directories;
 - .13 items requested specifically in Section Articles.
- .2 The operating and maintenance instructions must relate to the job specific equipment supplied under this project and relate specifically to the Owner's building. The language used in the manuals shall be simple practical operating terms and language easy for the in-house maintenance staff to understand how each system should operate and should be maintained.
 - .3 Submit the operating and maintenance instruction manuals to the Consultant before applying for a Certificate of Substantial Performance of the Work.
 - .4 When shop drawings are returned to you marked "REVIEWED AS NOTED" with revisions marked on the shop drawing copies, such shop drawings are to be revised by the equipment supplier to incorporate the comments marked on the "reviewed" shop drawings and a clean updated copy is to be included in the operating and maintenance manual.

1.22 WARRANTY

- .1 Warrant the electrical work to be in strict accordance with the Contract Documents and free from defects for a period of one (1) year from the date of issue of a Certificate of Substantial Performance of the Work.

1.23 EXTENDED WARRANTIES

- .1 Where equipment specified in Sections of Division of the Specification has an extended warranty period, e.g., five (5) years, the first year of the warranty period will be governed by the terms and conditions of the warranty in the Contract Documents, and the remaining years of the warranty are to be direct from the equipment manufacturer and/or supplier to the Owner. Submit signed and dated copies of extended warranties to the Consultant before applying for a Certificate of Substantial Performance of the Work.

1.24 EQUIPMENT AND MATERIALS

- .1 Provide Canadian manufactured products wherever possible and where required quality and performance is obtainable at competitive prices. Products shall be supplied from manufacturer's authorized Canadian representative, unless otherwise noted. Unless otherwise specified, all materials and apparatus shall be new and shall comply with applicable respective CSA Standards and/or ULC listings. Equipment shall meet or exceed ASHRAE/IES 90.1 Standards, as applicable.
- .2 Materials and equipment scheduled and/or specified have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, base specified manufacturers are stated for any material or equipment specified by manufacturer's name and model number. Generally, where acceptable manufacturers are listed, the first name listed is the base specified company. The Bid Price may be based on materials and equipment supplied by any of the manufacturers base specified or named as acceptable for the particular material or equipment. If acceptable manufacturers are not stated for a particular material or piece of equipment, base the Bid Price on material supplied by the base specified manufacturers.
- .3 The listing of a product as "acceptable" does not imply automatic approval by the Consultant and/or Owner. It is the sole responsibility of the Contractor to ensure that any price quotations received and submittals made are for products/systems that meet or exceed the specifications included herein.

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

- .4 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the base specified manufacturer, be responsible for ensuring that the material or equipment is equivalent in performance and operating characteristics (including energy consumption if applicable) to the base specified materials or equipment, and, it is to be understood that any additional costs (i.e. for larger starters, larger feeders, additional space, etc.), and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the base specified manufacturer is included in the Bid Price. In addition, in equipment spaces where equipment named as acceptable is used in lieu of base specified equipment and the dimensions of such equipment differs from the base specified equipment, prepare and submit for review, accurately dimensioned layouts of rooms affected.
- .5 In addition to the manufacturers base specified or named as acceptable, other manufacturers of materials or equipment may be proposed as substitutions to the Consultant for acceptance, listing in each case a corresponding credit for each substitution proposed, however, the Bid Price must be based on equipment or materials base specified or named as acceptable. Certify in writing to the Consultant that the proposed substitution meets all space, power, design, energy consumption, and all other requirements of the base specified or acceptable material or equipment. In addition, it is to be understood that there will be no increase in the Contract Price by reason of any changes to associated equipment, mechanically, electrically or architecturally,, required by acceptance of proposed substitution. The Consultant has sole discretion in accepting any such proposed substitution of material or equipment. Indicate any proposed substitutions in areas provided on Bid Form.
- .6 Submit the names of the manufacturers/suppliers for materials and equipment that you will supply, and which were specified or scheduled with a manufacturer's/supplier's name. Note: The names of manufacturers on the list must be one (1) of the names as base specified or named acceptable for the particular products, unless prior written permission has been given for use of products by other manufacturers. If names are not submitted, or if name identified is not listed in issued documents, or if more than one (1) name is identified for a product, it shall be assumed and expected that the base specified products will be provided. Submit copy of Document 16002 as per instructions within the Document. Product manufacturer/suppliers shall not be changed unless approved by Consultant and generally in extraordinary circumstances at Consultant's discretion.
- .7 Where products are listed as "or approved equal", certify in writing that the product to be used in lieu of base specified product, at least meets space, power, design, energy consumption, and other requirements of the base specified product and thus shall be equivalent or better than the base specified product. When requested by the Consultant, provide full design detail drawings and specifications of proposed products. Acceptance of these "or approved equal" products shall be at the sole discretion of the Consultant. There shall be no increase in Contract price due to Consultant's rejection of proposed equivalent product. Do not order such product until accepted in writing by Consultant.
- .8 Whenever use of product other than base specified product is being supplied, ensure that the corresponding certifications and product information are submitted to Consultant for review and approval. Failure of submission of these approval documents to Consultant in timely manner to allow for review and approval within the constraints of the Work schedule, shall result in base specified product to be supplied at Consultant's discretion, at no additional cost to Contract. Note that this procedure and resultant approval of a product not base specified shall not in any way delay the work schedule. Do not order such product until such product is accepted in writing by Consultant.
- .9 Any proposed changes initiated by the Contractor after award of Contract may be considered by Consultant at Consultant's discretion, with additional costs for such changes if approved by Consultant, and costs for such review, to be borne by the Contractor.

1.25 IMPERIAL AND METRIC MEASUREMENTS

- .1 Generally, both imperial and metric units of measurement are given in Sections of the Specification governed by this Section. Metric conversions are "soft" and have been rounded off.

1.26 BREAKDOWN OF ELECTRICAL WORK COST

- .1 Submit to the Consultant a typewritten breakdown of the electrical work cost with a schedule of values of the various parts of the work, aggregating the total cost of the electrical work.

SECTION 16010 - ELECTRICAL WORK GENERAL INSTRUCTIONS

- .2 The extent of the breakdown shall be as directed by the Consultant. The breakdown must be acceptable to the Consultant and is required to assist in evaluation of monthly progress draws.
- .3 Submit the breakdown within ten (10) days of written notification of acceptance of bid and award of Contract.

PART 2 - PRODUCTS

NIL

PART 3 - EXECUTION

NIL

END OF SECTION

SECTION 16050 - ELECTRICAL BASIC MATERIALS AND METHODS

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- 3.23 FINISH PAINTING OF ELECTRICAL WORK
- 3.24 INSTRUCTIONS TO OWNER

SECTION 16050 - ELECTRICAL BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 16010, applies to and is a part of this Section.

1.2 APPLICATION

- .1 This Section specifies products, common criteria and characteristics, and methods and execution that are common to one (1) or more Sections of Division 16. It is intended as a supplement to succeeding Sections of Division 16 and shall be read accordingly.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for the following:
 - .1 a manufacturer's catalogue sheet or sheets indicating proposed switches and receptacles;
 - .2 cable tray complete with copy of CSA certificate;
 - .3 firestopping and smoke seal materials complete with ULC listing and dedicated ULC number;
 - .4 vibration controls and seismic restraints.

1.4 SUBMITTALS

- .1 Submit the following to the Consultant for review:
 - .1 a sample of each proposed type of access door, as well as prints of reflected ceiling plan drawings showing proposed ceiling access door locations;
 - .2 dimensioned location drawings indicating all required sleeves and formed openings in structural poured concrete or precast concrete construction;
 - .3 samples of materials and any other items as specified in succeeding Sections of this Division;
 - .4 sample board of wiring devices and faceplates with finishes and colour samples.
 - .5 proposed nameplate sizing, colours, symbols and nomenclature.

1.5 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the work of Division 16 is specified in other Sections of other Divisions of the Specification:
 - .1 installation of access doors in building finishes;
 - .2 finish painting of exposed electrical work.

1.6 TYPICAL DETAILS

- .1 Refer to typical details on the drawings for references to products and/or execution required in this Section.

1.7 REQUIREMENTS FOR BARRIER FREE ACCESS

- .1 Provide applicable requirements for physically challenged persons and for barrier free access in accordance with the latest edition of the OBC.

1.8 SPRINKLER PROOFING

- .1 Provide drip shields for protection of equipment from water spray and dripping of liquids.
- .2 The shields shall be constructed from non combustible materials, (sheet steel) and enamel painted of colour finished to match equipment. All surfaces and edges shall be filed/sanded smooth, prior to painting.
- .3 Shields shall be supported from equipment with structural steel rods/metal framing or other method approved by Consultant. Structural supports shall be finish painted to match shield.
- .4 Include with equipment shop drawings, detailed dimension of shields and method of support.
- .5 Equipment with top cable/conduit entries shall include additional sealing of entries with gasketting and/or waterproof sealant to prevent water from entering enclosure.
- .6 Ventilation louvers shall be designed such that "live components" shall not be exposed to water spray and dripping liquids.
- .7 The above requirements are general minimum additional "sprinkler proof" standards for equipment specified as "EEMAC 1 or 2", and shall generally be provided by the respective equipment manufacturers, unless otherwise noted or approved by Consultant. CSA approvals shall be obtained, where required.

PART 2 - PRODUCTS

2.1 CONDUIT

- .1 EMT (Thinwall), galvanized electrical metallic tubing to CSA C22.2 No. 83, complete with factory made bends where site bending is not possible and joints and terminations made with steel couplers and set screw type steel connectors with insulated throats, concrete tight where required.
- .2 Rigid galvanized steel to CSA C22.2 No. 45, with exterior zinc and interior enamel coatings, galvanized threads where factory cut, red lead coated threads where site cut, factory made bends where site bending is not possible, factory made and threaded fittings and connectors, and terminations with rigid couplings, concrete tight where required.
- .3 Galvanized steel flexible liquid-tight metallic conduit to CSA C22.2 No. 56, complete with Ideal "Steel Tough" liquid-tight flexible conduit connectors at terminations.
- .4 Galvanized steel flexible metallic conduit to CSA C22.2 No. 56, complete with proper and suitable squeeze type connectors at terminations.
- .5 CSA approved and labelled, FT-4 rated, rigid plastic (PVC) conduit complete with site made heat gun bends on conduit to 50 mm (2") diameter, factory made elbows in conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.
- .6 Medium density CSA certified polyethylene flexible plastic conduit in a continuous coil of the proper length.

2.2 BASKET CABLE TRAY

- .1 Cooper B-Line "Flextray", CSA approved and labelled, basket type cable tray system complete with factory made couplers, fittings, tee sections, elbows, universal dropouts, etc., and required supporting and installation accessories. Features include but are not limited to the following:
 - .1 minimum 300 mm x 100 mm (12" x 4") unless otherwise noted on drawings;
 - .2 electro-galvanized before fabrication, and hardware galvanized in compliance with ASTM B633; final finish shall be smooth with no burrs that may damage cables;
 - .3 continuous, rigid, welded steel wire mesh cable tray system;
 - .4 top wire safety edge;

SECTION 16050 - ELECTRICAL BASIC MATERIALS AND METHODS

- .5 wire mesh welded at intersections;
 - .6 all mesh sections having minimum one (1) bottom longitudinal wire along entire length;
 - .7 warning signs;
 - .8 accessories included as required.
- .2 Prior to start of work, prepare detailed installation drawings, including plans, elevations and sections of the proposed tray and routing. Coordinate such drawings with coordination drawings of trades. Include for design calculations to determine load limitations. Submit documentations as part of the shop drawing submission.
 - .3 Tray features to include no sharp edges to protect installers and cables from damage.
 - .4 use manufacturer's trained and certified installers to perform work. Use tools as recommended by and supplied by the tray manufacturer. Utilize manufacturer's supplied cutter for cutting tray. Submit with shop drawings, copies of installing technicians' certificates of training on respective tray systems.
 - .5 Provide support of a trapeze configuration containing horizontal hanger brackets and vertical threaded rods on each side. Secure rods to brackets as per system manufacturer's instructions. Space supports at maximum 1.5 m (5'), to provide support of loads up to 53 kg/m (36 lbs per foot).
 - .6 Where cable tray penetrates fire rated construction, provide ULC listed and labelled, fire stopping and smoke seal materials or fittings to protect the integrity of the fire rated construction. Install work in compliance with ULC standards and where required by local governing codes, provide suitable for plenum environments.
 - .7 Provide tray complete with grounding/bonding provisions, fittings, tee sections, elbows, universal dropouts, expansion fittings, etc., and required supporting and installation accessories. Provide dividers to separate the various system cabling to a degree confirmed by the Consultant, but typically two (2) dividers in a 300 mm (12") wide tray. Provide conduit fittings where conduits enter tray and provide dropouts at ends where cables exit/enter. Supply cable installation rollers for pulling cables safely into tray. System accessories to be supplied by system manufacturer and must be as recommended for specific applications.
 - .8 Acceptable manufacturers:
 - .1 Cooper "Flextray" (GSMetals) only, as per Owner's direction.

2.3 OUTLET BOXES

- .1 CSA approved stamped galvanized steel outlet boxes.
- .2 Crouse-Hinds Canada Ltd., CSA certified, "FS" or "FD" Series cast Feraloy and aluminum outlet boxes.
- .3 CSA certified, rigid plastic (PVC) outlet boxes.
- .4 Hubbell Canada Inc., CSA approved, fully adjustable, both vertically and angular, formed galvanized steel, round/rectangular/square as required, flush, concrete floor mounting, boxes complete with adjustable collars, brass screw on or hinged flip open covers with provisions for mounting of duplex power receptacles, telephone jacks and data jacks. Boxes with both power and communication outlets shall be barriered.
- .5 Each outlet box and back box must be suitable in all respects for the application, and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory.
- .6 Surface mounted boxes shall be solid construction.

SECTION 16050 - ELECTRICAL BASIC MATERIALS AND METHODS

2.4 PULLBOXES AND JUNCTION BOXES

- .1 Galvanized or prime coat plated steel, suitable in all respects for the application and complete with screw-on or hinged covers as required, and connectors suitable for connected conduit.
- .2 Crouse-Hinds Canada Ltd., "Condulet", threaded cast Feraloy outlet boxes of an exact type to suit the application, each complete with screw-on gasketed cover.
- .3 Rigid plastic (PVC), CSA certified, junction boxes and access fittings with solvent weld type joints and screw-on PVC covers.
- .4 The physical size of pullboxes shall be as required by the OESC to suit the number and size of conduits and conductors.

2.5 CONDUCTORS AND CONNECTORS

- .1 "RW90" CSA certified, single copper conductor to CSA C22.2 No. 38, 600 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, X-link polyethylene insulation, colour coded.
- .2 "T90 Nylon", CSA certified, single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 90°C (194°F) dry conductor temperature, -10°C (-14°F) minimum installation temperature,, PVC insulated, nylon covered.
- .3 "AC90" flexible armoured cable with "RW90" conductors and bare copper ground conductor and overall interlocked aluminium tape armour, to CSA C22.2 No. 51 (R2004).
- .4 "TWU" single copper conductor to CSA C22.2 No. 75, 600 volts, maximum 60°C (140°F) conductor temperature, -40°C (-40°F) minimum installation temperature, PVC insulated suitable for wet and buried installations, colour coded.
- .5 "RWU90" CSA certified, single copper conductor to CSA C22.2 No. 38, 1000 volts, maximum 90°C (194°F) conductor temperature, -40°C (-40°F) minimum installation temperature, extra thickness X-link polyethylene insulation suitable for wet and buried installations, colour coded.
- .6 Conductors to and including No. 10 AWG. shall be solid. Conductors in sizes larger than No. 10 AWG. shall be stranded. All conductors shall be constructed of 98% conductive copper and shall be approved for minimum 600 volts.
- .7 Armoured cable connectors shall be proper squeeze type connectors and plastic anti-short bushings at terminations.
- .8 Connectors for conductors in conduit shall be equal to IDI Electric (Canada) Ltd., "Ideal" No. 451, No. 452 and No. 453, "Wing-Nut", CSA certified, 600 volts, rated pressure type connectors.

2.6 LOW VOLTAGE (24 VOLT) CONDUCTORS

- .1 ULC listed and labelled, CSA certified to C22.2 No. 127, No. 18 AWG "TEW" thermoplastic insulated wire rated for 600 volts service, and 220 degrees F. (105 degrees C), complete with the required number of copper conductors and colour coding.
- .2 Nexans, "Securex II", FAS 105, 300 volts, 220 degrees F. (105 degrees C.) rated fire alarm system flexible armoured cable with solid copper conductor, flame retardant PVC insulation and red colour outer jacket, ULC listed and labelled and CSA certified to C22.2 No. 208. Cable shall be complete with overall jacket.

2.7 CONDUCTOR PULLING LUBRICANT

- .1 IDI Electric (Canada) Ltd., "Ideal Yellow 77" or "Wire Lube" as required.

2.8 SWITCHES AND RECEPTACLES

- .1 The switches and receptacles in the following paragraphs shall be CSA certified devices.

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- .2 Hubbell Canada Inc., HBL 1221 Series, CSA approved, extra heavy duty, industrial grade, back and side wired, A.C. quiet action toggle type, 20 ampere, and 120/277 volts switches. Switches shall include steel-nickel plated bridge, nylon toggle, one piece rivetless copper alloy spring contact arm and terminal plate, silver cadmium oxide contacts, brass binding head screws, one piece integral grounding terminal and stainless steel automatic grounding clips. Provide key type switches where required.
- .3 Hubbell Canada Inc., No. HBL 5262 CSA approved, ULC listed, extra heavy duty industrial grade, back and side wired, nylon face/body construction, duplex U ground, 15 ampere, 125 volts, 2 pole, 3 wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic base.
- .4 Hubbell Canada Inc. No. 1221 IL, CSA approved, heavy duty, Specification grade, AC quiet action, illuminated polycarbonate handle toggle type, 20 ampere, 120/277 volt switches.
- .5 Hubbell, No. GF 5262/GF 5362 series, Specification grade, 15/20 ampere, 125 volts, duplex, ULC Class "A", Group One, ground fault circuit interrupting receptacles (for climate controlled areas).
- .6 Hubbell, No. GFR 5262TR/GFR 5362TR Series, extra heavy duty, 15/20 ampere, 125 volts, duplex, ULC Class "A", Group One, tamper resistant, weather resistant ground fault circuit interrupting receptacles (for non-climate controlled areas).
- .7 Hubbell Canada Inc., No. HBL 5362, (NEMA 5-20R alternate), heavy duty, specification grade, duplex, U-ground, 125 volts, 15/20 ampere, 2-pole, 3-wire receptacles.
- .8 Hubbell Canada Inc., No. BR-15 series, specification grade, 15 ampere, 125 volts AC, 2-pole, 3-wire, duplex, tamper resistant, receptacles that limit access to energized internal components.
- .9 Crouse-Hinds Series EDS, CAS approved, hazardous location, explosion proof surface mounting, front operated switches and Crouse-Hinds ENR series hazardous location explosion proof receptacles. Devices shall be suitable for Class 1 Division 2 applications, unless otherwise noted by Consultant. Exact classification shall be confirmed with Consultant prior to ordering. Coordinate receptacle requirements with Owner to ensure compatibility with plugs.
- .10 Hubbell Canada Inc., No. 4710, heavy duty, 15 ampere, 125 volts, single, flush mounting twist lock receptacles.
- .11 The colour of switches and receptacles (unless specified above), shall be as specified in PART 3 of this Section of the Specification.
- .12 Special switches and receptacles not specified above will be specified on the drawings.
- .13 Acceptable manufacturers are Hubbell Canada Inc., Cooper Wiring Division, Pass & Seymour Canada Inc. and Leviton.

2.9 FACEPLATES

- .1 Grade 18-8, type 302/304, 1 mm (0.040") thick stainless steel, satin, brushed or natural finish, complete with a peel-off protective plastic film, and stainless steel screws.
- .2 Galvanized steel stamped faceplates.
- .3 Hubbell Canada Inc., No. WP8M, single gang, vertical mounting, weather-proof, in-use, gasketed, cast aluminum faceplates for standard duplex receptacles in wet locations.
- .4 Hubbell Canada Inc., No. WP26M, single gang, vertical mounting, weather-proof, in-use, gasketed, cast aluminum faceplates for GFI receptacles in wet locations.
- .5 Hubbell Canada Inc., forged brass "S" series faceplates.
- .6 The colour of faceplates shall be as specified in PART 3 of this Section.

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2.10 SLEEVES

- .1 Galvanized steel sleeves as follows:
 - .1 No. 24 gauge with an integral flange at one (1) end to secure the sleeve to formwork construction;
 - .2 Schedule 40 pipe.

2.11 FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Asbestos-free, elastomeric materials and in tumescent materials, tested, listed and labelled by ULC in accordance with CAN 4-S115-M85, and CAN/ULC-S101-M for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal and a fire resistance rating (flame, hose stream and temperature) not less than the fire rating for surrounding construction. The fire stopping and smoke seal material system must be specifically ULC certified with designated reference number for its specific installation. Submit to Consultant, copies of ULC certificate, number and drawings for each installation.
- .2 Systems shall consist of both elastomeric and in tumescent materials that shall be compatible with abutting dissimilar materials and finishes. Coordinate material requirements with trades supplying abutting areas of materials.
- .3 Include costs for and arrange for manufacturer's authorized representative to inspect and verify each installation and application. Submit test report signed and verified by Contractor and manufacturer's representative.
- .4 Acceptable certification shall also include certification by Underwriters Laboratories of Northbrook IL, using tests conforming to ULC-S115 and given CUL listing published by UL in their "Products Certified for Canada (CUL) Directory".
- .5 Acceptable manufacturers are 3M Canada Inc., Tremco, Specified Technologies Inc., A/D Fire Protection Systems and Hilti Canada.

2.12 FASTENING AND SECURING HARDWARE

- .1 Concrete inserts - Crane Canada Ltd., No. 4-M for concrete work for single or double conduit, cable tray, etc., runs and for equipment, and Unistrut Ltd. or equal multiple type inserts for runs of three (3) or more conduits etc., or where a grid support system is required.
- .2 Concrete fasteners - "WEJ-IT" anchors, lead cinch anchors and/or "STAR" or "PHILLIPS" self-drilling anchors.
- .3 Masonry inserts - "WEJ-IT" expansion shields and machine bolts or, for light loads, fibre or lead plugs and screws.
- .4 Drywall or plaster wall and/or ceiling fasteners - two-wing spring toggles.
- .5 Structural steel - Crane Canada Ltd., beam clamps.
- .6 Metal framing channels - Unistrut 1-5/8" (40mm) width, hot dipped galvanized steel channels complete with required fittings and ancillary hardware; acceptable manufacturers include Thomas & Betts and Cooper B-Line.
- .7 Erico Caddy "Cablecat" metal J-hook cable support systems for communications system cabling in accessible ceiling spaces where conduit or cable tray is not being provided and where use is subject to written approval of the Consultant.

SECTION 16050 - ELECTRICAL BASIC MATERIALS AND METHODS

2.13 ACCESS DOORS

- .1 Minimum No. 12 gauge prime coat painted steel flush access doors, each complete with a heavy frame and anchor, heavy duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing provisions to suit the particular construction in which it is installed. Access door sizes shall suit the concealed work for which they are supplied. Access doors in fire rated ceilings, walls, partitions, structures, etc., shall be ULC listed and labelled and of a rating to maintain the fire separation integrity.
- .2 Where access doors are located in surfaces where special finishes are required, they shall be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout.

2.14 IDENTIFICATION NAMEPLATES

- .1 Laminated plastic (Lamacoid) black lettering on white background with bevelled edges, stainless steel screws, and proper identification engraving.
- .2 Contractor to confirm exact equipment nomenclature wording with Consultant and Owner prior to installations.
- .3 Brother "P-Touch" or equivalent, portable electronic labelling system with securely affixed, self-adhesive identification labels, permanently printed with circuit identification nomenclature shall be provided on the fact plate of every receptacle through the building. Each label shall identify receptacle feed source and circuit number (i.e. PP01-26). Upon completion, turn over label maker to the Owner.

2.15 WARNING SIGNS

- .1 Thomas & Betts Ltd. semi-rigid vinyl panels with drilled holes in each corner, stainless steel screws, pressure sensitive mounting pads on the back, and the required printed wording. Generally, wording shall be red on a white background with black trim.

2.16 SYSTEMS BACKBOARDS

- .1 G1S construction grade fir plywood, flame retardant prime coat painted on both sides, minimum 20 mm (3/4") thick, with flame spread rating in accordance with OBC requirements. Generally, refer to drawing notes for sizing and increase to include 20% spare space where it can be accommodated on the walls.

2.17 VIBRATION CONTROL AND SEISMIC RESTRAINTS

- .1 Provide seismic requirements for suspended electrical raceways, luminaires and other equipment as per latest OBC requirements and as per paragraphs, which follow.
- .2 Include for manufacturer of vibration control products, such as Vibro-Acoustics or Mason Industries to develop/design a seismic restraint system and perform seismic calculations in accordance with latest requirements of governing Building Code, requirements of local authority having jurisdiction, and additional requirements specified in this article. The design of the seismic restraints shall be able to withstand the forces of the area rating as per governing building code requirements.
- .3 The calculations, restraint selections, and installation details shall be performed and prepared by restraint system manufacturer's professional engineer licensed by the Association of Professional Engineers of Ontario and experienced in seismic restraint design and installation and are licensed in the area of the project in accordance with the requirements of governing local building code requirements.
- .4 The seismic restraint design, including calculations, restraint selection, installation details, and other documentation, shall be submitted for review by the Consultant. This submittal shall be signed and sealed by the manufacturer's seismic restraint engineer. This submittal shall become part of the project design calculations, included in the project records, and when required, will be submitted to the authority having jurisdiction.

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- .5 The seismic restraint design to clearly indicate the attachment points to the building structure and design forces (in X, Y, and Z direction) at the attachment points. The seismic restraint engineer shall coordinate attachments with the building's structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed.
- .6 The seismic restraint design shall be based on actual equipment data (dimensions, weight, centre of gravity, etc.) obtained from submittals or the manufacturers. The equipment manufacturer to verify that the attachment points on the equipment can accept the combination of seismic, weight, and other loads imposed. For life safety systems and other systems that must remain operational during and after an earthquake, the manufacturer shall provide certification that the equipment can accept the loads imposed and remain operational.
- .7 Analysis shall include calculated dead loads, static seismic loads, and capacity of materials used for the connection of the equipment or system to the structure. Analysis shall detail anchoring methods, bolt diameter, embedment, and/or welded length.
- .8 Seismic restraint engineer shall verify that seismic restraints and combination isolator/restraints intended for use on the project are fit for the intended purpose. The seismic restraint engineer, shall stamp, seal and endorse the seismic restraint shop drawing. The Electrical Contractor shall take full responsibility for ensuring that the seismic restraints are in compliance with applicable building code requirements for the site of Work.
- .9 Upon completion of work, the seismic restraint engineer shall visit the site to review and verify that the seismic restraint system has been installed in accordance with the seismic restraint design. The seismic restraint engineer shall issue a letter to the Consultant and Owner certifying that the system has been installed in accordance with the design. Submit certification letter prior to the issuance of Certificate of Substantial Performance. Include copies of the letter in the Operating and Maintenance Manuals.
- .10 Acceptable manufacturers of seismic restraints include Vibro-Acoustics (Douglas Ross 416 – 291-7371); Mason Industries, Kinetics and other approved equal manufacturers.

PART 3 - EXECUTION

3.1 GENERAL CONDUIT AND CONDUCTOR INSTALLATION REQUIREMENTS

- .1 Install conduit and conductors concealed in all finished areas, and concealed to the degree made possible by finishes in partially finished and unfinished areas. Conduit may be exposed in unfinished areas such as Electrical and Mechanical Rooms, unless otherwise noted on the drawings or specified herein. Refer to and examine the architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of the building.
- .2 Where conduit and/or conductors are exposed, arrange same to avoid interference with other work and parallel to the building lines. Where horizontal conduits and/or conductors are exposed, install as high as possible. Do not install conduit and/or conductors within 150 mm (6") of "hot" pipes or equipment unless the conduit and/or conductors are associated with the equipment. Independently run conduit and conductors must be supported from the ceiling/wall structure, not from ceiling hangers, ductwork, piping, cable trays, etc.
- .3 Temporarily pack all open boxes located in concrete, plaster and masonry to prevent debris from entering the box.
- .4 Where conduit is to be embedded within structural concrete, install such conduit in compliance with the requirements of the latest edition of CSA Standard CAN3-A23.1-04, "Concrete Materials and Methods of Concrete Construction," with specific reference to Section 13.5. Generally, installation practices and methods shall be confirmed with and accepted by the Structural Consultant.
- .5 All circuits must contain separate phase, neutral and ground conductors (i.e.: common neutral configuration is unacceptable). Conductors shall be minimum No. 12 AWG and No. 10 AWG for runs longer than 15 m (50').
- .6 At no extra cost, allow for final relocations of devices up to 3 m (10') to suit final coordinated device locations, prior to installation of wall coverings.

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- .7 Generally, conductors and conduits are sized on drawings, but in absence of direction in type, sizing and quantity, type, size and provide quantity in accordance with the intended application, to applicable OESC requirements. Note that sizing shown on drawings are minimum requirements that shall not be reduced unless approved by Consultant.
- .8 Conduits and boxes in non-climate controlled areas shall be weatherproof and corrosion resistant construction. Provide proper NEMA rated boxes and enclosure to suit applications.
- .9 Conductors installed in cable tray and surface raceways shall be bundled separately by systems and tagged identifying the system. Conductors in cable tray running vertically shall be secured with ties in a manner to relieve and stress of the weight of cables. Cable ties shall be provided to applicable BICSI standards.

3.2 INSTALLATION OF CONDUIT

- .1 Provide conduit for all conductors except as noted otherwise.
- .2 Conduit shall be as follows:
 - .1 for interior building surface mounted services greater than 600 volts – rigid galvanized steel;
 - .2 for main distribution wiring in Electrical rooms - rigid galvanized steel with separate insulated ground wire;
 - .3 for exposed conduit outside the building to surface mounted "FS" boxes and for semi-exterior areas such as loading areas - rigid galvanized steel with separate insulated ground wire;
 - .4 for exposed conduit mounted at a height of less than 1200 mm (4') in electrical, mechanical or other service areas - rigid galvanized steel;
 - .5 for short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm (18"), maximum length 600 mm (24") with 180° loop where possible) - galvanized steel flexible liquid-tight conduit;
 - .6 at points, where conductors cross building expansion joints - galvanized steel flexible conduit;
 - .7 for branch circuit conductors underground inside the building, and underground outside the building beneath concrete, asphalt, and similar paving material - rigid PVC with separate insulated ground wire;
 - .8 for branch circuit conductors underground outside the building clear of concrete, asphalt and similar paving material - flexible polyethylene plastic conduit with separate insulated ground wire;
 - .9 for branch circuit conductors in poured concrete slab - rigid PVC with separate insulated ground wire;
 - .10 for interior conduit above 50 mm (2") diameter containing distribution conductors-EMT with separate insulated ground wire;
 - .11 for conductors except as noted above or elsewhere in this Specification or noted on drawings - EMT.
- .3 Secure conduit located in poured concrete work in place in a manner such that conduit will not float or move when concrete is poured. Adequately protect such conduit from damage prior to and during the concrete pour, and from the concrete and water penetration.
- .4 The maximum allowable size of conduit for installation in poured concrete must be determined in consultation with the Consultant prior to installation. The placement of reinforcing steel in structural concrete work will take precedence over the placement of conduit. Multiple runs of conduit in poured concrete work must be spaced adequately as directed by the Consultant.

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- .5 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by the conduit manufacturer.
- .6 Install flexible polyethylene conduit in continuous lengths wherever possible and "snake" the conduit in the trench. Where joints are necessary, make same with nylon inserts and stainless steel gear type clamps. Terminate with rigid conduit threadless connectors.
- .7 Provide a separate insulated ground conductor in all conduit.
- .8 Support underground conduit on a well tamped flat bed of earth, free from rocks or protrusions of any kind. Underground conduit must be provided sloping with proper and suitable drainage provisions. Generally, conduit shall slope away from building structure, vaults, manholes, etc., unless means of water drainage are provided to satisfaction of Consultant.
- .9 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with OESC requirements by means of galvanized pipe straps, conduit clips, ring bolt type hangers, or by other proper manufactured devices.
- .10 Support multiple mixed size metal conduit runs with Unistrut Ltd., Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks spaced to suit the spacing requirements of the smallest conduit in the group.
- .11 Unless otherwise noted, conduit fittings shall be constructed of the same materials as the conduit and shall be suitable in all respects for the application.
- .12 Provide proper adaptors for joining conduits of different materials.
- .13 Cut square and properly ream all site cut conduit ends.
- .14 Generally, conduit is sized on the drawings. Conduit not sized on the drawings shall be sized in accordance with the latest edition of the OESC. Note that the sizes of branch circuit conductors indicated are minimum sizes and must be increased as required to suit length of run and voltage drop in accordance with the voltage drop schedule found on the drawings or obtained from Consultant. Where conductor sizes are increased to suit voltage drop requirements, increase the scheduled or specified conduit size to suit.
- .15 Site made bends for all conduit must maintain the full conduit diameter with no kinking, and conduit finishes must not flake or crack when the conduit is bent.
- .16 Plug ends of roughed-in conduit which are exposed during construction with approved plugs.
- .17 Ensure that all conduit systems which are left empty for future wiring are clean, clear, capped and properly identified at each termination point. Provide end bushing fitting and suitable fish wires in all such conduit.
- .18 Provide empty conduits to ceiling spaces from flush mounted panelboards located below and/or near hung ceiling. Refer to the detail sheet found on drawings.

3.3 EXPANSION FACILITIES FOR CONDUIT CROSSING BUILDING EXPANSION JOINTS

- .1 Wherever concealed or surface mounted conduits cross building expansion joints, provide expansion facilities to permit free movement without imposing additional stress or loading upon the support system, and to prevent excessive movement at joints and connections, all in accordance with the detail sheet found on drawings.

3.4 INSTALLATION OF CABLE TRAY

- .1 Provide with shop drawings, drawing of proposed layout and routing of the tray, including dimensions, penetrations, connections, supports, etc. Provide sample of tray to Consultant. Provide cable tray for conductors where shown and as required. Exact length requirements shall be site measured. Ground/bond cable tray as per OESC requirements.

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- .2 Install and hang the tray at maximum 1.5 m (5') centres and in accordance with the manufacturer's published literature employing a trapeze configuration of Unistrut c-channel hangers secured with threaded rods to ceiling structure. Any cuts to the steel material must be re-finished with corrosion resistant finish.
- .3 Equip the tray with the necessary fittings and similar accessories required. Make provisions in the cable tray where required for conduit entry. Terminate conduits at or in the tray with proper grommetted and bushed terminations. Equip the tray with the necessary wall flanges, dropouts, enclosures, reducers, fittings and similar accessories required, maintaining effective free cross-sectional area of tray clear of all obstructions that might damage conductors insulation during installation.
- .4 The cable tray routing shown on the floor plans is general only and shall be carefully coordinated with the work of other trades. Adjust location or routing as may be required and include for all offsets necessary for coordination.
- .5 Properly secure, adequately support and neatly harness conductors in the tray. Seal cable tray penetrations of building fire barriers by means of ULC listed and labelled packing material. Provide continuous paths along the entire lengths of the cable tray to maintain proper ground continuity. Use manufacturer's hardware to provide continuous paths along the entire lengths of the cable tray to maintain proper ground continuity and bonding.

3.5 INSTALLATION OF OUTLET BOXES AND BACK BOXES

- .1 Provide an outlet box or back box for each luminaire, wiring device, telephone outlet, fire alarm system component, communications systems components, and each other such outlet.
- .2 Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where the connecting conduit is EMT, shall be stamped and galvanized steel outlet boxes unless otherwise noted.
- .3 Outlet boxes for surface mounted exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where the connecting conduit is rigid, and for boxes in perimeter walls where insulation and vapour barrier is present, shall be "FS" or "FD" Series cast boxes unless otherwise noted.
- .4 Outlet boxes in underground plastic conduit systems shall be rigid PVC plastic outlet boxes unless otherwise noted.
- .5 Outlet boxes for flush floor mounted devices shall be concrete tight formed galvanized steel fully adjustable flush floor boxes. Locate boxes where shown and install in accordance with manufacturers requirements.
- .6 Outlet boxes for special wiring devices, for special equipment and special applications if required, shall be specified hereinafter in other Sections of this Division of the Specification or on the drawings.
- .7 The size and arrangement of outlet boxes shall suit the device which they serve.
- .8 Generally, mounting heights and locations for outlets are indicated on the electrical drawings, however confirm the exact location and arrangement of all outlets prior to roughing-in. Architectural drawings and the Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
- .9 Do not install outlet or back boxes "back-to-back" in walls and partitions. Stagger such outlets and seal against noise transmission in accordance with the typical detail found on drawings or at the end of this Section. "Thru-wall" type boxes will not be permitted for any application.
- .10 Provide blank cover plates over all boxes left empty for future installation of devices. Clearly identify each box as to its intended use to the Consultant's approval. Generally, blank cover plates shall be stainless steel.

3.6 INSTALLATION OF PULLBOXES AND JUNCTION BOXES

- .1 Provide pullboxes in conduit systems wherever shown on the drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100') in length, or with more than three (3) 90 degree bends, shall be equipped with a pullbox installed at a convenient and suitable intermediate accessible location.
- .2 Provide junction boxes wherever required and/or indicated on the drawings.
- .3 Boxes in rigid conduit and EMT inside the building shall be stamped galvanized or prime coated steel.
- .4 Boxes in exterior rigid conduit shall be "Condulet" cast gasketed boxes unless otherwise noted.
- .5 Boxes in plastic conduit shall be rigid PVC plastic boxes.
- .6 All pullboxes and junction boxes must be accessible after the work is completed.
- .7 Accurately locate and identify all concealed pullboxes and junction boxes on "As-built" record drawings.
- .8 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by spray painting the outside of the covers. Paint colours shall be in accordance with the following schedule:
 - .1 lighting - yellow;
 - .2 normal power - blue;
 - .3 essential power - orange;
 - .4 fire alarm - red;
 - .5 telephone - green;
 - .6 miscellaneous signals - brown.
- .9 In addition to painting miscellaneous signal boxes, clearly identify the specific system in which the box is installed.
- .10 Cover boxes in fire rated walls with aluminum tape and seal with caulking.

3.7 INSTALLATION OF CONDUCTORS

- .1 Provide all required conductors.
- .2 Conductors, unless otherwise noted, shall be as follows:
 - .1 underground inside or outside the building – "TWU";
 - .2 in accessible suspended ceiling spaces for drops to luminaires and down drops in stud wall construction, and wherever else shown or specified – "AC-90" flexible armoured cable ("BX"); (maximum 6 m (20') run permitted);
 - .3 for all wiring except as noted above or except as specified elsewhere – "T90 Nylon."
- .3 Support "BX" armoured cable in ceiling spaces and in stud wall construction with steel two (2) hole cable straps to "Code" requirements. Run "BX" in ceiling spaces in a neat manner, parallel and perpendicular to building lines.
- .4 Make joints in thermoplastic insulated conductors by means of pressure type twist connectors.
- .5 Low voltage conductors shall be No. 18 AWG "TEW" except for use in fire alarm system applications and unless otherwise noted. Provide specified fire alarm cables for fire alarm system applications or security system applications as approved by Code and local Governing Authorities.

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- .6 Generally, conductor sizes are indicated on the drawings. Such sizes are minimum requirements and must be increased, where required, to suit the length of run and voltage drop in accordance with the conductor voltage drop schedule found on drawings or obtained from Consultant.
- .7 Do not use conductors smaller than No. 12 AWG in systems over 30 volts, unless otherwise noted.
- .8 Do not use conductors smaller than No. 10 AWG for exterior luminaire wiring unless otherwise noted.
- .9 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, shall be as follows:
 - .1 phase A - red;
 - .2 phase B - black;
 - .3 phase C - blue;
 - .4 ground - green;
 - .5 neutral - white;
 - .6 control - orange.
- .10 Control conductors, in addition, shall be numbered with Brady Ltd., Ideal Industries or Electrovert Ltd. Z-type markers.
- .11 Colour code conductors for communications systems in accordance with the system component manufacturer's recommendations.
- .12 When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraided.
- .13 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.
- .14 Install all low voltage conductors in conduit unless otherwise noted.
- .15 All conductors not installed in conduit or raceways must be FT insulated rated in accordance with the latest Governing Code flame spread requirements.

3.8

INSTALLATION OF SWITCHES AND RECEPTACLES

- .1 Provide switches and receptacles where indicated on the drawings and as required. Where mounted in control panels, provide samples and/or dimensions of devices to panel manufacturer to ensure proper installation and cutout openings. Coordinate work.
- .2 Switches and receptacles shall be ivory for devices, unless otherwise noted. Refer to drawings.
- .3 Confirm switch and receptacle finishes with Consultant prior to ordering.
- .4 Provide a separate insulated ground wire for all circuits.
- .5 Where receptacles are indicated in laboratory bench splashbacks, a box cutout shall be provided in splash back by bench supplier. Provide device box, receptacle, plate and branch circuit wiring. Branch circuit wiring within benches shall be flexible armoured cable (BX).
- .6 Where applicable, provide hazardous location switch in Outdoor Storage Room to control room lighting. Surface wall mount were shown.
- .7 Provide self-adhesive label on the faceplate of each receptacle as previously described.
- .8 Ensure that switches located adjacent to doors are located at the strike side of the door. Confirm door swing requirements on the architectural drawings, not on the electrical drawings.

3.9 INSTALLATION OF FACEPLATES

- .1 Equip each switch and receptacle with a faceplate with an opening or openings suitable for the device it conceals. Secure faceplates to the device frames with screws to match the faceplates.
- .2 Faceplates for flush mounted switches and receptacles shall be stainless steel.
- .3 Faceplates for surface mounted switches and receptacles shall be galvanized steel.
- .4 Faceplates for weatherproof receptacles denoted "WP" on the drawings shall be weatherproof insulated faceplates with hinged and gasketed receptacle access flaps.
- .5 Confirm the exact material, finish and colour of faceplates for devices in any particular area with the Consultant prior to ordering.

3.10 INSTALLATION OF SLEEVES

- .1 Where conduits, round ducts and conductors pass through structural poured concrete, provide galvanized steel sleeves unless otherwise noted.
- .2 Sleeves in concrete slabs, except as noted below, shall be No. 24 gauge with an integral flange to secure the sleeves for formwork construction.
- .3 Sleeves in waterproof concrete slabs and in other slabs where waterproof sleeves are required shall be lengths of Schedule 40 pipe sized to extend 100 mm (4") above the floor.
- .4 Sleeves in poured concrete walls and foundation shall be Schedule 40 pipe.
- .5 Size sleeves, unless otherwise noted, to leave 13 mm (1/2") clearance around the conduit, duct, conductor, etc. Pack and seal the void between the sleeves and the conduit, duct, conductors, etc., for the length of the sleeves as in accordance with the article entitled "Firestopping and Smoke Seal Materials" specified here in this Section of the Specification. Pack and seal sleeves set in exterior walls with approved materials suitable for application and seal both ends of sleeves watertight with approved permanently flexible and water tight materials.
- .6 Submit drawings indicating all required sleeves, recesses and formed openings in poured concrete work. Such drawings shall be completely and accurately dimensioned and shall relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .7 Supply sleeves of a water protecting type in accordance with the detail found on drawings or at the end of this Section for installation in the following locations:
 - .1 in Mechanical and Fan Room floor slabs, except where on grade;
 - .2 in slabs over Mechanical, Fan, Electrical and Telephone Equipment Rooms or closets;
 - .3 in all floors equipped with waterproof membranes;
 - .4 in the roof.
- .8 "Gang" type sleeving will be permitted only with the approval of the Consultant.
- .9 Terminate sleeves for work which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeve may be covered completely by escutcheon plates.
- .10 All sleeved or formed openings through the structure must be shown on sleeving drawings which are to be submitted to all Consultants for review prior to construction. No holes through the structure will be permitted without written approval of Consultant.

3.11 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS

- .1 Where electrical work penetrates or punctures fire rated construction, provide ULC certified, listed and labelled firestopping and smoke sealing packing material systems to seal holes and voids around and within the raceway and to ensure that the continuity and integrity of the fire separation is maintained. Submit certificates of compliance from an independent testing agency, attesting that fire stopping and smoke seal materials meet ULC requirements.
- .2 Examine condition of voids to be filled to ensure suitability for systems. Verify installation of service penetrations and adjacent construction has been completed. Prepare substrates and surfaces to a clean, dry, frost free condition, and primed to firestop system manufacturer's recommendations to receive the firestopping system.
- .3 Install fire stopping and smoke seal materials for each installation in strict accordance with specific ULC certification number and the manufacturer's instructions. Comply with OBC requirements and obtain approvals from local building inspection department. Ensure that openings through fire separations, do not exceed the maximum size wall opening and maximum and minimum dimensions, indicated in ULC Guide No. 40 U19 for Service Penetration Assemblies and fire stopping materials.
- .4 Ensure that the continuity and integrity of the fire separation is maintained and conform to requirements of the latest edition of ULC publication "List of Equipment and Materials, Volume II, Building Construction".
- .5 Work shall be executed by qualified applicator approved by the manufacturer.
- .6 Arrange for manufacturer's authorized representative to inspect and verify each installation and provide a test report signed by Contractor and manufacturer's representative. The test report must list each installation and respective ULC certification and number.
- .7 Copies of ULC certifications must be submitted to Consultant.

3.12 SUPPLY OF ACCESS DOORS

- .1 Supply access doors to give access to all junction boxes, pullboxes, conductor joints and other similar electrical work which may need maintenance or repair but which is concealed in inaccessible construction.
- .2 Before commencing installation of electrical work, prepare on a set of reflected ceiling plans, complete layouts of all ceiling access doors which will be required. Submit these layouts for approval and show the exact sizes and locations of such ceiling access doors. Locate and arrange electrical work to suit.
- .3 Access doors will be installed by the trade responsible for the particular type of construction in which the doors are required. Supply the access doors to the trade installing same at the proper time.
- .4 Access doors shall wherever possible, be of a standard size for all applications. Confirm exact dimensions prior to ordering.

3.13 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide all fasteners and similar hardware required for conduit, duct, raceway, conductors, etc., and for equipment hanger and/or support material unless otherwise noted.
- .2 Accurately and properly set concrete inserts in the concrete framework. Where multiple type inserts are used, space same to suit requirements of the smallest conduit, etc., in the group.
- .3 Fasten hanger and support provisions to masonry with expansion shields and machine bolts, or, for light loads, use plugs and screws.
- .4 In drywall or plaster walls and/or ceilings use two (2) wing toggles and for heavy loads, provide steel anchor plates with two (2) or more toggles to spread the load.
- .5 Provide beam clamps for attaching hanging and/or support provisions to structural steel, or where approved by the Consultant, weld the hanging and support provisions to the structural steel.

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- .6 Explosive powder actuated fasteners will not be permitted unless specific written approval for their use and type has been obtained from the Consultant.
- .7 Under no circumstances use ceiling suspension hangers or grids for suspension of conduit and conductors.
- .8 Provide metal framing channels for support of equipment as shown. Install as per manufacturer's instructions.
- .9 Provide "J" hooks in accessible ceiling spaces for network cabling runs or other communication cabling as approved by the Consultant. Refer to Section 16750 and drawing note for additional requirements.
- .10 Comply with J-hook manufacturer's loading limitations and spacing criteria. Do not exceed 1.2 m (5') spacing interval. Add additional J-hooks if cabling sags, at discretion of the Consultant. Do not install more than one system on each J-hook.

3.14 INSTALLATION OF IDENTIFICATION NAMEPLATES

- .1 Submit proposed nomenclature, sizing and colours with shop drawing submission.
- .2 For each piece of electrical distribution equipment from the electrical source of supply up to and including panelboards, for special control panels and cabinets, and for each other piece of electrical equipment, provide engraved Lamacoid identification nameplates secured to apparatus with stainless steel screws. Nameplates shall indicate the equipment designation number and the source of electrical supply.
- .3 Equip large multiple cell or component apparatus such as sub-stations, switchboards and distribution panels with main nameplates identifying the equipment, voltage characteristics, capacity and source of supply, and with sub-nameplates clearly identifying each cell or component and its service.
- .4 Nameplates shall identify the equipment number as designated on the drawings, and/or schedule, unless otherwise instructed. Nameplates for disconnect switches, control panels, and cabinets shall outline their service and source of supply.
- .5 Provide identification labels on the outside of each device outlet faceplate, identify the location from where each device is fed. Verify nomenclature with Consultant. Upon completion of work, turn over electronic labelling device to Consultant, for forwarding to Owner. Labels shall not be hand printed.
- .6 Confirm exact nameplate wording, designations, and sizes with the Consultant prior to manufacture. Nomenclature must be in accordance with the Owner's standards.

3.15 INSTALLATION OF WARNING SIGNS

- .1 Provide warning signs as required and wherever required by local governing authorities.
- .2 Secure the signs to the equipment with stainless steel screws. The number of signs required and the sign wording and colours must be approved by the Utility.

3.16 INSTALLATION OF SYSTEM BACKBOARDS

- .1 Provide the specified terminal backboards for communication systems and electrical distribution equipment.
- .2 Securely wall mount each backboard in locations as shown on the drawings.
- .3 Ensure that backboards are sized to sufficiently provide adequate termination space for each system plus 20% spare space.

3.17 PROVISIONS FOR MISCELLANEOUS SYSTEMS

- .1 Provide the following components to accommodate the installation of the telephone system and other systems by the system installers who will provide the equipment and wiring:

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- .1 conduit - diameters as sized on the drawings with suitable bushings for conduit terminations, and as specified herein;
 - .2 outlet boxes - standard galvanized steel, each complete with a blank type faceplate;
 - .3 pull boxes, junction boxes and sleeves - as specified herein;
 - .4 backboxes – as required to suit respective system manufacturers component requirements.
- .2 Provide pullboxes in conduit runs longer than 100' (30 m) or having more than two (2) 90 degree bends. Pullbox sizes shall not be less than eight (8) times the entering conduit in length. Note that network cabling conduit and pull box requirements must comply with system manufacturer's instructions to meet EIA/TIA standards.
 - .3 Leave conduits free and clear of all obstructions and terminate as shown. Equip terminations with bushing, and clearly identify each run. Provide fish wires in all empty conduit. Coordinate conduit home run requirements to specific devices, with respective system suppliers.
 - .4 Confirm the exact requirements and locations of the equipment with the Consultant and the system installers prior to roughing-in. Ensure that conduit runs comply with cabling bending radii of respective systems.
 - .5 Refer to the system riser diagram on the drawings.
 - .6 Quantities for outlets shall be as per the floor plan drawing and not the riser diagram.
 - .7 The security systems shall be provided under the cash allowance carried in Division 01. Include for the following:
 - .1 a system of empty conduits with fish cord and boxes to accommodate future system installation;
 - .2 coordination of conduit and box requirements with successful security system vendor.

3.18 GENERAL ELECTRICAL WORK TESTING

- .1 In addition to the tests required by the Governing Authorities, codes and regulations, perform the following:
 - .1 after all luminaires, switches, receptacles, motors, signals, etc., are installed, whether same are installed as part of this Section of the work or by other Sections (telephone systems excepted), test all work to ensure that there are no grounds or crosses;
 - .2 establish and ensure proper motor rotation - measure full load running currents and check overload elements - report to the Consultant any discrepancies which are found;
 - .3 demonstrate to the Consultant that branch circuit voltage drop is within the specified units;
 - .4 ensure that all devices are commissioned and operable.

3.19 BRANCH CIRCUIT BALANCING

- .1 Connect all branch lighting and power circuits to panelboards so as to balance the actual loads (wattage) within 5%. If required, transpose branch circuits when the work is complete to meet this requirement.
- .2 At the request of the Consultant, perform all necessary tests to show the above requirement has been fulfilled. Make such tests after the building is occupied.

3.20 EQUIPMENT BASES AND SUPPORTS

- .1 Unless otherwise noted, secure floor mounted equipment in place on 100 mm (4") high concrete housekeeping pads 100 mm (4") wider and longer than the equipment base dimensions.

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- .2 Furnish dimensioned drawings, templates and anchor bolts for proper setting of equipment on bases and pads. Be responsible for all required levelling, alignment, and grouting of the equipment.
- .3 Where equipment is suspended above floor level it shall be, unless otherwise noted, supported on a suitable welded or bolted prime coat painted structural steel angles or channels bracketed to the wall or secured by hanger rods.
- .4 Refer to Section 16500 for requirements for the pole base for parking areas luminaires.

3.21 CONCRETE WORK

- .1 Provide concrete required for work, including formwork and reinforcing steel. Include for luminaire pole bases and equipment bases unless otherwise noted.
- .2 Concrete shall be minimum 20700 kPa (3000 psi) ready mix concrete provided in accordance with latest editions of CAN/CSA A23.1 "Concrete Materials and Methods of Concrete Construction" and CAN/CSA-A23.2 "Methods of Tests for Concrete."

3.22 EXCAVATION AND BACKFILL

- .1 Provide all excavation, backfill and related work required for luminaire poles bases and feeders. Perform such work in accordance with requirements of Division 2, except as modified by this article. Obtain a copy of the soil test report from the Consultant. Examine and understand the soil test report included in Division 2 and structural drawings and details as applicable, during the Bid period.
- .2 Grade the bottom of the excavation as required.
- .3 In firm, undisturbed soil, lay services directly on the soil. Backfill excess excavation with 13,790 kPa (2,000 psi) concrete.
- .4 Prepare new bedding under the service in unstable soil, in fill, and in all cases where bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, and at manholes and catch basins. Compact to maximum possible density and support the service by means of 200 mm (8") thick concrete cradles spanning the full length between firm supports. Refer to the detail found on drawings.
- .5 Where excavation is necessary in proximity to and below the level of any footing, backfill with 13,790 kPa (2,000 psi) concrete to the level of the highest adjacent footing. Proximity is determined by the angle of repose as established by the Consultant.
- .6 Do not open trenches ahead of installation of services and backfilling more than weather will permit. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically approved by the Consultant.
- .7 Before backfilling, obtain approval from Consultant, local governing authority or utility as required. Failure to obtain such approvals of work prior to backfilling will require Contractor to re-excavate work at no additional cost to Owner. Remove all shoring during backfilling.
- .8 Backfill trenches within the building with clean sharp sand in individual layers of maximum 150 mm (6") thickness, compacted to a density of 100% Standard Proctor. Hand compact the first layers up to compacted level of 300 mm (12") above the top of the service. Hand or machine compact the balance up to grade using approved equipment. Final surface toppings shall generally be the responsibility of General Trades. Coordinate exact requirements with General Contractor.
- .9 Backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") above the service with Granular "A" material, hand compacted to a density of 95% Standard Proctor. Backfill the balance with 150 mm (6") layers of approved excavated material, compacted to 95% Standard Proctor density using approved equipment.
- .10 Backfill trenches outside the building under roads, parking lots or traffic areas with granular "A" material in layers not exceeding 150 mm (6") thickness, compacted to 100% Proctor density up to grade level.

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- .11 Fill all depressions to correct grade level with appropriate material, after an adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay all costs required to make good all damages caused by settlement.
- .12 Unless otherwise directed in Division 2, store and dispose of excavated materials as follows:
 - .1 during the progress of the contract, place the material as directed in such a manner that a minimum of damage or disfigurement of the existing ground will result and the material will not in any way impede the progress of the work;
 - .2 separately place surplus topsoil and subsoil as directed, leave the site clean and unencumbered.
- .13 Do pumping as required to keep excavations free of water.
- .14 Before commencement of excavation for your work, determine in consultation with the Consultant, Owner, Municipality and Utilities the presence, if any, of existing underground services at the site. Locate such services and mark out same. Ensure that all trades concerned are aware of their presence.
- .15 Note: You will be held responsible for any damage done to existing underground services caused by your neglect to determine and mark out the location of such services prior to excavation work commencing.
- .16 The inverts and locations of existing site services may have been site surveyed and the approximate location may be shown on the drawings. It is your responsibility to confirm and satisfy yourself that the inverts and locations if/as shown are correct, prior to commencing excavation. Where discrepancies are found, immediately inform the Consultant and await a direction.
- .17 Where Work falls under the jurisdiction of the local Utility, confirm requirements and comply with Utility requirements.

3.23 FINISH PAINTING OF ELECTRICAL WORK

- .1 Unless otherwise noted, finish painting of exposed electrical work will be done as part of the work of Division 9.
- .2 Touch-up paint pre-finished equipment and provide identification painting of conduit, duct and equipment to the Consultant's approval. Confirm colour requirements prior to ordering.

3.24 INSTRUCTIONS TO OWNER

- .1 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 to receive instructions.
- .2 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.
- .3 Submit to the Consultant prior to application for a Certificate of Substantial Performance of the Work, a complete list of systems for which instructions were given, stating for each system:
 - .1 date instructions were given to the Owner's staff;
 - .2 duration of instruction;
 - .3 names of persons instructed;
 - .4 other parties present (manufacturer's representative, consultants, etc.).
- .4 Obtain the signatures of the Owner's staff to verify that they properly understood the system installation, operation and maintenance requirements, and have received operating and maintenance instruction manuals and "As-built" record drawings.

END OF SECTION

LIST OF CONTENTS

PART 1 - GENERAL

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SECTION 16400 – ELECTRICAL SERVICE AND DISTRIBUTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 16010 applies to and is a part of this Section.
- .2 Section 16050 forms a part of this Section and contains requirements, products and methods of execution that apply to this Section.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the electric service and distribution work is specified in other Sections of the Specification:
 - .1 supply of motor control centres, motor starters and accessories.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for the following:
 - .1 transformers;
 - .2 secondary switchboard;
 - .3 panelboards;
 - .4 utility's metering cabinet;
 - .5 coordination study.

1.4 LOCAL ELECTRICAL UTILITY REQUIREMENTS

- .1 Comply with the latest requirements of the local electrical Utility conditions of supply. Confirm exact requirements with the local Utility and co-ordinate Utility requirements with the respective Divisions of the Work providing such work. The Utility requirements generally include but are not limited to the following:
 - .1 inspection: on site access for Utility's Inspector to be on duty for duration of work;
 - .2 underground inspection: submission of approval drawings and application for inspection prior to any inspection of work;
 - .3 preconstruction meeting;
 - .4 prior to any underground installations, site must be prepared to within 6" (150 mm) of final grade;
 - .5 installation of "DANGER MARKING TAPE" in electrical trenches, within 12" (300 mm) of final grade;
 - .6 all work and materials must be approved by Utility's Inspector prior to any backfilling work.

1.5 INCOMING ELECTRIC SERVICE WORK

- .1 Be responsible for coordinating the required metering work of the electrical utility.
- .2 At no cost to the owner the local Utility will perform the following work:
 - .1 Provide pad mount main power transformer, provide primary cabling, make all necessary primary connections and secondary connections to transformer.
 - .2 Provide testing of primary conductors;
 - .3 Required off site work on city property to incoming system. (if applicable)

- .3 Please note that if any of the work is requested to be done after hours when the local Utility could be carrying it out during their regular hours, the local Utility will recover their labour costs.

1.6 SERIES RATED COMBINATIONS

- .1 Comply with OESC Rule 14-014 with regards to series rated combinations of overcurrent protective devices and ensure that equipment in which the lower rated devices is installed is marked with a series combination interrupting rating at least equal to the available fault current.

BREAKERS

- .2 Breakers shall be NEMA rated types, and for switchboards and distribution panelboards breakers when frame sized 225 amperes and greater, shall be provided with solid state adjustable trip units with long time, short time, instantaneous time (LSI) and time delay functions to provide protective device coordination as per coordination study. Include for ground fault functions as required and as confirmed by Consultant.
- .3 Breakers shall generally be sized on the drawings, but in absence of direction, size breakers to suit intended application, to suit coordination study requirements and in accordance with OESC.

1.7 EQUIPMENT WITHSTAND RATINGS

- .1 Electrical equipment, circuit protective devices, bussing and switches shall be rated to interrupt or withstand short circuit faults greater than the available fault current.
- .2 Refer to notes on drawings and to Part 3 article entitled "Distribution System Testing, Coordination and Commissioning".

1.8 SYSTEM START-UP, TESTING, INSPECTION AND COMMISSIONING

- .1 When each system/equipment installation is complete and ready for acceptance, arrange for the system manufacturer or manufacturer's authorized representative to visit the site to:
 - .1 check all component connections and overall installation;
 - .2 program systems, as applicable;
 - .3 provide start-up procedures for systems;
 - .4 test and adjust the system and ascertain that the components are as specified;
 - .5 commission system and ensure that devices operate as specified and as designed; commissioning work herein this section, refers to manufacturer's general start-up requirements;
 - .6 verify system component operations;
 - .7 prepare, document and evaluate test results;
 - .8 authenticate test results with signature of authorized testing Engineer/Technician;
 - .9 check and verify nameplates;
 - .10 provide maintenance and operating instructions to Owner's personnel.
- .2 When the system start-up, testing, adjusting and commissioning specified above is complete, obtain from the supplier/manufacturer (or where specified, independent inspection company), a test report with test sheets, and covering verification letter signed by authorized testing technician, stating that the system has been inspected and tested, performs as specified and is ready for acceptance. Bind documents under cover and submit minimum four (4) copies to Consultant.

PART 2 - PRODUCTS

2.1 MAIN SECONDARY SWITCHBOARD

- .1 Eaton (Cutler-Hammer), "Pow-R-Line C", 347/600 volt, 3 phase, 4 wire, indoor, metal enclosed, standardized service entrance switchboard for use in a solidly grounded system with a short circuit capacity as scheduled. The switchboard shall be as shown and scheduled on the drawings and shall be manufactured in accordance with the latest editions of EEMAC Standard G8-2 and CSA Standard CAN/CSA C22.2 No. 31, and shall be factory tested in accordance with latest requirements of CAN/CSA C22.2 No. 31. Conform to local Utility requirements.
- .2 Structure:
 - .1 The switchboard shall consist of individual cells bolted together to form an enclosed, self-contained, self-supporting structure with all necessary facilities for proper ventilation. Each cell shall be of modern welded construction, fabricated from sheet steel in accordance with EEMAC and CSA requirements and reinforced wherever necessary to provide adequate strength. Front panels or doors shall be formed type, fabricated with cold rolled sheet steel. Unless otherwise required, rear, top and side panels shall be secured suitably to a channel type base. After fabrication, each cell shall be factory cleaned and factory finished with ASA No. 61/49 light grey enamel.
 - .2 The entire enclosure shall be in accordance with EEMAC 2 requirements. In addition, the top of switchboard shall be complete with a "drip-shield" to shed water without dripping on the cells. Ventilation louvres shall be protect "live" components from penetration of water from activated sprinklers and doors and component openings shall be gasketed.
- .3 Future Cells:
 - .1 Where shown, provide bus terminations for future extensions and gasketed water-tight removable side panels to accommodate installation and connection of future cells.
- .4 Bus Bars:
 - .1 Main bus bars shall be constructed of top quality, 98% pure, rectangular copper bars. The bus shall be properly isolated and designed to carry the currents as noted.
 - .2 A ground bus not less than 1/4" (6 mm) x 2" (50 mm) cross section area shall be provided for the length of the switchboard and solidly bolted to the steel framework. The ground bus shall be constructed of the same material as the main bus and shall be complete with suitable lugs for grounding connections outlined on the drawings. The ground bus shall have momentary current rating equal to or greater than that of the apparatus in the switchboard.
 - .3 Supply all required bolts, nuts and washers for field connection of bus joints between cells.
- .5 Control Wiring:
 - .1 Each cell shall be complete with all required control wiring and terminal blocks. Control wiring shall be type "SIS", size No. 14, extra flexible wire with thermoplastic insulation. Control wiring shall be neatly harnessed and suitably secured.
- .6 Switchboard Arrangement & Components:
 - .1 The switchboard cell arrangement and components shall be as detailed on the drawings.
- .7 Current & Potential Transformers:
 - .1 Potential transformers shall be of the compartment type and shall incorporate current limiting fuses.
 - .2 Current transformers shall have ratios to suit the application, a mechanical rating equal to the momentary rating of the circuit breakers, and shall be insulated for the full voltage rating of the switchgear.

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- .3 CT's and PT's shall be provided as part of the central metering system specified later in this Section. Coordinate installation and integration work, as required.
- .4 Current and potential transformers for Utility metering will be supplied by the Utility and will be shipped to the switchboard manufacturer's factory for factory mounting and connection.
- .8 Main Breakers:
 - .1 Series "C", frame type as scheduled and as required for application, sized as scheduled, fixed mounted, solid state moulded case circuit breaker with adjustable trip unit and ground fault protection, and with a minimum interrupting capacity as scheduled.
 - .2 The breaker shall be complete with "Digitrip-310" RMS sensing solid state trip unit having the following adjustable tripping functions: long time pick-up, long time delay; short time pick-up; short time delay; instantaneous pick-up; ground fault pick-up; and ground fault delay. Trip settings shall be as determined by the distribution system testing and co-ordination study specified herein this Section. The tripping unit shall have three (3) sensors, one (1) on each phase conductor, arranged such that a trip signal from any sensor shall open all three (3) poles of the breaker.
 - .3 The breaker shall be ULC listed for application of 100% of its trip setting. The breaker shall be capable of carrying its full rated ampere capacity, indefinitely without tripping.
- .9 Circuit Breaker Distribution Section:
 - .1 Circuit breaker panelboard distribution section shall be Series "C" moulded case, bolt-on circuit breakers with an interrupting capacity as scheduled and frame size to suit application. Breakers shall be provided with solid-state adjustable trip unit as specified in Part 1.
- .10 Voltmeter, Ammeter & Accessories:
 - .1 Microprocessor based monitoring and metering system to provide complete electrical metering. System measures and displays voltage, current and frequency, and calculates and displays kW, kWh, kW demand, ampere demand, kVA, kVA demand, kVAr and kVArh. A LED display is provided on the unit. The system includes required inputs/outputs, contacts, RS232/485/MODBUS/Ethernet communications to remote monitoring terminal or printer and/or BAS, current transformers, potential transformers and control wiring. Include custom clear acrylic, hinged locking cover over each unit.
- .11 Surge Protective Devices (SPD):
 - .1 Switchboards shall be complete with integral SPD unit. The unit shall be factory installed and connected onto bussing through integral disconnect as recommended by manufacturer. The unit shall include diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts. The unit shall be maintenance free. The SPD features shall be as follows:
 - .1 in accordance with ANSI/UL 1449 3rd Edition, IEEE C62.41, C62.45, UL 1283, and CSA Standards;
 - .2 maximum voltage protection rating shall not exceed 700 V (120/208 V) or 1500 V (600/347V); (L-N, L-G, N-G);
 - .3 peak surge current 250 KA per phase;
 - .4 warranty: standard manufacturer's minimum 5 years parts and labour warranty;
 - .5 flush mounting onto switchboard enclosure.
- .12 Incoming & Outgoing Conductor Connection Facilities:
 - .1 All required facilities and hardware including cubicle for incoming ductbank feeder, and outgoing cable in conduit feeders shall be provided for the switchboard as shown and scheduled.

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- .13 Mimic Bus & Nameplates:
 - .1 Red, single line vinyl bus approximately 1/8" (3 mm) thick x 3/8" (9mm) wide, representing internal bussing and components shall be riveted to the front of the switchboard and shall extend through the handles of the respective breakers. Engraved Lamacoid nameplates shall be secured with stainless steel screws, adjacent each panel component and identifying each component.
- .14 Accessories:
 - .1 The switchboard shall be complete with Manufacturer's standard accessories, spare parts and maintenance tool kit.
- .15 Acceptable Manufacturers:
 - .1 Eaton (Cutler-Hammer), Schneider Electric (Square D) and Siemens Electric.

2.2 UTILITY'S METERING CABINETS

- .1 Surface wall mounting, sprinkler proof, EEMAC 2, enamelled steel meter cabinets complete with gasketting, front viewing shatter-resistant window to allow reading of meter, meter base sockets and padlocking provisions, in accordance with the Utility's requirements. The cabinet must be approved by the local Utility.
- .2 Conduit and fish cord will be provided in accordance to the requirements of the Utility.

2.3 DISTRIBUTION TRANSFORMERS

- .1 Hammond Manufacturing Co. Ltd., dry type transformers as per the drawing schedule, constructed and factory tested in accordance with the latest requirements of CSA Standard C9-M1981, CAN/CSA C22.2 No.47 M90 (R2007) and as per CAN/CSA-C802.2-06 with regards to minimum efficiency values.
- .2 The transformers shall be complete with:
 - .1 an EEMAC 2 "drip-proof" enclosure with a rigid end frame, removable gasketed front and rear plates, and a terminal compartment located at the bottom of the enclosure;
 - .2 Class "H" silicone type coil insulation, such that the winding temperature rise will not exceed 150 C. degrees and the enclosure temperature rise will not exceed 65 C. degrees under full load in a 40 degrees C. ambient temperature;
 - .3 factory painted drip shield.
- .3 Each transformer shall also be complete with:
 - .1 copper windings;
 - .2 core construction consisting of stacked laminations of high permeability silicone steel;
 - .3 lugs or pressure type terminals to suit primary and secondary conductors;
 - .4 four (4) 2-1/2% full capacity taps, two (2) above normal and two (2) below normal;
 - .5 electrostatic shielding;
 - .6 an integral vibration dampening system;
 - .7 a factory painted ASA No. 61 light grey enamel finish;
 - .8 an aluminum nameplate indicating impedance rating, weight, connection diagram, style and serial number, riveted to the front of the enclosure.
- .4 Acceptable manufacturers are Hammond Manufacturing Co. Ltd., Schneider Electric (Square D), Siemens Electric (Delta Group), Delta Group, BEMAG and REX Transformers.

2.4 DISTRIBUTION PANELBOARDS

- .1 Eaton (Cutler-Hammer), "Pow-R-Line" series, factory assembled dead front panelboards as per the drawing schedule, manufactured to CSA Standard C22.2 No. 29.
- .2 Type "PRL4B" circuit breaker distribution panelboards shall be single or double row as required and complete with moulded case, bolt-on circuit breakers calibrated for 104 degrees F. (40 degrees C.) ambient temperature and conforming to CSA Standard C22.2 No. 5 (Note No. 1). Both main lugs and neutral bar shall be located at the same end. Main lugs shall be shielded by a removable cover. Each circuit breaker shall be identified adjacent the breaker handle. Breakers of frame sized 225A and greater shall be provided with solid state adjustable trip units with LSIG settings.
- .3 Type "PRL4F" switch and fuse distribution panelboards, complete with quick-make, quick-break, visible contact load break switches with operating handles projecting through the dead front panel and interlocked with the switch mechanism, facilities for padlocking in either the ON or OFF position, and, unless otherwise noted, HRC Form I, Class "J" fuses.
- .4 Panelboard boxes shall be constructed of code gauge galvanized steel and shall be complete with removable ends and wiring gutter space on all sides in accordance with CSA requirements.
- .5 Floor mounted enclosures shall be free-standing type, reinforced as required to provide adequate strength.
- .6 Enclosures shall be EEMAC 2 sprinkler-proof, complete with drip shield. Enclosures and drip shields shall be factory painted in ASA No. 61/49 grey enamel.
- .7 Distribution panelboards surface mounted in secure areas shall not require doors. Panelboards located in insecure areas shall be complete with doors, latches, and keyed alike locks.
- .8 Bus shall be hard drawn electrical grade copper, silver plated and shall extend to full capacity of panel.
- .9 Distribution panelboards must be supplied with a minimum of 25% space capacity to accommodate future breakers and complete with bussing for full panel size and where spare breakers are scheduled, the breakers with required connector kits.
- .10 Distribution panelboards where scheduled shall each be equipped with a main breaker, factory mounted in a barriered section and cable connected to panelboard bus.
- .11 Acceptable manufacturers are Eaton (Cutler-Hammer), Schneider Electric (I-Line series) and Siemens Electric.

2.5 BRANCH CIRCUIT PANELBOARDS

- .1 Eaton (Cutler-Hammer), "Pow-R-Line" series, factory assembled dead front panelboards as per the drawing schedule, manufactured to CSA Standard C22.2 No. 29 and the "OESC", and designed for sequence phase connection of branch circuit breakers.
- .2 Panelboards as scheduled, shall generally be of the following types:
 - .1 "Pow-R-Line 1", 120/208 volt, 3 phase panelboards with, bolt-on moulded case circuit breakers with an interrupting capacity of 10,000 amperes symmetrical at 208 volts, unless otherwise noted;
- .3 Where specified and/or scheduled on the drawings, breakers shall be ground fault, CSA Class "A", Group 1, combination thermal magnetic circuit breakers solid-state ground fault interrupters.
- .4 Panelboards shall be complete with:
 - .1 an EEMAC 2 sprinkler-proof box constructed of code gauge galvanized steel with removable box ends, wiring gutter space on all sides;

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- .2 trim for flush or surface wall mounting as shown, constructed of code gauge steel and with steel hinged doors complete with concealed fasteners, concealed hinge, chrome plated door latch and keyed alike lock with key, a steel frame holder and circuit directory card protected by clear acetate and secured to the back of the door, and Mylar circuit breaker identification strips; factory finished in ANSI-61/49 grey enamel;
 - .3 hard drawn electrical grade copper bus, extending for full capacity of panel;
 - .4 high strength, set screw type, anti-turning wire connectors;
 - .5 ground bus constructed of the same material as the standard bus;
 - .6 drip shields for surface mounted panelboards;
 - .7 dedicated isolated copper ground bus;
 - .8 200% capacity neutrals for panelboards as scheduled and as required;
 - .9 spaces and spare breakers as scheduled, complete with bussing for full panel size and where future breaker sizes are scheduled, the required breaker connector kits.
- .5 Circuit breakers connected to dedicated devices shall be complete with handle lock devices.
 - .6 Surface mounted tubs shall be factory finished in ANSI-61/49 grey enamel.
 - .7 Comply with onsite space limitations for installation location of panels.
 - .8 Acceptable manufacturers are Eaton (Cutler-Hammer), Schneider Electric (Square D) and Siemens Electric.

2.6 LOW VOLTAGE DISTRIBUTION WIRING

- .1 Conductors as specified in Section 16050.

2.7 CONTACTORS

- .1 Eaton (Cutler-Hammer), CSA approved, NEMA rated, factory assembled, magnetic, full voltage contactors as follows:
 - .1 "Freedom" CN15 series, non-reversing type for heating and motor loads; features long life twin break, silver cadmium oxide contacts and steel mounting plate; the magnetically actuated switch to include remote operation capability;
 - .2 series A202 electrically held, magnetically latched contactor for lighting loads; contactors designed to withstand large initial inrush currents.
 - .3 each contactor to be suitable in respects for the application and complete with following, as applicable:
 - .1 "Hand-off-auto" switch and pilot lamp;
 - .2 an enclosure of NEMA size to suit application with necessary accessories;
 - .3 factory primed and painted enclosures; minimum NEMA 12 type enclosures for climate controlled areas;
 - .4 ampere rating, number of poles, etc., as noted on the drawings.
- .2 Acceptable manufacturers are:
 - .1 Eaton (Cutler-Hammer);
 - .2 Schneider Electric (Square D);
 - .3 Rockwell Automation (Allen Bradley);

.4 General Electric Co.

2.8 DISCONNECT SWITCHES

- .1 Eaton (Cutler-Hammer), heavy duty, CSA approved, front operated with a handle suitable for padlocking in the "OFF" position and arranged so that the enclosure cover cannot be opened while the handle is in the "ON" position. Operating mechanisms shall be quick-break, positive acting with visible blades and a line terminal shield. Fusible units shall be complete with fuse clips suitable for HRC fuses, unless otherwise noted. The ampere rating, number of poles and fuse requirements shall be as indicated on the drawings. Enclosures shall be factory painted in ASA No. 61 grey enamel finish.
- .2 Disconnects for variable speed drives shall be suitable for use with such drives and include auxiliary switch/contact to de-energize the control power circuit, as required and as applicable.
- .3 Acceptable manufacturers are Eaton (Cutler-Hammer), Schneider Electric (Square D), and Siemens Electric.

2.9 FUSES

- .1 Unless otherwise indicated, fuses shall be English Electric Ltd., Form I, Class "J" HRC fuses for constantly running equipment, and Form II, Class "C" fuses for motor equipment that cycles "ON" and "OFF".
- .2 Acceptable manufacturers are English Electric Ltd., Ferraz Shawmut Co., Noram and Bussmann.

PART 3 - EXECUTION

3.1 INSTALLATION OF MAIN SECONDARY SWITCHBOARD

- .1 Provide main secondary switchboard in the Electrical Room where required.
- .2 Assemble the individual sections of the switchboard in accordance with the manufacturer's recommendations and instructions, and secure the assembly to the concrete base. Ensure that all bus joint bolts are torqued to the manufacturer's prescriptions.
- .3 Provide replacement feeder in concrete encased ductbank as noted.
- .4 Coordinate delivery and installation of utility supplied metering transformers.
- .5 Arrange for the switchboard manufacturer to provide all necessary drawings for erection and installation of the switchboard. In addition, if required, obtain from the manufacturer all necessary copies of detail, erection, etc., drawings required for approval of the installation from the Utility and any other authority having jurisdiction. Obtain all required approvals.
- .6 Install controls and displays at height of between a minimum 4' (1200 mm) to a maximum of 6' (1800 mm) above finished floor level. Coordinate installation of central metering system CT's/PT's, as required.
- .7 Refer to the distribution testing and co-ordination study article hereafter in this Section.
- .8 The switchboard shall be arranged as indicated on the drawings.
- .9 Make all necessary incoming and outgoing power cable connections to the equipment in strict accordance with the equipment and cable manufacturer's recommendations. Ensure all connections, stress cones and terminations are suitable for specific incoming and outgoing cables.
- .10 Include in your Bid Price, for the switchgear manufacturer's personnel to provide inspection and testing of the switchgear prior to energizing the system. Refer to the distribution system testing and co-ordination study article hereinafter in this Section.

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3.2 INSTALLATION OF UTILITY'S METERING CABINETS

- .1 Provide approved metering cabinets and conduit and install in accordance with Utility requirements. Install cabinet in locations as shown on the drawings. Provide all required supporting hardware. Extend empty conduit from cabinets to metering compartments of the switchboard or to main disconnect as shown.
- .2 Coordinate the installation with the Utility who will install meter equipment, and connect from the meters to the metering compartments of the switchboard. Confirm exact location of metering cabinet with Utility.

3.3 INSTALLATION OF DISTRIBUTION TRANSFORMERS

- .1 Provide distribution transformers where shown and as required, and connect complete.
- .2 Secure transformers 75 KVA and larger to a concrete housekeeping pad on Vibro-Acoustics Ltd. type "RSR" vibration isolation pads.
- .3 Secure the transformers smaller than 75 KVA in place on an angle wall mounting bracket support assembly located approximately 12" (300 mm) below the ceiling. Provide each support assembly and adequately secure to wall and/or ceiling construction.
- .4 Ensure that the transformers are equipped with lugs or connections suitable for the primary and secondary connections indicated. Isolate primary and secondary connections from the transformer enclosures by means of 12" (300 mm) to 18" (450 mm) of liquid-tight flexible conduit.
- .5 When installation is complete, test and check the secondary voltages. Make all required adjustments and furnish to the Consultant a written report indicating the secondary voltage readings and any adjustments made to achieve the proper voltages. Furthermore, when the building is in normal use, re-check the voltages and make any required adjustments.

3.4 INSTALLATION OF DISTRIBUTION PANELBOARDS

- .1 Provide distribution panelboards where shown on the drawings and as required, and connect complete. Refer to schedules found at end of this Section or on the drawings.
- .2 Install floor mounted panelboards on concrete housekeeping pads. Surface wall mount other panelboards, unless otherwise noted, independent of connecting conduit.
- .3 Equip each panelboard with suitable lugs to accommodate main and branch conductors scheduled.

3.5 INSTALLATION OF BRANCH CIRCUIT PANELBOARDS

- .1 Provide factory assembled branch circuit panelboards as indicated on the schedules found at end of this Section or on the drawings.
- .2 Support cabinets and enclosures independent of connecting conduit, and accurately install with reference to wall finishes.
- .3 Equip panelboards with suitable lugs or provisions to accommodate the main and branch conductors scheduled.
- .4 Turn over to the Consultant, prior to application for a Certificate of Substantial Performance of the Work, a quantity of a three (3) keys for each panelboard cabinet or enclosure. All branch circuit panelboards shall be keyed alike.
- .5 Where two (2) or more panelboards are installed in one (1) cabinet, equip the panelboards with double lugs and increase gutter capacity to accommodate additional cabling.
- .6 Connect main breakers to emergency power off pushbuttons for panelboards as scheduled.
- .7 Identify all panelboard breakers in a permanent manner, and complete panelboard circuit directories to the Consultant's approval. Use Owner's actual room names/numbers. Provide copies of directories in maintenance manuals.

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- .8 Upon completion of the installation of the ground fault breakers, demonstrate in the presence of the Consultant that all protected circuits will "trip" when a simulated ground fault is applied to the "load" side of each circuit breaker/ ground fault interrupter combination. Megger the load side neutral on all GFI protected branch circuits to ensure that the neutral is not grounded on the load side on the GFI. Verify the GFI operation with a temporary load (100 watt lamp in an insulated socket with pigtail leads). Provide a written report confirming that all tests have been performed and that the system is functioning properly.

3.6 INSTALLATION OF LOW VOLTAGE DISTRIBUTION WIRING

- .1 Provide all required distribution wire and cable. The conductors, unless otherwise noted, shall generally be as per branch circuit wiring requirements as specified in Section 16050 and shall be installed in conduit.
- .2 Provide all required cable support system accessories which are not specified herein or shown on the drawings but are required for proper installation.

3.7 INSTALLATION OF CONTACTORS

- .1 Provide contactors in enclosures for electric heating and outside lighting control as shown on the drawings and connect complete. Identify each contactor enclosure.
- .2 Wall mount each enclosure independent to the panelboard to which the loads are connected.

3.8 INSTALLATION OF DISCONNECT SWITCHES

- .1 Provide safety switches (disconnects) as follows:
- .1 wherever shown on the drawings and/or specified herein;
 - .2 wherever required by starter schedule drawings;
 - .3 for motorized equipment which cannot be seen from the motor starter location or is more than 30' (9 m) from the starter location;
 - .4 for all "packaged" equipment fed from a motor starter panel.
- .2 Ensure that enclosures for safety switches located outside the building are EEMAC 3. All other enclosures shall be EEMAC 2, sprinkler proof, unless otherwise noted.

3.9 INSTALLATION OF FUSES

- .1 Provide a complete set of fuses for each fusible disconnect, motor starter, and similar fusible equipment provided or supplied by you.
- .2 Supply three (3) spare fuses of each size and type used on the project, mount the fuses on a painted and identified plywood rack, and secure the rack in a location where later directed.

3.10 GROUNDING AND BONDING

- .1 Provide required grounding and bonding work in accordance with the drawings and in accordance with requirements of governing authorities, including the OESC. Provide Utility's grounding requirements for the Electrical Room and all equipment under their governing jurisdiction.
- .2 Provide a ground electrode in Electrical Room consisting of but not limited to a minimum of four (4) ground rods driven into the grade in arrangement as shown, at 10' (3 m) spacing and interconnected with minimum No. 3/0 bare copper conductor. Ground rods shall be a minimum 3/4" (20 mm) diameter copper rods of minimum 10' (3 m) length.
- .3 Provide 3/8" x 2" x 36" (10 mm x 50 mm x 900 mm) electrical grade copper ground bus in the Electrical Room, 12" (300 mm) above finished floor level. Secure the ground bus on 3/4" (20 mm) standoff insulators.

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- .4 When the buses are in place and all bolts have been tightened and all lugs have been installed, coat the entire installation with two (2) 100% covering coats of suitable shellac to prevent the bus from oxidizing.
- .5 Connect Electrical Room ground grid with ground bus with minimum 3/0 copper ground conductor in conduit.
- .6 Provide minimum No. 3/0 insulated ground wire from the electrical room ground bus to the switchboard, structure, floor, etc., as shown and as required. Extend ground conductor to incoming water service and connect ground conductor to street side metal piping of water meter.
- .7 Throughout the complex, solidly ground and bond the system and make all required grounding and bonding connections to all electrical devices and apparatus. Ground conductors shall be insulated copper wire connected with approved fittings in accordance with the OESC. Provide separate insulated ground wire for all circuits.
- .8 All ground connections is slab or buried underground shall be made using welded copper connections, "Cadweld" as supplied by Erico Products or compression lugs "Hyground" supplied by Burndy Ltd.
- .9 Do not pour concrete until all grounding conductors and grounding connections to be embedded in the concrete, are inspected and approved by ESA and the Engineers.
- .10 Service conductors exceeding 400 amperes shall be provided with minimum no. 3/0 AWG grounding conductor, unless otherwise noted.
- .11 Provide conductors as sized on drawings and in accordance with Codes and Standards requirements, but which shall be of size no smaller than the requirements specified herein this article or on the drawings.
- .12 Provide LAN Room Ground Bus: unless otherwise noted, 300 mm x 50 mm x 9 mm (12" x 2" x 3/8"), copper ground bus with eight (8) drilled taped holes; mounted on walls with standoff insulators.

3.11 ELECTRICAL CONNECTIONS FOR MECHANICAL, OWNER'S, ETC., EQUIPMENT

- .1 In addition to providing electrical feeders and connections to equipment provided by Division 16, provide all required electrical connections to apparatus provided and/or supplied by Division 15/17, the Owner and as part of other Divisions of the Specification.
- .2 Unless otherwise noted, provide electrical connections including power and control wiring for equipment supplied by the Owner or by other Divisions, and except for control wiring of Section 15900 of Division 15. Where shown on the drawings and as required, provide complete wired and empty conduit systems with fish cord, with minimum diameters as sized on the drawings and junction boxes, pull boxes, outlet boxes, faceplates, sleeves, etc., as required. Provide disconnect switches, receptacles and all other required wiring and connection accessories. Coordinate work with the respective Consultants and suppliers of the equipment to be provided with electrical connections.
- .3 Coordinate with trades of other Divisions to ensure provision of proper electrical requirements. Unless otherwise noted or directed by Consultant, be responsible for provision of interconnect wiring between remote operator devices, controllers and equipment being controlled by the operator devices, whether or not such devices/controllers are supplied by Division 16. Provide disconnect switches, receptacles and all other required wiring and connection accessories. Provide system/equipment power feeds with hard wired or receptacle type connections, as required. Coordinate exact requirements prior to start of work, at time of shop drawing submissions and prior to roughing-in of work. Coordinate work with the suppliers of the equipment to be provided with electrical connections.
- .4 Division 15 will supply all starters and variable speed drives for motorized apparatus supplied by them and will provide Lamacoid identification throughout. Motor starter and variable speed drive requirements shall be as scheduled on the sheets found at the end of this Section or on the drawings. Starters generally will be supplied in the following manner:
 - .1 loose starters for mounting adjacent to apparatus or on motor starter panels;

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- .2 mounted starters on factory assembled and pre-wired packaged equipment.
- .5 Where applicable, motor control centres will be supplied and set in position by Division 15.
- .6 Connect variable speed drives in strict accordance with the manufacturer's instructions. Provide manufacturer's recommended conductors and connectors to suit the variable speed drives. Maintain separation of power and control conductors as per manufacturer's requirements to minimize effects of electromagnetic interference. Properly ground equipment.
- .7 Be responsible for:
 - .1 mounting loose starters and providing "line" and "load" power connections;
 - .2 providing motor starter panels - conduit work at motor starter panels must be horizontally and vertically plumb and the installation shall be planned to avoid crossovers;
 - .3 making "line" side power connections to starters/variable speed drives on "packaged" equipment;
 - .4 coordinating feeder entries to starters and starter assemblies with Division 15;
 - .5 providing additional disconnect switches complete with identification detailed on the drawings, or required by Code, or for apparatus which cannot be seen from its starter or is in excess of 30' (9 m) from its starter;
 - .6 connections to thermistors and provision of additional relays as required for connections to starters; generally, Division 15 shall supply required thermistors and relays necessary for starters; review Division 15 specifications and/or drawings defining these requirements and include necessary work, wiring, conduit and components not being supplied by Division 15;
 - .7 performing all required motor starter interlocking in accordance with requirements specified and as outlined on the starter schedule drawings - equip each starter to be interlocked with all required control connection accessories; co-ordinate exact requirements with Division 15;
 - .8 providing "line" side power connections to Division 15 control system equipment.
 - .9 providing an identification nameplate on each motor starter, variable speed drive or disconnect;
 - .10 providing and attaching with stainless steel screws to each separately mounted 3-phase motor starter or group of 3-phase motor starters a suitably sized black-white-black Lamacoid nameplate engraved to read:

"MOTOR(S) IS CAPABLE OF MAKING TWO (2) STARTS IN SUCCESSION, COASTING TO REST WITH APPROXIMATELY 15 MINUTES ELAPSED TIME BETWEEN STARTS, WITH THE MOTOR INITIALLY AT AMBIENT TEMPERATURE, OR OF MAKING ONE (1) START WITH THE MOTOR INITIALLY AT A TEMPERATURE NOT EXCEEDING ITS RATED LOAD OPERATING TEMPERATURE, IF THE WK² OF THE LOAD, THE LOAD TORQUE DURING ACCELERATION, THE APPLIED VOLTAGE AND THE METHOD OF STARTING ARE THOSE FOR WHICH THE MOTOR WAS DESIGNED."
- .8 Note that you will be liable for replacing motors due to abuse of the above prior to acceptance of the work. If additional starts are required, it is recommended that none be made until all conditions affecting motor operation have been thoroughly investigated and the apparatus examined for evidence of excessive heating. Note that the number of motor starts should be kept to the absolute minimum since the life of the motor is affected by the number of starts.
- .9 Where applicable, line voltage thermostats that are supplied by Division 15 and turned over to Division 16 to install, shall be provided with required wiring in conduit and connections by Division 16. Coordinate exact requirements with Division 15.

3.12 DISTRIBUTION SYSTEM TESTING, CO-ORDINATION AND COMMISSIONING

- .1 Provide on-site engineering inspection, testing and co-ordination study and commissioning of the distribution equipment. Provide coordination study of the entire distribution system.
- .2 The engineering inspection, testing and co-ordination study will be performed by an approved independent testing and co-ordination company and shall be done prior to the system being energized, and shall include the following items where applicable:
 - .1 testing, cleaning when necessary, and calibrating all relays and circuit breaker trip devices (calibration of all protective devices shall conform to requirements of approved co-ordination curves);
 - .2 function test of associated control devices;
 - .3 replacement of fuses destroyed during the testing;
 - .4 an acceptance test in the presence of and satisfaction of the Consultant;
 - .5 the presence, for the length of time required, of qualified and competent equipment manufacturer's service representative during start-up;
 - .6 carry out insulation resistance testing of all out going feeders with respect to ground;
 - .7 testing of cables, power panels, lighting panels, transformers, receptacles and switches.
- .3 Forward for approval prior to energization of the distribution system and equipment, four (4) neat, typewritten copies of the engineering and testing report.
- .4 Where relays, breakers, etc., do not perform to the approved co-ordination curves, they shall be revised as part of the work.
- .5 Co-ordination and Short Circuit Study:
 - .1 The protective system devices have been selected such that protection is adequate and good co-ordination is possible, however, since differences do exist between manufacturers, some changes in trip ratings or relay settings may be necessary and shall be carried out. Verify interrupting devices meets/exceeds indicated interrupting ratings. Obtain information regarding utility upstream protection devices and incorporate into study.
 - .2 The co-ordination study must be approved by the Engineer prior to the start of construction of the distribution equipment.
 - .3 Immediately upon award of the contract, arrange for the testing company to provide and carry out the following:
 - .1 prior to the manufacture of the switchboards, prepare a set of co-ordination curves on K.E. No. 336E Time Current Characteristic graph paper and forward eight (8) copies of the Consultant for review;
 - .2 this shall be accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to verify protection of the various elements of the systems under maximum and minimum fault conditions at the various points in the systems.
 - .4 The time-current characteristic curves for the following shall be plotted:
 - .1 Main and feeder protective devices at all voltage levels used in the distribution system.
 - .2 Protective devices associated with the largest motor in each MCC and the largest device in each distribution panel.
 - .3 Motor generator protective devices, damage curves and current decrement curves.

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- .5 Co-operate with and obtain from other manufacturers, a list of equipment requiring protective devices to be used in the distribution system and prepare co-ordination curves as soon as possible. Be responsible, along with the other manufacturers' equipment connected to the distribution system, to ensure that the proper control and protective devices are selected such that they co-ordinate with all protective devices.
- .6 It shall be the responsibility of the manufacturer to examine the plans and specifications to ensure that all the relays and protective devices being installed in the distribution system will provide satisfactory co-ordination.
- .7 Provide visual and mechanical inspection of the ground system and verify that it is in compliance with issued documents and OESC requirements.
- .8 Perform fall-of-potential test or alternative in accordance with the IEEE Standard 81 on the main grounding electrode or system. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames system neutral, and/or derived neutral points. The resistance between the main ground electrode and ground should be no greater than five (5) ohms. (Reference: ANSI/IEEE Standard 142).
- .9 Testing shall be documented in a report signed by Professional Engineers of Ontario licensed testing engineer authorized by testing company. Include for minimum four (4) copies of the report to be submitted to Consultant for review. The report shall include all test results with properly plotted curves, identified trouble areas of coordination, extensive comments regarding test results and recommended remedial course of action to resolve the problem areas.
- .10 The Owner and/or Consultant must be given the opportunity to witness testing. Such testing shall be performed to times acceptable to Owner and Consultant. Notify Owner and Consultant in writing minimum five (5) working days in advance of proposed testing date.
- .11 Acceptable testing and co-ordination companies must be independent of the equipment manufacturers/suppliers and are G.T. Woods Ltd., Brosz & Associates Ltd., Rondar Inc., K-Tek Electro Services, AC Tesla and Haronitis & Associates.

3.13 ARC FLASH HAZARD

- .1 Arc Flash Hazard Analysis
 - .1 Perform Arc Flash Hazard analysis according to the IEEE 1584-2002 equations that are presented in NFPA70E-2004, Annex D.
 - .2 Retrieve short circuit calculations and the clearing times of the phase overcurrent devices from the short-circuit and coordination study specified previously.
 - .3 Calculate flash protection boundary and the incident energy at significant locations in the electrical distribution system (switchboards, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
 - .4 The Arc-Flash Hazard Analysis to include significant locations in 347/208 V systems fed from transformers equal to or greater than 125 kVA.
 - .5 Specify safe working distances for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
 - .6 Include Arc Flash Hazard analysis calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation to assume that the utility contribution is at a minimum and a minimum motor load. Conversely, the maximum calculation to assume a maximum contribution from the utility and motors to be operating under full-load conditions. Other switching scenarios are to be included as necessitated by the power system design and layout.
 - .7 Arc Flash computation to include both line and load side of main breaker calculations, where necessary.

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- .8 Base Arc Flash calculations to be based on actual overcurrent protective device clearing time. Cap maximum clearing time at 2 seconds based on IEEE 1584-2002 section B.1.2.
- .2 Arc Flash Warning Labels
 - .1 Provide minimum 90 mm x 127 mm (3.5" x 5") thermal transfer type label of high adhesion polyester for each work location analyzed. Machine print labels shall be machine printed, with no field markings.
 - .2 The label to have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and include the following information:
 - .1 location designation;
 - .2 nominal voltage;
 - .3 flash protection boundary;
 - .4 hazard risk category;
 - .5 incident energy;
 - .6 working distance;
 - .7 engineering report number, revision number and issue date.
 - .3 Provide Arc Flash labels in the following manner and base labels on recommended overcurrent device settings:
 - .1 for each 600 V, 347 V and applicable 208 V panelboards, provide one arc flash label;
 - .2 for each motor control centre, provide one arc flash label;
 - .3 for each low voltage switchboard, provide one arc flash label shall be provided.
- .3 Incorporate documentation with distribution system testing and coordination report. Acceptable companies to provide this work to be as per distribution system testing and coordination work.

END OF SECTION

**APPENDIX – MOTOR STARTER SCHEDULES
PANEL SCHEDULES**

ITEM No.	ITEM	KW	RC AMPS	REQUIRED	COMBINATION STARTER & DISCONNECT			MODIFICATIONS								BRANCH FEEDERS				REMARKS		
					FUSED DISC.	STARTER	TYPE	CONTROL TRANSFORMER	START-STOP PUSH-BUTTON	H.C.A. SELECTOR SWITCH	PILOT LIGHT	N.C.	N.C.	CABLE OR BUS	AUX. CONT.	CONDUIT	WP DISCONNECT AT MOTOR	DISCONNECT AT MOTOR	F.A. SHUT DOWN		DISCONNECT ONLY	SEE NOTE No.
1	TE-1	0.19	5.8	-	-	-	B600	-	-	-	✓	-	-	-	-	✓	-	-	-	①		
2	ERE-1	0.19	5.8	-	-	-	B600	-	-	-	✓	-	-	-	-	✓	-	-	-	①		
3	ERE-2	0.19	5.8	-	-	-	B600	-	-	-	✓	-	-	-	-	-	✓	-	-	①		
4	ERE-3	-	-	-	-	-	B600	-	-	-	✓	-	-	-	-	-	✓	-	-	①		
5	GE-1	0.13	4.4	-	-	-	B600	-	-	-	✓	-	-	-	-	✓	-	-	-	①		
6	GE-2	0.13	4.4	-	-	-	B600	-	-	-	✓	-	-	-	-	✓	-	-	-	①		
7	ZRE-1	0.19	5.8	-	-	-	B600	-	-	-	✓	-	-	-	-	✓	-	-	-	①		
8	WRE-1	0.19	5.8	-	-	-	B600	-	-	-	✓	-	-	-	-	✓	-	-	-	①		
9	SUMP PUMP	0.37	9.8	-	-	-	B600	-	-	-	✓	-	-	-	-	-	✓	-	-	①		
10	SUMP PUMP	0.37	9.8	-	-	-	B600	-	-	-	✓	-	-	-	-	-	✓	-	-	①		

NOTES:

① REFER TO FLOOR PLANS AND PANEL SCHEDULES FOR BRANCH FEEDER.

JOB: NEW MARKET COMMUNITY CENTER	DATE:	JOB NO.	REVISION:	DRAWING NO.
DRAWING TITLE: MOTOR STARTER SCHEDULE - MECHANICAL & ELECTRICAL	DRAWN BY: T.A.	1810061-000		SS-01
MMM GROUP LTD.	CHECKED BY: T.A./ Y.Z.			

LOOSE THREE PHASE STARTERS			MOTOR STARTER SCHEDULE																	208, 3 ϕ , 3W		
ITEM No.	ITEM	KW	RC AMPS	REQUIRED	COMBINATION STARTER & DISCONNECT			MODIFICATIONS							BRANCH FEEDERS				REMARKS			
					FUSED DISC.	STARTER									AUX. CONT.							
					FUSE	SIZE	TYPE	CONTROL TRANSFORMER	START-STOP PUSH BUTTON	H.O.A. SELECTOR SWITCH	PILOT LIGHT	N.O.	N.C.	CABLE OR BUS	CONDUIT	WP DISCONNECT AT MOTOR	DISCONNECT AT MOTOR	F.A. SHUT DOWN	DISCONNECT ONLY	SEE NOTE No.		
1	RRE-1 VFD CONTROL	0.37	2.2	✓	-	-	-	✓	-	-	-	-	-	-	-	✓	-	-	-	①	CONNECT TO VFD	
2	RF-1 (RTU-6 RETURN AIR)	0.56	3.1	✓	-	1	FVNR	✓	-	-	✓	-	-	-	-	✓	-	-	-	①		
NOTES: ① REFER TO FLOOR PLANS AND PANEL SCHEDULES FOR BRANCH FEEDER.																						
JOB: NEW MARKET COMMUNITY CENTER										DATE:			JOB NO.			REVISION:			DRAWING NO.			
DRAWING TITLE: MOTOR STARTER SCHEDULE - MECHANICAL & ELECTRICAL										DRAWN BY: T.A.			1810061-000						SS-02			
MMM GROUP LTD.										CHECKED BY: T.A./ Y.Z.												

LOAD DESCRIPTION				BREAKERS								BREAKERS								LOAD DESCRIPTION			
AREA SERVED	REC-EPT.	TOTAL LOAD	FEEDER & CONDUIT	L/B	GFI	OTHER	20A 1P	15A 2P	15A 1P	CCT No.	PH	CCT No.	15A 1P	15A 2P	20A 1P	OTHER	GFI	L/B	FEEDER & CONDUIT	TOTAL LOAD	REC-EPT.	AREA SERVED	
NEW VEST. 100, EAST VEST. 108, CORRIDOR 101 - LTG.	-	1460	2#12+G 13mmC	-	-	-	X	-	-	1	A	2	-	-	X	-	-	-	2#12+G 13mmC	1000	-	WASHROOMS 103,104 ROOM 109A - LTG.	
NEW WASHROOM 125 AND 126 - LTG.	-	900	2#12+G 13mmC	-	-	-	-	-	X	3	B	4	X	-	-	-	-	-	2#12+G 13mmC	500	-	NEW WOMEN WASHROOM SENSOR	
WOMEN WASHROOM 103 SENSORS FOR SINKS	-	800	2#12+G 13mmC	-	-	-	X	-	-	5	C	6	X	-	-	-	-	-	2#12+G 13mmC	200	-	VESTIBULE 100, WASHROOM 125 DOOR OPERATOR	
WOMEN WASHRM. 103 & MEN WASHRM. 104 SENSORS	-	1000	2#12+G 13mmC	-	-	-	X	-	-	7	A	8	X	-	-	-	-	-	2#12+G 13mmC	1000	-	NEW MEN WASHROOMS SENSOR	
MEN WASHROOM 104 & BF WASHRM. 105 SENSOR	-	800	2#12+G 13mmC	-	-	-	X	-	-	9	B	10	X	-	-	-	-	-	2#12+G 13mmC	1000	4	NEW MEN + WOMEN W/R & OFFICE 109 RECEPT.	
NEW WOMEN WASHROOM BASE BOARD HEATER	-	2250	2#12+G 13mmC	-	-	20A 2P	-	-	-	11	C	12	-	-	-	20A 2P	-	-	2#12+G 13mmC	2250	-	NEW MANS WASHROOM BASE BOARD HEATER	
										13	A	14											
NEW WOMEN WASHROOM BASE BOARD HEATER	-	1000	2#12+G 13mmC	-	-	-	-	X	-	15	B	16	-	X	-	-	-	-	2#12+G 13mmC	1000	-	NEW MANS WASHROOM BASE BOARD HEATER	
										17	C	18											
MAIN VESTIBULE CABINET HEATER CONNECTION	-	1500	3#8+G 25mmC	-	-	45A 3P	-	-	-	19	A	20	X	-	-	-	-	-	2#12+G 13mmC	500	-	CONNECTION TO DOOR OPERATOR	
										21	B	22	X	-	-	-	-	-	-	2#12+G 13mmC	-	1	CORRIDOR 101 FUTURE LCD MONITOR
										23	C	24	X	-	-	-	-	-	-	2#12+G 13mmC	-	1	CORRIDOR 101 FUTURE LCD MONITOR
WOMEN WASHROOM 103 HAND DRYER	-	1300	2#12+G 13mmC	-	X	-	X	-	-	25	A	26	X	-	-	-	-	2#12+G 13mmC	500	1	HALL 1 AND HALL 2 CEILING RECEPTACLES		
WOMEN WASHROOM 103 HAND DRYER	-	1300	2#12+G 13mmC	-	X	-	X	-	-	27	B	28	-	-	X	-	X	-	2#12+G 13mmC	1300	-	MEN WASHROOM 104 HAND DRYER	
BF WASHROOM 105 HAND DRYER	-	1300	2#12+G 13mmC	-	X	-	X	-	-	29	C	30	-	-	X	-	X	-	2#12+G 13mmC	1300	-	MEN WASHROOM 104 HAND DRYER	
NEW WOMENS WASHROOM HAND DRYER	-	1300	2#12+G 13mmC	-	X	-	X	-	-	31	A	32	-	-	X	-	X	-	2#12+G 13mmC	1300	-	NEW MEN WASHROOM 125 HAND DRYER	
NEW WASHROOM 104 TOILET & URINAL SENSORS	-	-	2#12+G 13mmC	-	-	-	-	-	X	33	B	34	X	-	-	-	-	-	2#12+G 13mmC	750	3	CORRIDOR 101 AND HALL 1	
CORRIDOR 101 VENDING MACHINE	-	1000	2#12+G 13mmC	-	-	-	-	-	X	35	C	36	X	-	-	-	-	-	2#12+G 13mmC	1000	4	CORRIDOR 101 AND OFFICE 109	
ELECTRICAL CLOSET 106A EXH. FAN ERE-3	-	-	2#12+G 13mmC	-	-	-	-	-	X	37	A	38	X	-	-	-	-	-	2#12+G 13mmC	200	-	WASHROOM EXHAUST FAN 'TE-1'	
							X			39	B	40	X	-	-	-	-	-	2#12+G 13mmC	200	-	ROOM 102 EXHAUST FAN 'ERE-1'	
							X			41	C	42	X										
							X			43	A	44	X										
							X			45	B	46	X										
							X			47	C	48	X										
							X			49	A	50	X										
							X			51	B	52	X										
							X			53	C	54			X								
							X			55	A	56			X								
							X			57	B	58			X								
							X			59	C	60			X								

TOTAL 60 CIRCUITS, MUST BE A SINGLE TUB PANEL

LIGHTING PANEL-	VOLTAGE- 120/208V, 3ø, 4W	CONNECTED LOADS				DOUBLE LUG.	DEMAND LOAD.
		LIGHTS	RECEPT.	MOTORS	HEATING		
POWER PANEL- PANEL F	MAINS - 225A	FLUSH-SURFACE- <input checked="" type="checkbox"/>				JOB NO: 1810061-000	
HEATING PANEL-	MAIN 200A BREAKER	PANEL TYPE-	AMP	KW.	FEEDER	LOCATION.	ROOM 106A
MMM GROUP LTD.						JOB NAME: NEW MARKET COMMUNITY CENTER	
						SHEET NO. 1	

LOAD DESCRIPTION				BREAKERS							BREAKERS							LOAD DESCRIPTION					
AREA SERVED	REC-EPT.	TOTAL LOAD	FEEDER & CONDUIT	L/B	GFI	OTHER	20A 1P	15A 2P	15A 1P	CCT No.	PH	CCT No.	15A 1P	15A 2P	20A 1P	OTHER	GFI	L/B	FEEDER & CONDUIT	TOTAL LOAD	REC-EPT.	AREA SERVED	
KITCHEN AND BAR #1 AND KITCHEN AND BAR #2	-	800	2#12+G 13mmC	-	-	-	-	-	X	1	A	2	-	-	X	-	-	-	2#12+G 13mmC	500	1	HALL #3 CEILING RECEPTACLE	
ELECTRICAL ROOM 115 AND HALL 2	4	1000	2#12+G 13mmC	-	-	-	-	-	X	3	B	4	X	-	-	-	-	-	2#12+G 13mmC	1000	4	KITCHEN #1, KITCHEN #2 AND HALL 1	
KITCHEN #2 STOVE	-	5000	2#8+G 25mmC	-	-	50A 2P	-	-	-	5	C	6	X	-	-	-	-	-	2#12+G 13mmC	1000	1	KITCHEN #1 DISHWASHER	
										7	A	8	-	-	-	50A 2P	-	-	2#8+G 25mmC	5000	-	KITCHEN #1 STOVE	
HALL 3 - RECEPTACLES	2	500	2#12+G 13mmC	-	-	-	-	-	X	9	B	10	X	-	-	-	-	-	2#12+G 13mmC	200	-	ELECTRICAL ROOM 115 EXHAUST FAN 'ERE-2'	
KITCHEN #2 CHEST FREEZER	1	1000	2#12+G 13mmC	-	-	-	-	-	X	13	A	14	-	-	-	15A 3P	-	-	3#12+G 19mmC	560	-	RTU-6 RETURN FAN	
KITCHEN #2 FRIDGE	1	1000	2#12+G 13mmC	-	-	-	-	-	X	15	B	16	-	-	-		-	-	-	2#12+G 13mmC	1000	1	'RF-1'
KITCHEN #1 AND #2 EXHAUST HOOD	-	-	2#12+G 13mmC	-	-	-	-	-	X	17	C	18	-	-	-	-	-	-	2#12+G 13mmC	1000	1	KITCHEN #1 CHEST FREEZER	
KITCHEN #1 OVEN	-	5000	2#8+G 25mmC	-	-	50A 2P	-	-	-	19	A	20	X	-	-	-	-	-	2#12+G 13mmC	1000	1	KITCHEN #1 FRIDGE	
										21	B	22	X	-	-	-	-	2#12+G 13mmC	1000	1	KITCHEN #1 FRIDGE		
									X	23	C	24	X										
									X	25	A	26	X										
									X	27	B	28	X										
									X	29	C	30	X										
									X	31	A	32	X										
									X	33	B	34	X										
									X	35	C	36	X										
									X	37	A	38	X										
									X	39	B	40	X										
									X	41	C	42	X										

TOTAL 42 CIRCUITS

LIGHTING PANEL-	VOLTAGE-	120/208V, 3 ϕ , 4W		CONNECTED LOADS				DOUBLE LUG.	DEMAND LOAD.	
		LIGHTS	RECEPT.	MOTORS	HEATING					
POWER PANEL- PANEL G	MAINS-	225A	FLUSH-SURFACE-					JOB NO: 1810061-000		
HEATING PANEL-	MAIN BREAKER		PANEL TYPE-	AMP	KW.	FEEDER		LOCATION.	ELECTRICAL ROOM 115	
MMM GROUP LTD.				JOB NAME: NEW MARKET COMMUNITY CENTER					SHEET NO.	1

LOAD DESCRIPTION				BREAKERS							BREAKERS							LOAD DESCRIPTION					
AREA SERVED	REC-EPT.	TOTAL LOAD	FEEDER & CONDUIT	L/B	GFI	OTHER	20A 1P	15A 2P	15A 1P	CCT No.	PH	CCT No.	15A 1P	15A 2P	20A 1P	OTHER	GFI	L/B	FEEDER & CONDUIT	TOTAL LOAD	REC-EPT.	AREA SERVED	
REFRIG. ROOM 128 AND ZAMBONI ROOM 127 - LTG.	-	700	2#12+G 13mmC	-	-	-	-	-	X	1	A	2				20A							NEW EXTERIOR
EXTERIOR STORAGE, ZAMBONI REFRIG. RM. 127	4	1000	2#12+G 13mmC	-	-	-	-	-	X	3	B	4	-	-	-				3#10+G 19mmC	-	-		GARBAGE STORAGE
REFRIG. ROOM 127	3	800	2#12+G 13mmC	-	-	-	-	-	X	5	C	6				3P							AREA - COMPACTOR
CONNECTION TO WATER TREATMENT SYSTEM	-	500	2#12+G 13mmC	-	-	-	-	-	X	7	A	8	X	-	-	-	-	-		2#12+G 13mmC	500	-	ZAMBONI ROOM DOOR OPENER
EAST VESTIBULE						40A				9	B	10	X	-	-	-	-	-		-	-	-	RESERVED
CABINET HEATER	-	1200	3#8+G 25mmC	-	-		-	-	-	11	C	12	X	-	-	-	-	-		2#12+G 13mmC	500	1	HALL 4 CEILING RECEPTACLE
CONNECTION						3P				13	A	14	X	-	-	-	-	-		2#12+G 13mmC	1000	4	HALL 4
NEW IT ROOM TWIST LOCK	1	1500	2#10+G 13mmC	-	-	30A-1P	-	-	-	15	B	16	X	-	-	-	-	-		2#12+G 13mmC	500	1	ZAMBONI ROOM 127 CONNECTION TO JB
NEW IT ROOM TWIST LOCK	1	1000	2#10+G 13mmC	-	-	30A-1P	-	-	-	17	C	18	-	-	X	-	-	-		2#12+G 13mmC	1000	1	NEW IT ROOM 20A RECEPTACLE
NEW IT ROOM 20A RECEPTACLE	1	1000	2#12+G 13mmC	-	-	-	X	-	-	19	A	20	-	-	X	-	-	-		2#12+G 13mmC	1000	1	NEW IT ROOM 20A RECEPTACLE
REFRIGERATION ROOM 127	-	400	3#12+G 19mmC	-	-	15A	-	-	-	21	B	22	-	-	X	-	-	-		2#12+G 13mmC	400	-	EXHAUST FANS 'GE-1' AND 'GE-2'
EXHAUST FAN 'RRE-1'						3P				23	C	24	X	-	-	-	-	-		2#12+G 13mmC	400	-	ZAMBONI GARAGE FAN 'ZRE-1' AND UH-1
									X	27	B	28	X										
									X	29	C	30	X										
									X	31	A	32	X										
									X	33	B	34	X										
									X	35	C	36	X										
							X			37	A	38			X								
							X			39	B	40			X								
							X			41	C	42			X								

TOTAL 42 CIRCUITS

LIGHTING PANEL-	VOLTAGE- 120/208V, 3Ø, 4W	CONNECTED LOADS				DOUBLE LUG.	DEMAND LOAD.
		LIGHTS	RECEPT.	MOTORS	HEATING		
POWER PANEL- PANEL R	MAINS - 225A	FLUSH- SURFACE- <input checked="" type="checkbox"/>				JOB NO: 1810061-000	
HEATING PANEL-	MAIN BREAKER 200A	PANEL TYPE-	AMP	KW.	FEEDER	LOCATION.	STORAGE 121A
MMM GROUP LTD.			JOB NAME: NEW MARKET COMMUNITY CENTER				SHEET NO. 1

LOAD DESCRIPTION				BREAKERS						BREAKERS						LOAD DESCRIPTION						
AREA SERVED	REC-EPT.	TOTAL LOAD	FEEDER & CONDUIT	L/B	GFI	OTHER	20A 1P	15A 2P	15A 1P	CCT No.	PH	CCT No.	15A 1P	15A 2P	20A 1P	OTHER	GFI	L/B	FEEDER & CONDUIT	TOTAL LOAD	REC-EPT.	AREA SERVED
SUMP PUMP CONTROL PANEL	-	500	2#12+G 13mmC	-	-	-	-	-	X	1	A	2	-	-	-	25A-1P	-	-	2#10+G 19mmC	500	-	SUMP PUMP
UV STERILIZER PANEL	-	3500	2#10+G 19mmC	-	-	25A 2P	-	-	-	3	B	4	-	-	-	40A 2P	-	-	2#8+G 25mmC	6500	-	UV STERILIZER PANEL
										5	C	6										
WATER FEATURE CONTROL PANEL	-	-	2#12+G 13mmC	-	-	-	-	-	X	7	A	8	-	-	-	40A 2P	-	-	2#8+G 25mmC	6500	-	UV STERILIZER PANEL
WATER FEATURE MONITORING PANEL	-	-	2#12+G 13mmC	-	-	-	-	-	X	9	B	10										
ELECTRICAL UNIT HEATER 'EUH-1'	-	5000	3#10+G 19mmC	-	-	20A 3P	-	-	-	11	C	12	X	-	-	-	-	-	2#12+G 13mmC	700	-	ROOM 005 - LTG. ROOM 005A - LTG.
										13	A	14	-	-	-	25A-1P	-	-	2#10+G 19mmC	300	-	SUMP PUMP
										15	B	16	X	-	-	-	-	-	2#12+G 13mmC	500	-	SUMP PUMP CONTROL PANEL
WATER FEATURE ROOM RECEPTACLES	-	-	2#12+G 13mmC	-	-	-	X	-	-	17	C	18	X	-	-	-	-	-	2#12+G 13mmC	1500	-	STORAGE ROOM 005A BASE BOARD HEATER
WATER FEATURE ROOM EXHAUST FAN 'WRE-1'	-	200	2#12+G 13mmC	-	-	-	-	-	X	19	A	20	X	-	-	-	-	-	2#12+G 13mmC			
STORAGE ROOM 005A MEETING ROOM 2	2	500	2#12+G 13mmC	-	-	-	-	-	X	21	B	22	X	-	-	-	-	-	2#12+G 13mmC	1000	4	MEETING ROOM 3
MEETING ROOM 4	3	750	2#12+G 13mmC	-	-	-	-	-	X	23	C	24	X	-	-	-	-	-				
									X	25	A	26	X	-	-	-	-	-				
									X	27	B	28	X	-	-	-	-	-				
									X	29	C	30	X	-	-	-	-	-				
									X	31	A	32	X	-	-	-	-	-				
									X	33	B	34	X	-	-	-	-	-				
							X			35	C	36			X							
							X			37	A	38			X							
							X			39	B	40			X							
							X			41	C	42			X							

TOTAL 42 CIRCUITS

LIGHTING PANEL-	VOLTAGE- 120/208V, 3Ø, 4W	CONNECTED LOADS				DOUBLE LUG.	DEMAND LOAD.
		LIGHTS	RECEPT.	MOTORS	HEATING		
POWER PANEL- PANEL W	MAINS - 225A	FLUSH- SURFACE-✓				JOB NO: 1810061-000	
HEATING PANEL-	MAIN BREAKER 200A	PANEL TYPE-	AMP	KW.	FEEDER	LOCATION.	WATER FEATURE ROOM
MMM GROUP LTD.	JOB NAME: NEW MARKET COMMUNITY CENTER					SHEET NO. 1	

SECTION 16500 - LIGHTING

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SECTION 16500 - LIGHTING

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 16010 applies to and is a part of this Section.
- .2 Section 16050 contains requirements, products and methods of execution that apply to this Section.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the lighting work is specified in other Sections:
 - .1 finish painting of exposed conduit and equipment.

1.3 SHOP DRAWINGS

- .1 Submit shop drawings for equipment and accessories specified in this Section. Include photometric data, and information on ballasts, lamps and accessories for all luminaires.

1.4 WARRANTY

- .1 Unless otherwise noted, warrant fluorescent and high intensity discharge (HID) lamps and associated standard ballasts for a period of twelve (12) months from the date of acceptance of the Work. Warrant incandescent lamps for the period of their rated life from the date of acceptance of the Work. Include costs for personnel, equipment and labour for replacing lamps and ballasts that became defective during the period of the Warranty.

PART 2 - PRODUCTS

2.1 LUMINAIRES

- .1 Luminaires shall be in accordance with the luminaire schedule sheets found at the end of this Section and shall be CSA approved or have special ESA approval.
- .2 Unless otherwise noted, fluorescent luminaire bodies shall be constructed from minimum 20 gauge cold rolled prime steel and of rigid construction to permit any suspension method without sag. Unless otherwise noted, provide body finishes of corrosion resistant, chemically treated and electrostatically spray-painted baked white enamel. Reflecting surfaces to be white with an average reflectance of not less than 85%.
- .3 Provide neoprene or silicone gasketing, barriers and stops where required to prevent light leaks or water/water vapour penetration.
- .4 Fabricate housings to allow for easy accessibility and replacement of parts.
- .5 Fabricate fixtures with a minimum number of joints. Make unexposed joints by acceptable method such as welding, brazing, screwing or bolting. Soldered joints are unacceptable. Do not use blind metal tapping methods or rivets for fastening parts which must be removed during service, or for fastening electrical components and supports. All cast parts, including die-cast members, shall be of uniform quality, close grained, rigid, true to pattern, free from blow holes, pores, discoloration, hard spots, shrinkage defects, cracks or other imperfections that affect strength and appearance or are indicative of inferior metals or alloys.
- .6 Reflectors and reflecting cones or baffles shall be free of any tooling marks, spinning lines or marks by other assembly techniques. For fluorescent sources, iridescence shall be low. Finishes to be equal to first quality polished, baffled and anodized "Alzak".
- .7 All lamp sockets shall be suitable for the indicated lamps and shall be set so that lamps are positioned in optically correct relation to all luminaire components. All adjustable sockets shall be preset at the factory for lamp specified.
- .8 Unless otherwise noted, acrylic lens shall be constructed from 100% virgin acrylic and not less than 0.125" (3.22 mm) thick. Glass lenses shall be minimum 9.5 mm thick.

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- .9 Exterior luminaire poles shall be provided of corrosion resistant finish and construction. All exterior luminaire exposed parts and hardware shall be corrosion resistant. Pole suppliers shall ensure that poles supplied are suitable for the steady wind velocity and gust velocity of the area of installation, and suitable for the total effective projected area of the lighting equipment.
- .10 When requested, submit luminaire samples.
- .11 Dimensions for coves, valances and strips as shown on the drawings are for bidding purposes only. Job measure for exact dimensions of louvres, lenses and strips.
- .12 Confirm exact colours and finishes of luminaires with the Consultant after award of contract but prior to ordering. Obtain information in time to meet installation schedule.
- .13 Unless otherwise noted, luminaires requiring ballasts shall be provided with its own ballast and ballasts shall not be shared.

2.2 LAMPS

- .1 T-8 fluorescent lamps in climate controlled areas to be Philips Lighting, "ALTOS II" Series, as follows:
 - .1 for 4' lamps, 28 watts, unless otherwise scheduled;
 - .2 phosphor coated;
 - .3 reduced mercury content;
 - .4 energy saving, high efficiency;
 - .5 colour temperature of 3500 K (for pricing purposes); confirm colour temperature requirements with Owner / Consultant prior to ordering;
 - .6 colour rendering index (CRI) of at least 85;
 - .7 rated average life of a minimum 36,000 hours (using programmed start ballasts and 12 hour cycling per start) and initial lumens of at least 2725 (4' lamps);
 - .8 for non-climate controlled areas: provide high output lamps suitable for reliable starting and operation at low temperatures below freezing (-29°C) (-20 °F) and supplied with proper low temperature operating ballasts.
- .2 Pin based compact fluorescent lamps to have a rated average life of a minimum 12,000 hours, colour temperature of 3500 K, minimum colour rendering index of 80 and complete with electronic energy saving programmed start ballasts compatible with lamps.
- .3 Fluorescent lamps for luminaires connected to dimmers are to be suitable in all respects for the application. Lamps, ballasts and dimmers must be approved by respective manufacturer for connection and use together.
- .4 Metal halide lamps to be based on Osram Sylvania "Metalarc" series with following features:
 - .1 pulse start, coated type;
 - .2 apparent colour temperature of approximately 3900K;
 - .3 minimum lamp life of 15,000 hours and colour rendering index (CRI) of at least 65.
 - .4 compatible lamp and ballast combination that meets ANSI specifications.
 - .5 of same manufacturer and production batch.
- .5 Low voltage MR 16 halogen lamps to be based on Osram Sylvania "Titan-IR" series with following features:
 - .1 hard coated dichroic reflector providing consistent colours throughout life of lamp and using IR technology for energy savings and reduced heat;

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- .2 transmits heat through back of lamp;
- .3 UV filter capsule to reduce fading of UV sensitive materials;
- .4 ratings chosen from 20, 37 or 50 watts;
- .5 beam spreads from narrow spot, spot, narrow flood, flood and wide flood;
- .6 minimum 5000 hours lamp life without sacrificing full rated light output;
- .7 transformers with regulation to maintain voltage between 11.5 to 12.5 volts.
- .6 Incandescent lamps to include following features:
 - .1 rated for 125 volt power supply and for use on 120 volt (nominal) supply;
 - .2 suitable for burning in any position;
 - .3 reflector lamps to have minimum life of 2000 burning hours lamp life;
 - .4 unless otherwise noted, conventional filament incandescent lamps to have minimum life of 1000 burning hours at rated voltage;
 - .5 unless otherwise noted, colour temperature of 2700 K.
- .7 Confirm exact colour temperature of lamps with Consultant, prior to ordering. Fluorescent lamp lengths shall be as noted on Luminaire schedules.
- .8 Acceptable lamp manufacturers are:
 - .1 Philips Lighting;
 - .2 OSRAM Sylvania Ltd;
 - .3 GE.

2.3 FLUORESCENT LUMINAIRE BALLASTS

- .1 Fluorescent luminaire ballasts for T8 fluorescent lamps in climate controlled areas to be based on Advance "Optanium" series, programmed start electronic ballasts as follows:
 - .1 CSA approved and ULC listed and labelled;
 - .2 comply with FCC Rules and Regulations, and ANSI Spec C62.41-1980/C62.45-1987;
 - .3 in accordance with ANSI Spec C82.11;
 - .4 Class A sound rating;
 - .5 minimum starting temperature of 60°F (16°C) (28 watt lamps);
 - .6 total harmonic distortion not greater than 10%;
 - .7 minimum power factor of 0.97 and ballast factor of at least 0.88;
 - .8 lamp current crest factor not greater than 1.7;
 - .9 frequency of operation between 20 kHz minimum to 60 kHz maximum, but not between 30kHz. and 42 kHz; lamps shall operate without visible flicker;
 - .10 EMI/RFI filtering;
 - .11 nameplate identifying manufacturer, model number, electrical data and standards of compliance;
 - .12 five (5) year full replacement parts and labour included warranty.

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- .2 Ensure that ballasts and lamps are completely compatible with each other, as per respective manufacturer's recommendations. Where occupancy sensors are used for controls, ensure that ballasts and sensors are of type suitable for such controls and operations that will not affect ballast and lamp life. Instant start types may be used in non-sensor controlled applications subject to written approval from Consultant.
- .3 Ballasts for compact fluorescent lamps to be dedicated to size of lamps and designed to operate the lamps with which they are used. Unless otherwise noted, ballasts to be programmed start and high power factor electronic types with circuitry to sense end of lamp life. Generally specification features to be as specified above for T8 ballasts.
- .4 Acceptable manufacturers are:
 - .1 Advance;
 - .2 OSRAM Sylvania Ltd;
 - .3 GE.

2.4 HIGH INTENSITY DISCHARGE BALLASTS

- .1 Advance Transformer Co., CSA approved, high power factor (95%) or better, nominal ballast factor of 1.0, constant wattage design, high intensity discharge ballasts capable of delivering rated lamp performance with input voltage fluctuation of $\pm 10\%$, and reliable lamp starting in ambient temperatures as low as -20°F (-28°C). Each ballast shall be complete with a core of laminated electrical grade steel, Class H (180°C) insulation, and colour coded and insulated copper conductor leads.
- .2 HID ballasts shall be compatible with respective lamp types.
- .3 Ballasts integral with luminaires shall be core and coil type and shall be encapsulated utilizing Class H polyester compound.
- .4 Remote mounting ballasts shall be encased type with a steel barrier in the enclosure to shield the capacitor from heat generated in the core and coil, spacers and fill to permit mounting in any desired position, and suitable mounting hardware.
- .5 Remote ballasts located outdoors shall be weather-proof with a weather-tight steel case and cover, and integrally moulded neoprene insulated leads with a water-proof plug at the casing entrance.
- .6 Acceptable manufacturers are:
 - .1 Advance;
 - .2 OSRAM Sylvania Ltd;
 - .3 GE.

2.5 WALL BOX DIMMERS

- .1 Lutron Electronics Co. "Nova-T" Series, ULC listed and labelled, CSA approved wall box dimmers as follows:
 - .1 of type and size to suit intended loads;
 - .2 air gap accessible without removing faceplate, to meet UL20 and UL1472 short circuit test requirement for snap switches;
 - .3 withstand voltage surges up to 600 V and current surges up to 200 A as per ANSI/IEEE C62.41;
 - .4 voltage regulated;
 - .5 power failure memory;
 - .6 LC filtering to minimize RFI;
 - .7 linear slide with smooth and continuous square law dimming curve operation;
 - .8 snap on faceplate (seamless multi-gang at locations with multiple devices);
 - .9 finish to Consultant's direction.

SECTION 16500 - LIGHTING

- .2 CSA approved, EEMAC 2 type, flush wall mounting, electrical cabinet with hinged locking front door, of painted enamel painted steel construction, complete with conduit knockout entries, flush trim and sized to accommodate dimmers. Refer to drawing detail.
- .3 Acceptable manufacturer is Lutron.

2.6 PHOTOCELL

- .1 Intermatic Inc., K4100 Series, CSA approved, 120 volt, weather-proof photo-control with a hermetically sealed cadmium sulphide photo cell, colour coded leads, adjustable light level slide, swivel, threaded pipe stem and heavy duty die cast housing. The unit shall be designed such that the load remains on if the cell fails, and shall be complete with thermal inertia time delay to prevent switching by artificial light.
- .2 Acceptable manufacturers are Intermatic Inc., Paragon Electric and Tork Canada Ltd.

2.7 EMERGENCY LIGHTING

- .1 Emergi-lite "ESL" Series, CSA approved, 120 VAC/24 VDC emergency lighting battery units. The units shall be complete with batteries, charger, dual lampheads per unit (where shown), cabinet and 4' (1.2 m) AC cord and plug set. Units shall also be complete with automatic testing and self-diagnostic circuitry. The system shall be designed to provide emergency lighting levels in accordance with the OBC requirements.
- .2 The chargers shall be fully automatic, solid-state type that automatically and instantaneously energizes lamp load upon failure of AC supply. Battery protection circuit automatically shuts down lamp load when battery reaches full discharge. Chargers shall fully recharge battery in twelve (12) to twenty-four (24) hours and shall be current limited and short circuit proof.
- .3 The batteries shall be long life sealed lead, maintenance free and shall have a capacity to supply sufficient output power to the lamp loads and to exit sign emergency loads for a period of time in accordance with the latest requirements of the OBC but which shall be a minimum of thirty (30) minutes. Batteries shall be designed for and guaranteed for at least ten (10) years of life expectancy.
- .4 The cabinets shall be constructed of No. 18 gauge steel, finished in white enamel. Front cover shall be removable to provide easy and full access to battery and charger connections. Knockouts shall be provided on top for the lampheads. Cabinet shall include protective wireguard.
- .5 Units shall include "PUSH-TO-TEST" switch, AC and high charge pilot lights and AC cordset.
- .6 Integral lampheads shall be 24 volts, 20 watts, quartz halogen, decorative design, high impact plastic, adjustable, dual heads complete with wireguards.
- .7 Remote surface mounted heads shall be type EF40M/EF40MD, vandal resistant polycarbonate cube type, single and double adjustable head complete with 24V-20W MR16 lamps.
- .8 Include costs for manufacturer's authorized representative to perform on-site after installation testing and commissioning of the equipment. Such work to be performed during premium after hours time.
- .9 Acceptable manufacturers are Emergi-lite, Lumacell, and Beghelli.

2.8 LOW VOLTAGE LIGHTING CONTROL

- .1 To facilitate ground floor (only) interior luminaire control via the security system, provide Legrand-Watt Stopper, CSA approved, switching components for low voltage lighting control, consisting of, as required components from the following:
 - .1 NEMA 1 enamelled painted steel tub, with hinged, key lockable, surface or flush mounting cover;
 - .2 interiors consisting of motherboard with relay LED status indication, colour coded connections, card slots and barrier to separate voltage levels;

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- .3 sized suitable for up to forty-eight (48) relays and multiple contactors as required;
 - .4 specification grade, heavy duty, 20 ampere rated plug-in relays complete with auxiliary contacts to provide status indication;
 - .5 colour coded and labelled terminals with push-on connections;
 - .6 panel identification card in plastic pouch affixed inside of cover;
 - .7 barrier for separation of high voltage (class 1) and low voltage (class 2) wiring;
 - .8 screwless, removable plug-in connections for all low voltage terminations;
 - .9 din rail mounted contactors, NO or NC as required and compatible with and of rating to suit lighting, ballast and loads being connected and controlled;
 - .10 power supply as required to supply sufficient power to system components;
 - .11 master ON/OFF group switching card to sequence all or any number of relays in a panel ON or OFF without requiring handheld device or special programming tools; pushbutton controls with LED indicators shall be provided for group operation and status;
 - .12 individual direct overrides shall be provided for each relay or per group as zoned on the drawings;
 - .13 Volt, momentary contact, key operated switches complete with pilot lights and keys;
 - .14 Type 302 stainless steel wallplates, number of gang as required, suitable for switches specified and complete with mounting brackets and matching screws;
 - .15 wiring in conduit, in accordance with the system manufacturer's requirements;
 - .16 programming and interfacing module cards for integration to DDC BAS to suit required system sequence of operation of lighting circuits;
 - .17 confirm sequence of operation with Consultant;
 - .18 refer to detail on drawings.
- .2 Supply with shop drawings, detailed wiring diagrams and floor plans identifying lighting controls and lighting panels being integrated to and any mechanical systems interconnections.
 - .3 Acceptable manufacturers are Legrand-Watt Stopper, Douglas Power Equipment Ltd. and Hubbell Automation.

PART 3 - EXECUTION

3.1 INSTALLATION OF LUMINAIRES

- .1 Provide luminaires as scheduled.
- .2 Thoroughly review ceiling types, finishes and construction details before placing luminaire orders, and ensure that required mounting assemblies, frames, rings and similar features are included. Confirm colours and finishes with the Consultant prior to ordering.
- .3 Include for assembly and mounting of luminaires and lamps, complete with wiring, connections, fittings, hangers, aligners, box covers and accessories required for a complete, safe and fully operational assembly. Luminaires shall be supported directly by the ceiling slab structure and not to ceiling hangers, ductwork, piping, cable trays, etc.
- .4 Do not tighten wing nuts, bolts, or screws that allow fixture adjustment for recessed adjustable fixtures.
- .5 Install spread lenses only where called out on the Luminaire Schedules and Specifications.

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- .6 Use cloth gloves when handling reflector cones, louvres, halogen lamps, glass, sconces and all exposed surfaces of fixtures.
- .7 Install fixtures in lay in ceiling in centre of tile unless dimensioned otherwise on Reflected Ceiling Plans.
- .8 Provide spacers for fixtures mounted on low density ceiling material.
- .9 Provide plaster frames for recessed fixtures in plaster or gypsum board ceilings.
- .10 Install fixtures in and on acoustical tile ceilings in alignment with tile joints.
- .11 Prepare fixtures, trim and poles and standards required to be painted.
- .12 Where outlet boxes locations as shown on drawings, they are diagrammatic only. Position outlet boxes to coincide with suspension hangers and knockouts.
- .13 Wiring between fluorescent lampholders and associated operating and starting equipment shall be of similar or heavier gauge than the leads furnished with the approved types of ballasts with equal or better insulating and heat-resistant characteristics.
- .14 Wiring shall be protected with tape or tubing at all points where abrasion may occur. Wiring shall be concealed within the fixture construction except where design or mounting dictates otherwise.
- .15 Minimize splices. Make splices with approved mechanical insulated steel spring type connectors, suitable for temperature and voltage conditions to which splices are to be subjected.
- .16 Carefully co-ordinate the luminaire installation with the work of other trades to ensure that the necessary recessing depths and mounting spaces are provided.
- .17 Install luminaires in accordance with applicable architectural drawing reflected ceiling plans and/or wall elevations and/or field instructions issued by Consultant. Confirm luminaire locations prior to roughing-in. In equipment rooms, shafts and similar secondary areas, install luminaires after the mechanical and other major work is roughed in and adjust luminaire locations as required.
- .18 If requested, demonstrate the operation of special applications of luminaires such as building floodlights and other decorative luminaires, and adjust their locations within a reasonable distance to obtain the effects desired.
- .19 Align and position all adjustable luminaires, and ensure that luminaires with adjustable lamp holders are properly positioned to correspond to the lamps specified.
- .20 Comply with the requirements of OESC regarding support of luminaires in suspended ceilings.
- .21 Note: Fluorescent luminaires in suspended ceilings must be independently suspended from the ceiling slab. For each luminaire, provide minimum two (2) cable supports secured to ceiling slab and to luminaire.
- .22 Contractor to notify immediately if fixture placement is in conflict with a structural beam, mechanical duct, plumbing pipe, a space above ceiling is not sufficient, or any other reason that a fixture can not be located where it is dimensioned or shown on the construction documents. Contractor is to move fixture, if necessary, where Consultant decides.
- .23 All lamps shall be new and intact when the project is complete and ready for acceptance.
- .24 Include a full lamp listing in the Operating and Maintenance Instruction Manuals.
- .25 Secure poles for pole mounted, exterior type luminaires to concrete bases as detailed. Provide required work including excavation/backfilling/concrete work to provide bases as shown. Provide anchor bolt covers and anchor bolt templates for proper positioning of anchor bolts in the concrete. Refer to the concrete base detail found on drawings. This detail is for general requirements only. Additional details may be confirmed with the Architect. Include costs for a Professional Engineers of Ontario licensed Engineer to review and endorse base work. Grade levels may be different in various areas. Co-ordinate work.

SECTION 16500 - LIGHTING

- .26 Secure grade mounted building floodlighting luminaires to concrete pads set flush with finished grade level.
- .27 Provide remote ballasts for luminaires as scheduled. Secure in place where shown, and connect complete.
- .28 Provide safety cables for HID fixtures with integral ballasts. Attach cables to fixture and building structure. Safety cable to be designed and secured so as to withstand the sudden weight of the fixture.
- .29 Connect designated circuits to Division 15 building management system. Provide required contactors, wiring in conduit, connections, etc. Coordinate work with Division 15.

3.2 INSTALLATION OF OUTSIDE LIGHTING CONTROL

- .1 Provide a photo cell to switch designated outside lighting on, and relay/contacts to connect to Division 15 BMS system as required such that BMS system can override the photocell if desired. The relay/contacts shall be suitable for operation with the BMS system supplied. Provide required wiring in conduit and system connections to provide outside lighting control.
- .2 Flush mount the photo cell in the roof of the building. Confirm exact location prior to roughing-in.
- .3 When outside lighting control work is complete, test operation of the control system and adjust as required.

3.3 INSTALLATION OF WALL BOX DIMMERS

- .1 Provide flush wall box dimmers where shown and connect to control lighting as indicated. Confirm exact locations prior to roughing-in. Equip each dimmer with a faceplate. Confirm faceplate colour prior to ordering.
- .2 When installation is complete, check and test operation of each dimmer and adjust as required.
- .3 Ensure that each dimmer is properly sized to suit the connected load

3.4 INSTALLATION OF EMERGENCY LIGHTING

- .1 Provide emergency lighting battery units as scheduled and wall mount each on a shelf where shown. Plug each unit into an adjacent receptacle. Confirm exact mounting heights and locations prior to roughing-in receptacles. Extend wiring in conduit and connections to remote lampheads and exit lights, back to central battery unit serving area and connect complete.
- .2 Note that drawings identify location for battery units and generally identify circuiting of remote heads. In absence of direction of circuiting, provide wiring in conduit to feed the remote heads and exit lights from nearest battery unit with sufficient capacity in the area, in accordance with application requirements, manufacturer's requirements and applicable codes. Multiple battery units may be required to accommodate the connection of remote heads in some areas. Provide sufficient battery units to accommodate connected lamp loads and system design time of operation. Note that where more than one battery unit is installed in same immediate location, only one unit is required to be provided with integral lampheads.
- .3 Provide remote mounting lampheads as specified and as required for system performance in compliance with OBC. Install lampheads in locations as shown on the drawings. Connect complete to the battery units. Be responsible for revisions to system, including relocations, aiming and additional remote heads as determined by testing results. Generally, wiring shall be in accordance with manufacturer's requirements and be minimum No. 10 AWG, but must be increased to suit voltage drop requirements reviewed with system manufacturer.
- .4 Provide wiring in conduit and install devices in accordance to manufacturer's instructions.

SECTION 16500 - LIGHTING

- .5 When installation of emergency lighting equipment is complete, and in conjunction with the manufacturer's representative, commission and test the entire system, adjust as required, and certify in writing to the Consultant that the system is complete, have been tested, adjusted, and are in proper operating condition. Also, be responsible for engaging the emergency lighting manufacturer to perform an illumination level test in the presence of the Consultant, throughout all areas of the building. Manufacturer shall be responsible for properly aiming remote light heads, recording light level readings on a record set of floor plans, calculating light level readings, and issuing a letter listing light level readings, to the Consultant stating that the emergency lighting levels meet the requirements of the Ontario Building Code. Notify Owner and Consultant at least ten (10) days prior to proposed testing date. Testing dates and times shall be subject to approval by Consultant.

3.5 INSTALLATION OF LOW VOLTAGE LIGHTING

- .1 Provide all required components for low voltage control of lighting as required such that the security system can provide control as shown on the drawings and as required. In addition, provide controls to interface lighting circuits as shown on drawings, to be controlled by the security system control panel. Refer to notes on drawings.
- .2 Where applicable, flush wall mount low voltage switches were shown, complete with a mounting bracket and faceplate for each switch. Confirm finishes with Consultant.
- .3 Install control panels as required. Clearly identify all low voltage relays and switching circuits. Locate the enclosures: adjacent to branch circuit panelboards to which the lighting loads are connected.
- .4 Confirm enclosure locations with Consultant prior to roughing-in.

END OF SECTION

SCHEDULE OF LUMINAIRES									
TYPE	SPECIFIED MANUFACTURER & CATALOGUE NO.	PRODUCT DESCRIPTION	VOLTS	WATTS & LAMPS	MOUNTING *				ACCEPTABLE MANUFACTURERS
					R	S	W/B	SUS	
F	PEERLESS LIGHTING CAT#LACH-24G-228-120-EL (ELECTRONIC BALLAST)	2' x 4' RECESSED FLUORESCENT LUMINAIRE c/w A HINGED AND LATCHED FLAT STEEL LENS FRAME WITH A PRISM DESIGN K12 MINIMUM 0.125" THICK, SUITABLE FOR INSTALLATION IN T-BAR CEILINGS.	120V	2@28W T8	√				CANLYTE COOPER LITHONIA THOMAS VISIONEERING
F1	COOPER LIGHTING "METALUX" CAT#VT-228-DR-120V-EB81- WL (ELECTRONIC BALLAST)	4' LONG SURFACE MOUNTED FLUORESCENT LUMINAIRE c/w FIBREGLASS HOUSING, NEOPRENE GASKET AND ONE PIECE CLEAR ACRYLIC CREPE PATTERN DIFFUSER, RETAINED WITH HIGH IMPACT PLASTIC TENSION LATCHES. FIXTURE SUITABLE FOR DAMP OR WET LOCATION.	120V	2@28W T8	√				CFI PEERLESS THOMAS VISIONEERING
F2	PEERLESS LIGHTING CAT#LS-4-128-120-EL (ELECTRONIC BALLAST)	48" LONG SURFACE MOUNTED STRIP FLUORESCENT LUMINAIRE	120V	1@28W T8		√			CFI LITHONIA COOPER THOMAS VISIONEERING
F3	COOPER LIGHTING "METALUX" CAT#BC-228-120-TEB81 (ELECTRONIC BALLAST)	48" LONG SURFACE MOUNTED FLUORESCENT WALL BRACKET LUMINAIRE c/w SPRING LOADED END CAPS AND A WRAP AROUND ACRYLIC LENS.	120V	2@28W T8			√		CFI PEERLESS THOMAS VISIONEERING
A	PRESCOLITE "ARCHITEKTUR" CAT.#D432EB-4D5-WT-B24	4" DIAMETER APERTURE, RECESSED COMPACT FLUORESCENT OPEN REFLECTOR DOWNLIGHT c/w SPECULAR CLEAR ALZAK REFLECTOR AND SUITABLE FOR INSTALLATION IN T-BAR CEILINGS	120V	1@32W TRIPLE TUBE	√				CANLYTE COOPER LITHONIA STAFF

PROJECT NAME: NEWMARKET COMMUNITY CENTRE		DATE: October 5, 2010 PAGE 1 OF 3
PROJECT NO.: 1810061-000	MMM GROUP LIMITED	
* - RECESSED, S- SURFACE, WB - WALL BRACKET, SUS - SUSPENDED		

SCHEDULE OF LUMINAIRES

TYPE	SPECIFIED MANUFACTURER & CATALOGUE NO.	PRODUCT DESCRIPTION	VOLTS	WATTS & LAMPS	MOUNTING *				ACCEPTABLE MANUFACTURERS
					R	S	W/B	SUS	
A1	PRESCOLITE "LITEFRAME" CAT.#LF8MH70EB-347-8MHV- CR-FL-WT-TRG	8" DIAMETER APERTURE RECESSED HID LENSED DOWNLIGHT c/w ONE-PIECE GALVANIZED STEEL HOUSING, SEMI-DIFFUSE CLEAR ALZAK REFLECTOR AND REGRESSED FRESNEL LENS. LUMINAIRE SHALL BE WET LOCATION LISTED.	347V	1@70W MH	√				CANLYTE COOPER LITHONIA STAFF
A2	PRESCOLITE "LITEFRAME" CAT.#LF8CFH-226-EB-120-WB- WT- B24	7 3/8" APERTURE, COMPACT FLUORESCENT OPEN REFLECTOR DOWNLIGHT c/w SPECULAR CLEAR LOW IRIDESCENT ALZAK REFLECTOR, SUITABLE FOR MOUNTING IN A DRYWALL & LAY-IN CEILING.	120V	2@26W QUAD TUBE	√				CANLYTE COOPER LITHONIA STAFF
A3	LITELINE CAT.# ML-1JC20-CH TRANSFORME # CL-THP1-105	2-7/8" DIAMETER RECESSED MOUNTED UNDERCOUNTER SINGLE MINI HALOGEN PUCK LIGHT FIXTURE WITH A CHROME FINISH. REQUIRES A REMOTE MOUNTED ELECTRONIC LOW VOLTAGE TRANSFORMER AND A HARDWARE BOX.	12V	20W HALOGEN	√				COOPER TPL
O	HUBBELL LIGHTING "TRP TRAPEZOID" CAT.#TRP-100-FT-XX (ELECTRONIC BALLAST)	16.5" WIDE x 7.13" HIGH x 9.25" DEEP H.I.D. ARCHITECTURAL TRAPEZOID SHAPE WALL PAK c/w DIECAST ALUMINUM HOUSING, MOLDED LINES AND AN IMPACT RESISTANT, CLEAR TEMPERED GLASS LENS. REFLECTOR SHALL BE SPECULAR POLISHED ALUMINUM WITH FORWARD THROW OPTICS. REFLECTOR CONSTRUCTION AND FINISH SHALL BE CAPABLE OF PRODUCING AN AVERAGE ILLUMINATION LEVEL OF 1.0 TO 1.5 FOOTCANDLES WITH A UNIFORMITY RATIO OF 4:1 (6:1 MAX. (AVG. TO MIN.)), WHEN MOUNTED AT A 9' HEIGHT AND AT THE SPACINGS INDICATED ON THE FLOOR PLANS. LUMINAIRE SHALL HAVE A POWDER COAT FINISH. COLOR TO BE SELECTED BY ARCHITECT FROM THE STANDARD COLORS.	347V	1@100W MH			√		COOPER GARDCO HADCO/KEENE LITHONIA LSI RUUD
O1	ALLSCAPE CAT.#BL-227-D-100MH-PAR 38 -347V-	WALL MOUNTED H.I.D LUMINAIRE c/w ROLL FORMED 0.080" ALUMINUM AND HEAVY ALUMINUM CASTING, 7/16" CLAR TEMPERED FLAT BOROSILICATE GLASS (F), SEALED TO THE HOUSING WITH HIGH TEMPERATURE INJECTION MODLED SILICONE GASKET. REFLECTOR SHALL BE SPUN ALUMINUM HIGHLY SPECULAR ALZAK FINISH , FIELD ADJUSTABLE AND SHALL BE CAPABLE OF PRODUCING AN AVERAGE ILLUMINATION LEVEL OF 1.0 TO 1.5 FOOTCANDLES WITH A UNIFORMITY RATIO OF 4:1 (6:1 MAX. (AVG. TO MIN.)), WHEN MOUNTED AT A 10.5' HEIGHT AND AT THE SPACINGS INDICATED ON THE FLOOR PLANS. LUMINAIRE SHALL HAVE A POWDER COAT FINISH. COLOR TO BE SELECTED BY ARCHITECT FROM THE STANDARD COLORS.	347V	1@100W MH					COOPER LITHONIA

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PROJECT NO.: 1810061-000	MMM GROUP LIMITED	
* - RECESSED, S- SURFACE, WB - WALL BRACKET, SUS - SUSPENDED		

SCHEDULE OF LUMINAIRES									
TYPE	SPECIFIED MANUFACTURER & CATALOGUE NO.	PRODUCT DESCRIPTION	VOLTS	WATTS & LAMPS	MOUNTING *				ACCEPTABLE MANUFACTURERS
					R	S	W/B	SUS	
X	EMERGILITE LPEX50 SERIES	WALL OR CEILING MOUNTED LED EXIT LIGHT WITH 6" LIGHT HIGH RED LETTERS, SINGLE OR DOUBLE STENCIL FACE, DC INPUTS AND DIRECTIONAL ARROWS AS REQUIRED. LED SOURCE CAPABLE OF GENERATING LIGHT LEVELS EQUAL TO CSA C860 REQUIREMENTS.	120V	LED		√		√	LUMACELL LUXNET BEGHELLI

NOTES:

1. ALL LUMINAIRE FINISHES AND COLOURS MUST BE CONFIRMED WITH THE ARCHITECT PRIOR TO ORDERING. CUSTOM COLOURS MAY BE REQUESTED. REFER TO SECTION 16500 FOR ADDITIONAL LUMINAIRE REQUIREMENTS.
2. SUCCESSFUL LIGHTING SUPPLIER SHALL PRODUCE A POINT-BY-POINT PHOTOMETRIC LAYOUT FOR SITE LIGHTING FOR REVIEW BY THE CONSULTANT.

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SECTION 16700 - COMMUNICATIONS

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SECTION 16700 - COMMUNICATIONS

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 16010 applies to and is a part of this Section.
- .2 Section 16050 forms a part of this Section and contains requirements, products and methods for execution that apply to this Section.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

- .1 The following work which is related to the communications work is specified in other Sections of the Specification:
 - .1 supply and mounting of fire alarm system supervised valve contacts, alarm valve contacts and piping pressure switches.

1.3 SYSTEMS START-UP TESTING, INSPECTION AND COMMISSIONING

- .1 When each system installation is complete and ready for acceptance, arrange for the system manufacturer or manufacturer's authorized representative to visit the site to:
 - .1 check all component connections and overall installation;
 - .2 program systems as applicable;
 - .3 adjust sound systems for high quality, distortion free performance, free from noise, cross-talk, hum or other interference;
 - .4 provide start-up procedures for systems;
 - .5 test and adjust the system and ascertain that the components are as specified;
 - .6 commission system and ensure that devices operate as specified and as designed; commissioning work shall refer to manufacturer's general start-up requirements;
 - .7 verify system component operations;
 - .8 prepare, document and evaluate test results;
 - .9 authenticate test results with signature of authorized testing Engineer/Technician;
 - .10 provide maintenance and operating instructions to Owner's personnel.
- .2 When the system start-up, testing, adjusting and commissioning specified above is complete, obtain from the supplier/manufacturer (or where specified, independent inspection company), a letter signed by an authorized testing technician, stating that the system has been inspected and tested, performs as specified and is ready for acceptance. Include copy of letter within test report and submit minimum four (4) copies to Consultant.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings for equipment and accessories specified in this Section. Provide connection wiring schematic drawings, block diagrams and sequence of operation for each system. Provide sample of fire alarm annunciator graphic.

SECTION 16700 - COMMUNICATIONS

PART 2 - PRODUCTS

2.1 FIRE ALARM SYSTEM

- .1 The existing Mircom FX-2000 fire alarm system shall be extended to serve the additional and renovated areas. Work shall include provision of all necessary control panel / data gathering panel work to accommodate additional devices, integration of devices to existing system, system programming and testing/verification work. Provision of devices shall be as specified in the paragraphs which follow. Engage existing system manufacturer to review system requirements to ensure that any additional devices and work are compatible with existing system and meet present standards.
- .2 Modify control panels and annunciators to accommodate additional devices and zones as required for the work. Additional control devices shall be of existing system manufacturer's devices and be ULC listed and labelled compatible for connecting to respective control units. Include costs for manufacturer's authorized representative to perform control panel / annunciator work and to reprogram system software to accommodate work.
- .3 Additional devices as shown on drawings and as required to comply with code requirements shall include but not be limited to the following ULC listed and labelled devices:
 - .1 additional communication boards and device connection modules to accommodate the additional devices;
 - .2 pull stations to match existing types;
 - .3 audible/visual devices (horns and horn/strobes) provided to match applications as per existing standards;
 - .4 device backboxes as required for mounting devices into locations.
- .4 Provide end-of-line resistors for standard alarm and signalling circuits, sized to ensure the correct supervisory current flows in each circuit. End-of-line resistors shall be mounted on a stainless steel plate for mounting on a standard single gang box and bear the ULC label. Provide isolators as required by code and local authority having jurisdiction.
- .5 Cable shall be CSA approved, ULC listed for fire alarm circuits, flexible armoured colour coded insulated solid copper conductors, of type as per OESC requirements (with specific reference to Table 19) and as specified in previously in this Section. All wiring and cable shall also be sized and installed in accordance with the system manufacturer's instructions but where a conflict exists in the documents, provide the more stringent arrangements.
- .6 Authorized technician of the existing fire alarm system manufacturer shall provide and perform work.
- .7 Also include for existing system manufacturer's authorized technician to verify and certify the system work and the interconnections to existing building fire alarm system. Prepare detailed verification report to ULC standards and submit signed copies of report to Consultant. Refer to Part 3 for additional testing and verification requirements.

2.2 NETWORK CABLING SYSTEM

- .1 The supply and installation of the network cabling system shall be excluded from this Division.
- .2 The Division 16 Electrical Contractor shall include for but not be limited to providing the following items to accommodate the installation of the network cabling system:
 - .1 provision of conduit and cable tray;
 - .2 provision of system device backboxes;
 - .3 provision of system grounding requirements;
 - .4 provision of system power requirements;
 - .5 coordinate conduit, box and power requirements with successful system tenderer.

SECTION 16700 - COMMUNICATIONS

- .3 Division 16 installation requirements shall include for the following system features:
 - .1 provision of types of backboxes co-ordinated with system supplier;
 - .2 supply and installation of conduits and boxes to comply with EIA/TIA 568 Standards for category 6 cabling requirements;
 - .3 cable tray shall extend down to backboard/racks;
 - .4 typically, backboard shall be located in main LAN room;
 - .5 all conduits from system device boxes shall terminate 12" (300mm) from cable tray in ceiling space of corridors only;
 - .6 conduit bending radii and pull box sizes shall comply with system manufacturer's requirements.

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRE ALARM SYSTEM

- .1 Provide retrofit work of existing fire alarm system as required.
- .2 During work to the existing fire alarm system, the time and duration of interruption shall be approved by the Owner. In all areas where the renovation work requires shutdown of any part of the fire alarm protection system, provide manual fire alarm protection (Fire Warden) by means of supervising the area as approved by Governing Authorities. At no time shall the fire alarm system or any one (1) zone be left inoperative overnight. Provide all required bypass wiring and temporary wiring as may be required to maintain all parts of the fire alarm system operative during construction and alterations.
- .3 Verify with existing fire alarm system manufacturer during Bid period, the exact requirements needed to provide renovation work. If necessary, visit site with manufacturer to review existing conditions. Items of clarification or proposed revisions to Bid Documents must be reviewed with Consultant during Bid Period.
- .4 Provide for the existing fire alarm system manufacturer's technicians to perform work.
- .5 Perform modifications to control panel and annunciators as required to accommodate the retrofit work and additional devices. Submit with shop drawings details of work and a list of revised and additional zones of annunciation.
- .6 Provide required devices to perform retrofit work. Standards of work shall match existing standards. Program system to accommodate retrofit work.
- .7 Install manual pull stations in boxes as required, recessed outlet boxes with plaster rings, except in unfinished areas where the pull stations must be surface mounted, in which case, install the stations in surface mounted boxes. Comply with mounting height requirements for OBC barrier free access. At electromagnetic locked doors, integrate pull station with security access control system such that activation of pull station or activation of fire alarm system, releases door. Provide required auxiliary contacts in pull stations.
- .8 Install ceiling mounted thermal detectors where shown on the drawings and connect with wiring as indicated. Secure the baseplate of each new detector to a recessed 4" (100 mm) outlet box.
- .9 Secure the base of each ceiling mounted products of combustion detectors to boxes as required, either flush or surface mounted as required. Secure detector heads to the bases. Provide cross-zoned configuration and sequence of operation as required. Detectors mounted under raised floor or in accessible ceiling areas shall be provided with remote indicators.

SECTION 16700 - COMMUNICATIONS

- .10 Provide audible/visual alarm devices on standard device boxes in locations as shown. Ensure that the sound levels are in accordance to the requirements of all applicable local Codes and as required by on site horn coverage site tests. Provide required soundmeters and personnel to perform test. Make necessary adjustments of taps, relocation of devices or provision of additional devices to ensure that audible levels comply with the requirements. Where existing devices are flush mounted, provide flush backbox and finished grille for the additional units.
- .11 Install backboxes in locations as shown, as per manufacturer's installation. Connect complete.
- .12 Modify existing annunciators as required to accommodate and reflect system work and revisions. Submit annunciator schedule with shop drawings. Verify zone nomenclature with Consultant prior to installation. Where applicable, provide proposed drawing sample of graphic display to Consultant and governing fire authorities for approval before manufacturing.
- .13 Provide end-of-line resistors to electrically supervise all wiring. Generally, locate end-of-line resistors at ceiling lines above a pull station location.
- .14 Refer to the drawing riser diagram. Quantities of components shall be as per the floor plans and not the riser diagram.
- .15 Confirm the exact location of all components prior to roughing-in. Where applicable, confirm component finishes with Consultant prior to ordering.
- .16 Install all wiring in conduit. All wiring connections associated with the fire alarm system shall be performed on terminal strips in junction boxes. When pulling wires into conduit, use lubricant and ensure that wires are kept straight and are not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with approved supports or ties. All wires must be clearly identified at all termination points. In addition they shall be numbered with Brady Ltd. or Electrovert Ltd. Z-type markers. Colour conductors for each part of the system in accordance with the system equipment manufacturer's recommendations.
- .17 Alarm signalling circuits (horns/strobes) and alarm initiating circuits (pullstations, detectors) must be run in separate conduits from each other. All wiring connections shall be performed on terminal strips in junction boxes. Conduit couplings for fire alarm system wiring shall be painted red. Control wiring shall be run in separate conduits as well.
- .18 Provide engraved Lamacoid identification nameplates for each equipment or wiring housing and secure to the front of the housing. Exact wording designations and sizes to be reviewed and confirmed with the Consultant prior to manufacture.
- .19 Verify nomenclature of the annunciator identification with the Consultant and obtain necessary approvals prior to ordering.
- .20 Wiring Connections To Equipment By Others:
 - .1 Do all required fire alarm system wiring connections to mechanical equipment to perform all functions specified herein and shown and/or specified on the drawings. Provide all required fire alarm system wiring between the fire alarm system and the various equipment to achieve the automatic or manual control of these units to perform all functions required.
 - .2 Provision of fire alarm supervisory/monitoring wiring connections shall include but not be limited to the following (where applicable):
 - .1 door holders and electromagnetic locks;
 - .2 fan equipment starters;
 - .3 supervised valves and flow switches;
 - .4 pumps.

SECTION 16700 - COMMUNICATIONS

- .21 All work in conjunction with this installation shall meet the requirements of the latest editions of the OBC, OESC, ULC Installation Standard CAN/ULC-S524 and any applicable local codes. If any requirements of these specifications are different, omitted or contrary to the ULC-S524 Standard, then the ULC Standard governs and overrides these specifications, but in no instance will the standards established by the drawings and specifications be reduced by any of the Codes referred to previously. Control units and annunciators shall be in accordance to the latest requirements of ULC Standard CAN/ULC-S527 "Control Units For Fire Alarm Systems.
- .22 When all fire alarm system work is complete and ready for acceptance, include costs for and arrange for existing system manufacturer's technician to inspect, test, verify and certify the additional equipment, including control devices, affected downstream devices and wiring. The inspection shall comprise an examination of such equipment in accordance with the latest editions of CAN/ULC-S537 for the following:
- .1 to ensure that the entire system functions in accordance with the existing sequence of operations;
 - .2 to ensure that the type of equipment installed is that designated by the contract documents;
 - .3 to ensure that the wiring connections to all equipment components show that the installer observed ULC and CSA requirements;
 - .4 to ensure that the equipment was installed in accordance with the manufacturer's recommendations, and that all devices were operated or tested to verify their operation;
 - .5 to ensure that the supervisory wiring of those items of equipment connected to a supervised circuit is operating and that the governmental regulations, if any, concerning such supervisory wiring, have been met to the satisfaction of inspecting officials;
 - .6 test audible devices, and demonstrate that their performance complies with specifications and code requirements;
 - .7 to ensure that all devices are commissioned and operable.
- .23 Correct deficiencies as required by the Consultant and local fire authority. Include for manufacturer's representative to be present during the re-verification and re-inspections of the deficiencies.
- .24 During the period of inspection, testing and verification, make Electricians available to do any required correction work and to assist during this Work.
- .25 The Contractor in coordination with the system manufacturer, shall contact local fire authority inspector and coordinate and arrange for the Fire Inspector to perform all required inspections. Integrate the local fire authority inspection requirements with the testing and verification work of the system manufacturer to extent as per Fire Inspector's directions. Include for all requirements to obtain full approval and certification by the local fire authority. Obtain from local fire authority the required certificate of approval of the system work and forward to Consultant.
- .26 On completion of the verification, inspection and testing of the system, obtain from the system manufacturer and forward to the Consultant, a certificate of liability insurance, of at least the amount of two million dollars (\$2,000,000.00), and a verification certificate together with detailed inspection reports listing each and every system component, its location in the building and its acceptability. The verification certificate and inspection reports shall be prepared and signed by the authorized testing technician, confirming that the system is installed in accordance with requirements specified above.
- .27 The Certificate of Liability Insurance shall be registered for this project and shall be supplied to show satisfactory proof of the manufacturer's coverage for both its product and personnel.
- .28 Ensure that all costs for the above testing, verification and certification are included in the Bid Price. Include costs for re-verification of any failed device repaired or replaced.
- .29 Note that open flame and/or smoke are not to be used for testing.

SECTION 16700 - COMMUNICATIONS

- .30 Prepare verification report and include complete schedule of system device test results. The authorized testing technician shall sign report to testify that system meets all required ULC, codes and local fire authority requirements. Submit minimum four (4) copies to Consultant.
- .31 The testing companies must employ technicians certified and approved for fire alarm system testing and verification by the Canadian Fire Alarm Association (CFAA) and the Ontario Fire Marshall as applicable.

3.2 PROVISIONS FOR MISCELLANEOUS SYSTEMS

- .1 Provide the following components to accommodate the installation of the telephone system and other systems by the system installers who will provide the equipment and wiring:
 - .1 conduit - diameters as sized on the drawings with suitable bushings for conduit terminations, and as specified in Section 16050;
 - .2 outlet boxes - standard galvanized steel, each complete with a blank type faceplate;
 - .3 pull boxes, junction boxes and sleeves - as specified in Section 16050;
 - .4 backboxes – as required to suit respective system manufacturers component requirements.
- .2 Provide pullboxes in conduit runs longer than 100' (30 m) or having more than two (2) 90 degree bends. Pullbox sizes shall not be less than eight (8) times the entering conduit in length. Note that network cabling conduit and pull box requirements must comply with system manufacturer's instructions to meet EIA/TIA standards for installation of category 6 cabling.
- .3 Leave conduits free and clear of all obstructions and terminate as shown. Equip terminations with bushing, and clearly identify each run. Provide fish wires in all empty conduits. Coordinate conduit home run requirements to specific devices, with respective system suppliers.
- .4 Confirm the exact requirements and locations of the equipment with the Consultant and the system installers prior to roughing-in. Ensure that conduit runs comply with cabling bending radii of respective systems.
- .5 Refer to the system riser diagram on the drawings.
- .6 Quantities for outlets shall be as per the floor plan drawing and not the riser diagram.

END OF SECTION

SECTION 16850 - ELECTRIC HEATING

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- 3.2 INSTALLATION OF ELECTRIC BASE BOARD HEATERS

SECTION 16850 - ELECTRIC HEATING

PART 1 - GENERAL

1.1 REFERENCES

- .1 Section 16010 in this Division of the Specification applies to and is a part of this Section of the Specification.
- .2 Section 16050 in this Division of the Specification also applies to and is a part of this Section of the Specification. The Section contains requirements, products, and methods of execution that apply to this Section as well as to other Sections of Division 16.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings for all products in Part 2.

PART 2 - PRODUCTS

2.1 ELECTRIC CABINET HEATERS

- .1 Stelpro CBH Series, CSA approved, surface wall mounted electric heater as per drawing schedules and as follows:
 - .1 Cabinet - fabricated of 16 gauge steel and finished in polyester powder coating. Supply air shall be drawn through a stamped louver periphery evenly across the heating element, and discharged through an outward drawn louver. A large, access panel shall extend the width of the heater. Heater and supply wiring diagram shall be permanently attached to the inside of the access door;
 - .2 Elements - Elements shall be all steel tubular sheath with spiral wound fins. Linear type thermal switch shall provide over heat protection;
 - .3 Motors - Motors shall be totally enclosed multi speed double shaft motor, with over temperature protection built-in. All units utilize sealed bearings to assure permanent lubrication. Motor and blowers are mounted as a single assembly with direct drive connection and blow through design. Multi-speed motor with built-in time delay on motor switch.
 - .4 Fan Blades – Fan blades shall be of the axial flow type designed for quiet efficient operation;
 - .5 Front panel - finished to Consultant's direction, impact resistant/16 gauge steel construction; access door over controls; tamper proof features;
 - .6 Thermostat - adjustable, integral, 45°F - 90°F (7°C - 32°C) range;
 - .7 Mounting backbox, as required;
 - .8 Permanent washable filter;
 - .9 Low voltage relay.
- .2 Acceptable manufacturers of electric cabinet heaters are Chromalox and Ouellet Canada Inc.

2.2 ELECTRIC BASE BOARD HEATERS

- .1 Stelpro CBB Series, CSA approved, commercial base board heaters as per drawing notes and as follows:
 - .1 Construction - 18 gauge steel cabinet with a 16 gauge front panel; front louvers prevent entry of foreign objects; and have thermal protection with automatic reset;
 - .2 Elements - Elements shall consist of a stainless steel sheath with boxed aluminium fins element secured in the centre and floating in nylon sleeves at each end;
 - .3 Finish - finished to Consultant's direction; epoxy polyester powder coat;

SECTION 16850 - ELECTRIC HEATING

- .4 Thermostat – factory installed built in thermostat, adjustable, integral, tamperproof, 45°F - 85°F (7°C - 30°C) range;
 - .5 Low voltage relay kit;
 - .6 Mounting hardware, as required.
- .2 Acceptable manufacturers of heating units are Dimplex (Chromalox) and Ouellet Canada Inc.

PART 3 - EXECUTION

3.1 INSTALLATION OF ELECTRIC CABINET HEATERS

- .1 Provide electric cabinet heaters where indicated on the drawings and connect with required power wiring. Wall mount heaters in locations as confirmed with Consultant.
- .2 Confirm finishes with the Consultant prior to ordering.
- .3 Provide required hardware and accessories for mounting the heaters. Ensure that mounting provisions are suitable in all respects for the particular construction on which the heaters are to be mounted.
- .4 When installation is complete, check and test operation of each heater and adjust as required.

3.2 INSTALLATION OF ELECTRIC BASE BOARD HEATERS

- .1 Provide electric heaters where indicated on the drawings and connect with all required power wiring. Install heaters in locations as confirmed with Consultant.
- .2 Sizing of all heating units shall be scheduled or noted on drawings. Confirm finishes with the Consultant prior to ordering.
- .3 Provide all required hardware and accessories for mounting the heaters. Ensure that mounting provisions are suitable in all respects for the particular construction on which the heaters are to be mounted.
- .4 When installation is complete, check and test operation of each heater and adjust as required.

END OF SECTION