



## Smith + Andersen

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### **ELECTRICAL SPECIFICATION**

**PROJECT NAME:**

LEGAL AID ONTARIO – 2<sup>ND</sup> FLOOR FIT-OUT  
20 DUNDAS STREET  
TORONTO

**OUR PROJECT NUMBER:**

94013.051.E.001

**DATE:**

2017-10-13

**ISSUED FOR:**

TENDER

SECTION	NUMBER	NAME
	16010	General Instructions for Electrical Sections
	16030	Record Drawings
	16031	Submittals/Shop Drawings
	16052	Sleeves
	16056	Identification
	16057	Mounting Heights
	16061	Operating and Maintenance Instruction
	16080	Cutting and Patching
	16111	Conduits, Conduit Fasteners and Fittings
	16122	Wires and Cables 1000V
	16130	Poke - Thru Devices
	16131	Splitters, Junction, Pull boxes and Cabinets
	16132	Outlet Boxes, Conduit Boxes and Fittings
	16141	Wiring Devices
	16440	Disconnect Switches - Fused and Non-Fused
	16471	Panelboards - Breaker Type
	16478	Fuses - Low Voltage
	16505	Lighting Equipment
	16591	Lighting Control Equipment - Low Voltage
	16721	Fire Alarm

END OF SECTION 16000

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to the requirements of Division 1, which applies to and forms part of all sections of the work.
  - 1.2. DESCRIPTION OF SECTION
    - 1.2.1. The specification is divided into sections of work and a section may consist of the work of more than one subcontractor. The responsibility as to which electrical subcontractor provides labour, materials, equipment and services required to complete the work rests solely with the Electrical Contractor.
  - 1.3. SECTIONS AFFECTED
    - 1.3.1. These instructions apply to and form a part of all electrical sections.
  - 1.4. SCOPE
    - 1.4.1. Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.
    - 1.4.2. Should any discrepancy appear between any parts of the specifications and/or the drawings to cause doubt as to the true meaning and intent of the drawings and specifications, a ruling shall be obtained from the Engineer's Representative before submitting the tender. If this is not done the following will be assumed:
      - .1 Where a discrepancy occurs between the specification and the drawings, the drawings take precedence.
      - .2 Where a discrepancy occurs in the drawings the more expensive alternative will be deemed as included in the contract.
      - .3 Where a discrepancy occurs in the specifications the more expensive alternative will be deemed as included in the contract.
  - 1.5. REGULATIONS
    - 1.5.1. All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction.
    - 1.5.2. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Engineer's Representative.
  - 1.6. PERMITS, FEES REVIEW
    - 1.6.1. Make submissions to obtain all permits. Include for and pay for all fees and arrange for all reviews required for the work of this division.
    - 1.6.2. Furnish certificates of Acceptance from the electrical inspection department and authorities having jurisdiction and include them in the Operation and Maintenance manual.
  - 1.7. COORDINATION WITH MECHANICAL DIVISIONS.
    - 1.7.1. Determine exact location of starters, motors and line voltage controls based on the mechanical drawings to coordinate with the locations of all equipment to ensure the required clearances are maintained. If no wall location is suitable for the motor starters then mount the

- starters on a plywood backboard on unistrut supports near the respective equipment to meet the applicable code requirements for motor isolation switches. If a motor or piece of equipment is listed on one of the starter schedules but is not shown on the floor plans, the contractor is to reference the mechanical drawings for the location of the respective piece of equipment. No additional costs will be entertained.
- 1.7.2. Should the mechanical contractor change any of the motor or equipment sizes from those identified on the mechanical schedules and drawings at any stage of the project to aide their installation, the mechanical contractor will incur all extra electrical costs to revise the electrical feeders, breakers, starters and equipment to supply power to the revised piece of equipment.
- 1.8. PLYWOOD BACKBOARDS, EQUIPMENT MOUNTING, & HOUSEKEEPING PADS
- 1.8.1. Provide fire rated plywood backboards as shown on the drawings and mount where all communication equipment is to be wall mounted. Plywood is to be 21 mm (13/16 in.), be urea-formaldehyde (UF) free and be either Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) or CSA Z809-08 certified. Plywood to be either fire rated with the appropriate label displayed once installed or coated with fire retardant paint. All Certification not to be painted. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering
- 1.9. FINISHES
- 1.9.1. Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.
- 1.10. SAFETY
- 1.10.1. Protect exposed live equipment during construction for personnel safety.
- 1.10.2. Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- 1.10.3. Arrange for the installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of an electrician.
- 1.11. FIRE STOPPING
- 1.11.1. Provide fire stopping in accordance with front end documents and as describe herein. Contractor to coordinate fire stopping with General Contractor. All paints, coatings, sealants and adhesives shall meet the VOC limits in accordance with the LEED Specification sections. Submit documentation as a shop drawing for review by the LEED Representative prior to ordering
- 1.11.2. Fire stopping and smoke seal systems: in accordance with CAN4 S115 M85.
- .1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN4 S115 M85 and not to exceed opening sizes for which they are intended.
  - .2 Fire stop system rating for service penetrations: to suit Ontario Building Code 1997, 3.1.9.1 Fire Stopping of Service Penetrations.
  - .3 Fire stop system rating for sealing junction of rated walls to rated floors and ceilings: to suit Ontario Building Code.
- 1.11.3. Service penetration assemblies: certified by ULC in accordance with CAN4 S115 M85 and listed in ULC Guide No. 40 U19.
- 1.11.4. Service penetration fire stop components: certified by ULC in accordance with CAN4 S115 M85 and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.

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- 1.11.5. Fire resistance rating of installed fire stopping assembly not less than the fire resistance rating of surrounding floor and wall assembly, and in accordance with Ontario Building Code.
  - 1.11.6. Fire stopping and smoke seals at openings intended for ease of re entry such as cables: elastomeric seal; do not use cementitious or rigid seal at such locations.
  - 1.11.7. Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal; do not use a cementitious or rigid seal at such locations.
  - 1.11.8. Colour: if range available to Engineer's Representative's choice of standard colours, generally to match background colour where visible in finished spaces.
  - 1.11.9. Where holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
  - 1.11.10. Submit a complete fire stopping system shop drawing package, identifying the products that may be used on the project. Prior to submitting data, review with Authority having Jurisdiction to confirm acceptability of proposed materials and assemblies.
  - 1.11.11. Installation
    - .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
  
  - 1.12. CLEANING AND WASTE REMOVAL
    - 1.12.1. Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to review by Engineer's Representative and/or Owner.
    - 1.12.2. Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.
  
  - 1.13. SPRINKLERS
    - 1.13.1. All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type-2 sprinkler proof.
  
  - 1.14. TEMPORARY LIGHT AND POWER
    - 1.14.1. Temporary light and power for construction shall be provided, metered, and maintained by the electrical trade, as directed by the General Contractor; but each trade shall provide all extension cords, lamps, etc., required to complete their work.
    - 1.14.2. All temporary light to be fluorescent. Provide adequate lighting to meet all health and safety standards.
  
  - 1.15. EXAMINATION AND PROTECTION OF SITE
    - 1.15.1. Before submitting Bid, each trade shall examine the site to determine the conditions which may affect the proposed work. No claims for extra payment will be considered because of failure to fulfil this condition.
    - 1.15.2. When requested by the Owner and/or Engineer's Representative, the Contractor is to provide digital pictures of the site, including but not limited to progress of work and installed equipment, via e-mail to the Owner and/or Engineer's Representative.
  
  - 1.16. DRAWINGS AND INSTALLATION
    - 1.16.1. The drawings are intended to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.

- 1.16.2. The location, arrangement and connection of equipment and materials shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the Engineer's Representative to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
- 1.16.3. Certain details indicate on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.
- 1.16.4. The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced.
- 1.16.5. Changes and modifications necessary to ensure co-ordination and avoid interference and conflicts with other trades or to accommodate existing conditions, shall be made at no extra cost to the Owner.
- 1.16.6. Contractor is to review Architect/Interior Designer's specifications, drawings and details to confirm locations of devices and equipment.
- 1.16.7. This Contractor is responsible to mark-out his work, fully co-ordinated with all other trades, in sufficient time for review by Architectural/Interior Designer Engineer's Representative prior to rough-in. Prepare dimensioned layouts of each room prior to rough-in for review by Architectural/Interior Designer Engineer's Representative. Do not proceed with any work until the Architectural/Interior Designer Engineer's Representative has reviewed the layout drawings.
- 1.16.8. The Contractor will reimburse the Engineer's Representative for their time spent on answering any written questions or requests for information where the answer is clearly identified on the drawings or in the specifications.
- 1.17. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS
  - 1.17.1. Interference drawings are required for shafts, ceiling spaces, basement areas, typical floors and wherever there is possible conflict in the positioning of electrical equipment, piping, ductwork sub-trades or architectural/interior designing features.
- 1.18. APPROVED MANUFACTURERS
  - 1.18.1. Where only one name appears in the specification, the bid shall include for the specified equipment.
  - 1.18.2. Where two or more names are shown in the specifications as alternates or equal to, this division can select which manufacturer is to be carried.
- 1.19. PRODUCTS AND MATERIALS
  - 1.19.1. Make and quality of materials used in the construction of this project shall be subject to the approval of the Engineer's Representative.
  - 1.19.2. All equipment and material are to be CSA certified or approved by an accredited organization. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Authorities.
  - 1.19.3. Materials and equipment supplied by this division shall be new and free from defects and shall be equivalent in physical characteristics and performance to that specified by the manufacturer's name and catalogue reference.
  - 1.19.4. Where a certain manufacturer's equipment has been specified by name or model number, the contractor shall be responsible for ensuring that the performance and quality meets the

specified equipment and that the same access or maintenance space is available for an alternative manufacturer's equipment that is used and that interfacing connections with other trades can be made at no extra cost.

1.19.5. Within 30 days of the award of contract, the Contractor is to submit a complete list of the manufacturers for all equipment being supplied on the project.

1.19.6. Availability

- .1 In submitting Bid, Contractor warrants that all materials are available in suitable time to meet Contract dates.
- .2 Subject to sentence .3 below, where the Contractor advises that the Contractor cannot supply materials in suitable time to meet Contract dates, and should it subsequently appear that Work may be delayed for such reason, the Engineer's Representative reserves the right to substitute more readily available products of similar character, even if more costly to the Contractor, at no increase in Contract Price.
- .3 Where the Contractor can show that the Contractor promptly ordered the originally specified materials the Owner will pay the differential in cost between the originally specified material and the substitute material with out any mark-ups applicable by the Contractor, subcontractors, subsubcontractors or suppliers. For greater certainty, the Contractor's failure to submit shop drawings or other submittals or seek direction in those instances where the Contract Documents so require in sufficient time to permit ordering materials is not cause for the Owner to pay the cost differential in sentence .2 above.

1.20. CO-OPERATION WITH OTHER DIVISIONS

- 1.20.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.20.2. Electrical conduits shall not touch or be supported on pipe or duct walls.
- 1.20.3. The supply of all items is to have built-in to the delivery schedule, ample time for rapid progress of work. Proceed with work determined by the construction schedule.

1.21. TEMPORARY USE OF EQUIPMENT

- 1.21.1. Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.
- 1.21.2. Before any area of the building is turned over to the Owner for acceptance and for beginning of the guarantee/warranty period, the systems and equipment shall be returned to the initial new condition.
- 1.21.3. Permanent electrical equipment is only to be used upon permission of Owner and Engineer's Representative and is only to be used on a limited basis. All equipment must be cleaned prior to turnover.

1.22. STATEMENT OF PRICES

- 1.22.1. To form a basis for progress payments the successful bidder shall submit a sample progress draw for the various portions of the work, including both labour and materials. The total price of all portions of the work shall equal the total price of the work covered under the electrical division. Cost for as-builts and manuals to be carried as a separate line item.
- 1.22.2. Contractor to list and track all cash allowances on separate lines on the progress draw.
- 1.22.3. Contractor to list and track each of the approved changes on separate lines on the progress draw.

- 1.22.4. Costs of temporary facilities and utilities shall be amortized over the duration of the Work. Claims for 'mobilization', 'bidding costs', or similar lump sums at or before start of work are not acceptable.
- 1.23. INTERRUPTION OF SERVICES
- 1.23.1. Any interruption of the electrical services to any part of the building shall come at a time agreeable to the Engineer's Representative. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- 1.23.2. All such overtime work shall be carried out without additional cost to the Owners.
- 1.23.3. Modifications to existing electrical equipment, which will require shutdown, must be coordinated with the Owner and will only be permitted on weekdays from 10:00 pm to 6:00 am and on weekends from Friday at 7:00 pm to Sunday 6:00 pm. Exact weekends to be co-ordinated with the Owner. Consecutive weekends of shutdowns will not be allowed. Contractor to pay for all Hydro costs associated with shutdowns. Any work not associated with live equipment can be done during normal working hours. Work considered disruptive to the normal operation of the building will be done after normal business hours. Exact times to be co-ordinated with Owner.
- 1.23.4. Contractor to provide a minimum of 5 days written notice of a requirement for a shutdown. Contractor to include for separate meetings with the Owner and Engineer's Representative to discuss the shutdown in detail and to coordinate all the work being performed.
- 1.23.5. The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required the disconnections and connections to existing buildings. This includes shutting down and isolating existing low and medium voltage services. The owner will not perform any isolations for the contractor but will be present during the work. The contractor is to use qualified personnel for these shutdowns ensuring compliance with all applicable safety requirements.
- 1.23.6. The Contractor is responsible for any damages caused to existing systems when making connections.
- 1.23.7. The Contractor is to keep shutdowns of existing buildings to a minimum by scheduling the work and providing the required number of personnel to keep the shutdown to a minimum. This Contractor is to include for as many multiple teams of electricians as is feasible to keep the shutdown work to a minimum.
- 1.24. VALUATION OF CHANGES
- 1.24.1. Further to contract requirements, the method to be used in determining the value of a change to the Work, by either Change Order or Change Directive, shall be:
- .1 Estimate and acceptance in a lump sum, unless the Engineer's Representative otherwise determines that the method shall be unit prices set out in the Contract.
- 1.24.2. Contractor shall provide the Engineer's Representative with a detailed cost analysis of the contemplated change indicating:
- .1 Quantity of each material.
  - .2 Unit cost of each material.
  - .3 Time involved.
  - .4 Sub-trade quotations including a complete analysis of costs.
  - .5 Mark-ups, if applicable.
  - .6 Value of GST or HST, as applicable.



.7 Proposed change in Contract Time.

The detailed cost breakdown is to list material and labour separately for each item on the proposed change. The breakdown for contemplated change is to follow the format of the attached document.

1.24.3. The following shall not be included in the cost of the work but are covered by the allowance (mark-ups) for overhead and profit:

- .1 The Contractor's head office and site office expenses, including stationary, postage and other office supplies.
- .2 The costs of the Contractor's Project Manager, clerical and administrative personnel, and executive personnel.
- .3 Use of temporary offices, sheds, small tools, etc., including the cost of telephone, light, power, water and heat used therein,
- .4 Transportation and overnight room expenses for out of town labour, if local labour is unavailable.
- .5 Insurance premiums.
- .6 Licenses and permits, except when these are special for a particular item of work.
- .7 Printing charges for Proposed Changes, Change Orders and Drawings for Contractor's and Subcontractors' use in the work. Engineer's Representative will provide one copy of change notice documentation and in the event of re-issue of full size drawings will provide one print.
- .8 The cost of record drawings and shop drawings.
- .9 The cost of clean up and disposal of waste material.
- .10 Parking.

1.24.4. The Contractor shall not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under CCDC2-2008.

1.24.5. The maximum percentage fee for mark-ups shall be as stated below.

1.24.6. In computing accounts for extras and credits for any Proposed Change, all credits shall be deducted from the total sum of the extras before mark-ups or charges for overhead and profit are added.

1.24.7. The Contractor shall inform the Surety Company or Companies who have issued any bonds for this Contract, and any Insurers who have insured any part of the work or operations or who have an interest in this Contract, of all changes in the Contract. Pay all costs of any changes in bonds or insurances required to maintain bonds or insurances in conformance with the requirements of the Contract Documents. Provide Owner immediately with any revised bonds or insurances.

1.24.8. Special equipment rental rates will be charged at cost. Invoices to be provided.

1.24.9. Permitted Mark-Ups

.1 The following maximum net overhead and profit mark-ups by Contractors will be permitted for extra work under Change Order or Change Directive:

Cost of Extra Work, not including GST or HST, as applicable	Contractor's Mark-Up on Work of Own Forces (%)	Contractor's Mark-Up on Subcontracted Work (%)
\$0 to \$5,000	10	7
>\$5,000 to \$10,000	10	7
>\$10,000 to \$50,000	7	5
>\$50,000	5	4

- .2 The following maximum net overhead and profit mark-ups by Subcontractors will be permitted for extra work:

Cost of Extra Work, not including GST or HST, as applicable	Contractor's Mark-Up on Work of Own Forces (%)	Contractor's Mark-Up on Subcontracted Work (%)
\$0 to \$5,000	10	7
>\$5,000 to \$10,000	10	7
>\$10,000 to \$50,000	7	5
>\$50,000	5	4

- .3 Where a proposed change order includes both credits and extras, overhead and profit mark-ups apply to the net extra or credits, if any, of the entire change.

- 1.24.10. All changes, change notices, revisions to contract, site instructions, change directives or any additional costs or deletes to the stipulated lump sum contract price are subject to review and scrutiny by a qualified third party or individual.

1.24.11. Labour Rate

- .1 During the duration of the electrical contract, extra work hourly labour units are to be based on the latest edition of the National Electrical Contractors Association (NECA) labour units column 1(one). No additional factors will be accepted.
- .2 The hourly labour rate for all changes will be based on a Journeyman Electrician rate. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be exclusive of overhead and profit. The labour rate will be inclusive of all labour burden charges including: payroll and administrative burdens, all government payroll burdens, variable labour factors and union or association funds. The following labour burdens are not part of the hourly labour cost and are covered under overhead and mark-up or under the NECA labour unit rates: all supervision, hand tools, warranties, storage, rentals, parking, clean-up, additional bonding, as-built drawings, material sorting/handling/hoisting, project financing, coffee break/rest periods, safety training including safety talks, WHMIS and the health and safety committee, non-productivity time and site office and consumables.
- .3 At the request of the Owner or the Engineer's Representative, the Contractor is to submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate to show how the Contractor has come to the proposed hourly rate. The Owner and the Engineer's Representative reserve the right to negotiate the hourly labour rate with the Contractor.

## PROPOSED CHANGE ORDER

Company Name:	CCN #
Address:	Date:
City, Prov.:	Project Name:
Postal Code:	Project Number:
Telephone:	Page Number:
Fax:	Change Order #:
E-Mail address:	
Client Address:	

### Work Description

We reserve the right to correct this quote for errors and omissions.  
 This quote covers direct costs only.  
 This price is good for acceptance within 30 days from the date of receipt.

### Itemized Breakdown

<u>Description</u>	<u>Qty</u>	<u>Net Price U</u>	<u>Total Mat(\$)</u>	<u>Labor U</u>	<u>Total Hours</u>
¾' EMT		150.39 C		5.00 C	
¾' EMT STL SS CONN		65.97 C		10.00C	
¾' EMT STL SS CPLG		70.60 C		5.00 C	
¾' EMT STRAO 1-H		11.24 C		4.00 C	
#8 TO 10 x 7/8" PLAS ANCHOR (3/16)		6.05 C		5.00 C	
#10 x 1" SELF TAPPING SCREW		5.50 C		5.5 0 C	
<b>TOTALS</b>					

### Summary

<u>Description</u>	<u>Total Hours</u>
General Materials	
Material Tax (@ 15.000 %)	
<b>Material Total</b>	
JOURNEYMAN (xx Hrs. @ \$xx.00)	
Subtotal	
<b>OVERHEAD AND MARK-UP</b>	
Overhead/Mark-up (@ 10.000 %)	
Subtotal	

### Final Amount

1.25. DEMOLITION

- 1.25.1. The demolition drawings show the general scope of the demolition and not exact details or total extent. For exact details and total extent each service must be carefully checked on site. Before removing services follow the service through to ensure other areas of the building are not affected.
  - 1.25.2. Whenever existing services or equipment are to be removed, all electrical connections for such services shall be removed and securely terminated in an approved manner. If necessary to facilitate installation of new work, any existing services and equipment shall be removed and then replaced by this division.
  - 1.25.3. Whenever it becomes necessary to relocate any electrical services equipment to make possible installation of the work under this contract, such relocation shall be done by this division without additional cost to the Owner.
  - 1.25.4. Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate with the demolition.
  - 1.25.5. Ensure that all electrical, life safety services, and services for existing equipment, in areas outside the areas of this work, that are required to remain in service, shall do so.
  - 1.25.6. Relocate any electrical feeders or equipment that are required to remain in service, that are secured to existing walls, floors or ceilings to be demolished or that are buried and required to be excavated for new work.
  - 1.25.7. Remove and replace any electrical equipment on walls or ceilings that will be demolished and rebuilt.
  - 1.25.8. Disconnect and remove existing light fixtures, devices, outlets, CCTV, security devices, etc. which are not to be reused by the Owner. Cut back and cap unused raceway and outlets and remove unused wiring back to panelboard in an approved manner.
  - 1.25.9. Ensure that all existing equipment which is to be reused and/or relocated is thoroughly inspected and refurbished to ensure correct operation when put back into service and to meet the requirements of the local authorities having jurisdiction. All existing electrical equipment which is no longer required shall be removed and disposed of off site.
  - 1.25.10. Carry out the work with a minimum of noise, dust and disturbance.
  - 1.25.11. Where a device is shown to be relocated on the drawings, contractor to remove and re-install device and back box and re-feed the device with new conduit and wire from the nearest existing accessible junction box.
  - 1.25.12. Electrical Contractor is responsible for the patching and re-painting the entire wall where a device and/or box has been added, removed or relocated.
  - 1.25.13. All shutdowns of existing base building systems shall be coordinated with the landlord or his representative at least 3 working days in advance.
  - 1.25.14. Provide all cleanup, lifting, storage, cutting, patching and flashing as required. Remove all excess debris, material and equipment from site.
  - 1.25.15. The existing building must be kept in operation at all times. Assume full responsibility for any disruption to existing services. Arrange work in such a manner that interruptions in services occur only at pre-scheduled times.
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2. Products
  - 2.1. NOT USED

3. Execution

- 3.1. NOT USED  
END OF SECTION 16010

1. General

1.1. WORK INCLUDED

1.1.1. Refer to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. RECORD DRAWINGS

2.1.1. The Electrical Contractor shall request in writing from the Engineer's Representative all electrical AutoCAD drawings. Contractor to complete attached form and pay the Engineer's Representative directly the costs identified within the form prior to receiving the drawings. After the final as-built drawings have been reviewed, provide multiple copies of the drawings on CD or DVD. One copy is to be returned to the Engineer's Representative for their records and a minimum of one copy with each set of maintenance manuals. Provide additional copies if required under the General Conditions. The Contractor is to use latest release of AutoCAD software.

2.1.2. The contractor to identify the cost of Record Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The following values are to be broken out:

\$1,000	Minimum Electrical Contracts
\$2,000	For Electrical Contracts up to \$100,000
\$5,000	For Electrical Contracts up to \$250,000

The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are approved.

2.1.3. Final as-built prints/plots shall not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.). References to the Architect/Interior Designer and Engineer must be deleted from the drawings.

2.1.4. Final as-built drawings to include all revisions made to the drawings during construction, including all approved change. The as-built drawings are to also include the routing of all feeders except for branch circuits, all junction boxes to be shown, drawing legend to be updated to include all symbols and lines used for as-builts, quantity of wires in each conduit, and circuit numbers of wires in each conduit. Include slab layout drawings in as-built drawing package.

2.1.5. CADD files are for the Contractor to update to produce as-built drawings for Engineer's Representative review.

3. Execution

3.1. NOT USED

END OF SECTION 16030

PROJECT NAME: Xxx

ATTENTION: Xxx

PROJECT NO.: Xxx

DATE: YYYY-MM-DD

ISSUED BY: Xxx

### Conditions for Limited Use of CAD Drawings

Authorization for limited use of the Computer-Aided Drafting (CAD) drawing files listed below is hereby granted, subject to the following conditions. Signing of this form constitutes acceptance and agreement with the conditions and limitations.

Copyright is reserved. The drawing and design contained in the CAD drawing file is at all times the exclusive property of the Architect/Engineer and shall not be used without the Architect/Engineer's written consent.

The CAD drawing file may not be used wholly or in part for any purpose other than the intended use as stated on this form. Copying or distribution of this CAD drawing file in whole or in part to parties other than those signing below is not allowed.

The CAD file represents drawings which were prepared primarily for the purpose of obtaining tender prices. The drawings may or may not incorporate subsequent revisions, change orders, or addenda which have modified the drawings. CAD files obtained from different disciplines may not be fully updated and coordinated with other disciplines and must be verified from the tender documents. The Architect/Engineer assumes no liability for errors or omissions in the CAD drawing files. Authorized user assumes all risk and expense associated with the use of the drawing files in the production of his work.

References to the Architect and Engineer must be deleted from the drawings.

Please indicate a P.O. Number for charges associated with administrative costs to provide requested AutoCAD drawings.

Our charges are as follows:	\$50.00 each for the first 5 drawings		
	\$20.00 for each additional drawing from 6 to 19		
	\$500.00 for 20 drawings or more		
List of requested drawings:			
Total No. of Drawings:		Total Charge:	+ GST or HST, as applicable

Intended use (Shop drawings, As-built drawings, Installation and Interference drawings, etc.)

CD ROM disc (please provide delivery address)

E-mail (please provide e-mail address)

A cheque in the above amount shall be payable to **Smith + Andersen**.

Please sign and fax back this form to Smith + Andersen (416-487-9104) acknowledging the above charges and Conditions for Limited Use of CAD Drawings.

Accepted by:

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Name (print or type)

\_\_\_\_\_  
Company Name

\_\_\_\_\_  
P.O. #

\_\_\_\_\_  
Company Address

\_\_\_\_\_  
Phone #

c.c. Accounting - D. Khan; (Project Principal) – Smith + Andersen

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
  - 2.1. SHOP DRAWINGS
  - 2.2. "SECTION 01340" SHALL APPLY EXCEPT AS AMENDED BELOW.
    - 2.2.1. Submittals/Shop Drawings shall indicate clearly the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each Shop Drawing shall give the identifying number of the specific assembly for which it was prepared (e.g. MCC-1).
    - 2.2.2. Each Shop Drawing for non-catalogue items shall be prepared specifically for this project. Shop Drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
    - 2.2.3. Each Shop Drawing or catalogue sheet shall be stamped and signed by the Contractor to indicate that he has checked the drawing for conformance with all requirements of the drawings and specifications, that he has co-ordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that electrical co-ordination is complete before submitting drawings for review.
    - 2.2.4. Contractor to submit all submittals/shop drawings electronically in PDF format. Submittal to come complete with a transmittal bound to the PDF file with the transmittal identifying the total number of pages in the submittal including the transmittal page. For any submittal with pages larger than 11x17, the Contractor is to submit a minimum of 3 hard copies unless additional copies are identified in the contract documents.
    - 2.2.5. Installation of any equipment shall not start until after final review of Shop Drawings by the Engineer's Representative has been obtained.
    - 2.2.6. One original Shop Drawing will be returned either hard copy or electronically. All copies required for the trades, suppliers or other Engineer's Representatives will be copied or printed by the Contractor.
3. Execution
  - 3.1. NOT USED  
END OF SECTION 16031



1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
  - 2.1. MATERIALS
    - 2.1.1. Sleeves passing through stud partitions shall be 0.75 mm (1/32 in.) 22 US Gauge steel.
    - 2.1.2. Sleeves passing through masonry walls shall be Schedule 40 steel pipe.
    - 2.1.3. Sleeves passing through floors in finished areas and concealed spaces may be sheet metal or factory fabricated reusable type.
    - 2.1.4. Sleeves passing through floors in electrical rooms, mechanical rooms, garages or other similar rooms in all areas except slab on grade, shall extend 50 mm (2 in.) above the housekeeping pad and shall be Schedule 40 steel pipe.
    - 2.1.5. Where conduits pass through exterior foundation walls 6 mm (1/4 in.) thick steel sleeve of inside diameter not less the 75 mm (3 in.) greater than the outside diameter of the pipe shall be used and shall be complete with anchor collar. Thunderline Link-Seal wall seal as distributed by Corrosion Service Co. Ltd. shall be used for the annular space between the sleeve and the conduit. A reinforced concrete bridge shall be installed between the wall and the adjacent undisturbed soil.
    - 2.1.6. Provide adequate bracing for support of sleeves during concrete and masonry work.
3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. Arrange for all chases and formed openings in walls and floors as required by the Electrical Division for the Electrical services. These chases and openings shall not be larger than necessary to accommodate the equipment and services. Advise on these requirements well in advance, before the concrete is poured and the walls are built. All necessary sleeves and inserts shall be supplied by this Division.
    - 3.1.2. Chases and openings not located in accordance with the above provisions shall be made at the expense of this Division. Cutting of structural members shall not be permitted without specified written acceptance of the Engineer's Representative.
    - 3.1.3. Provide sleeves for all service penetrations through walls, partitions, floor slabs, plenums and similar barriers. At non-rated barriers fill the annular space between the service and the sleeve with fire rated insulation as specified for rated separations and caulk around the edges with a minimum 12 mm (1/2 in.) thick of fire rated compound or acoustic non-setting mastic.
    - 3.1.4. Through all fire or smoke separations, after testing, the annular space between conduit sleeves shall be fire stopped.
    - 3.1.5. Where holes are to be installed in existing structure, contractor is to core drill the holes required. Contractor is required to scan all areas prior to coring and confirm layout with structural engineer prior to completing work. When installing sleeves in existing structures,

sleeves shall be provided as specified complete with a combination puddle/anchor flange bolted to the floor. Seal watertight between the flange and the floor.

END OF SECTION 16052

1. General
- 1.1. WORK INCLUDED
- 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

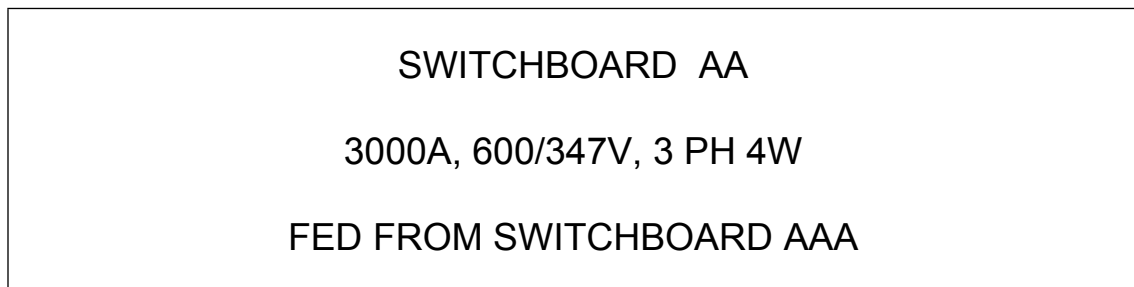
2.1. EQUIPMENT IDENTIFICATION

2.1.1. Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates:

- .1 Lamacoid 3 mm (1/8 in.) thick plastic engraved sheet, black or red face, white core, mechanically attached with self tapping screws.
- .2 White letters 20 mm (3/4 in.) high for major switchboards, panelboards and power transformers.
- .3 White letters 12 mm (1/2 in.) high for terminal boxes, junction boxes, grid boxes, splitter boxes, disconnect switches starters and contactors.
- .4 Allow for an average of twenty-five (25) letters per nameplate.
- .5 Identification to be in English.
- .6 Black nameplates for normal power.
- .7 Red nameplates for emergency power.
- .8 Blue nameplates for UPS Power.

Sample:



.2 Labels:

- .1 Embossed plastic labels with 6 mm (1/4 in.) high letters unless specified otherwise, for internal components, such as relays, fuses, terminal blocks.
- .2 Wording on nameplates to be approved by Engineer's Representative prior to manufacture.
- .3 Identification to be in English.
- .4 Nameplates for terminal cabinets, grid boxes pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Transformers: indicate capacity, primary and secondary voltages.

2.1.2. Equipment identification to be permanently fastened to the respective equipment with rivets.

2.2. WIRING IDENTIFICATION

2.2.1. Identify wiring with permanent legible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.

2.2.2. Maintain phase sequence and colour coding throughout.

2.2.3. Colour code: to CSA C22.1-2012.

2.3. CONDUIT AND CABLE IDENTIFICATION

2.3.1. Colour code conduits, boxes and metallic sheathed cables.

2.3.2. Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m (50 foot) intervals.

2.3.3. Colours: 25 mm (1 in.) wide prime colour and 20 mm (3/4 in.) wide auxiliary colour.

	<b>Colour</b>
up to 250 V Normal Power	Green
up to 600 V Normal Power	Blue
up to 250 V Emergency Power	Black
up to 600 V Emergency Power	Orange
Medium Voltage	Large independent label clearly identifying the voltage
Telephone/Data	White
Fire alarm	Red
Other security systems	Yellow
Controls	Purple

2.4. RECEPTACLE IDENTIFICATION

2.4.1. All receptacles are to be labelled with the respective circuit numbers with a printed label, similar to a Brady label, with 12mm characters. Circuit number to include full circuit number including panel board identification.

2.4.2. Label to be placed on cover plate. Location of label to be consistent throughout project.

2.5. WIRING TERMINATION

2.5.1. Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

2.5.2. Lugs, terminals, screws used for termination of multiple wires must be rated for their intended use.

2.6. WARNING SIGNS

2.6.1. Provide warning signs, as specified, and/or to meet the requirements of the Inspection Authorities.

2.7. FUSE SIZE LABELLING

2.7.1. Contractor to install a label on all equipment with fuses to identify the fuse sizes that are installed in the respective equipment.

2.7.2. Contractor to also install a label on all equipment with fuses to identify the maximum allowable fuse size based on the size of the respective feeders.

3. Execution

3.1. NOT USED  
END OF SECTION 16056

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
  - 2.1. MOUNTING HEIGHTS
    - 2.1.1. Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
    - 2.1.2. If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
    - 2.1.3. Install electrical equipment at following heights unless indicated otherwise.
      - .1 Local switches: 1050 mm (41-5/16 in.).
      - .2 Wall receptacles:
        - .1 General: 450 mm (18 in.).
        - .2 Above top of continuous baseboard heater: 200 mm (8 in.).
        - .3 Above top of counters or counter splash backs: 175 mm (7 in.).
        - .4 In mechanical rooms: 1200 mm (48 in.).
      - .3 Panelboards: 2000 mm (80 in.) to top of panel.
      - .4 Telephone and interphone outlets: 450 mm (18 in.).
      - .5 Wall mounted telephone and interphone outlets: 1050 mm (41-5/16 in.).
      - .6 Fire alarm stations: 1200 mm (48 in.).
      - .7 Wall Mounted Fire alarm bells: 2300 mm (90 in.).
      - .8 Television outlets: 450 mm (18 in.).
      - .9 Wall mounted speakers: 2100 mm (83 in.).
      - .10 Clocks: 2100 mm (83 in.).
      - .11 Handicap pushbuttons: 1050 mm (41-5/16 in.).
      - .12 Wall mounted Exit Signs
        - .1 For 2400 mm (95 in.) to 2500 mm (100 in.) ceiling areas: 2100 mm (83 in.).
        - .2 For all ceilings greater than 2500 mm (100 in.) ceiling areas: 2400 mm (95 in.).
      - .13 Wall mounted Battery Packs and Emergency Heads
        - .1 For 2400 mm (95 in.) to 2500 mm (100 in.) ceiling areas: 2100 mm (83 in.).
        - .2 For all ceilings greater than 2500 mm (100 in.) ceiling areas: 2400 mm (95 in.).
      - .14 Wall mounted occupancy sensors: 1050 mm (41-5/16 in.).
      - .15 Wall mounted visible signal devices: entire lens shall be no less than 2000 mm (79 in.) and no more than 2400 mm (95 in.)
      - .16 Top of remote annunciator and passive graphic panels shall be no more than 1800mm (72 in.) above finished floor

3. Execution

3.1. NOT USED  
END OF SECTION 16057

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.1.2. Comply with all requirements of Section 16030 – RECORD DRAWINGS.
    - 1.1.3. Comply with all requirements of Section 16031 – SHOP DRAWINGS.
2. Products
  - 2.1. NOT USED
3. Execution
  - 3.1. REQUIREMENTS FOR MANUALS
    - 3.1.1. A minimum of three copies of complete and approved operating and maintenance instructions for all electrical equipment and systems shall be supplied before substantial completion. Provide additional copies if required under the General Requirements. In addition to the three copies of manuals, the contractor to provide a manual in a searchable PDF format on CD. As-Built Drawings to be included on the CD.
    - 3.1.2. The contractor to identify the cost of Record Drawings and the Operation and Maintenance Manuals as a separate line item on their progress draw. The values to be broken out can be found in Section 16030 – Record Drawings. The project will remain incomplete and no money will be released until the final versions, both hard and electronic, of the drawings and manuals are received and reviewed without comments.
    - 3.1.3. Binders shall be three-ring, hard-cover, loose-leaf type and identified on the binding edges as “Maintenance Instructions and Data Book”, for “(Project Name)”.
    - 3.1.4. Terminology used in all the sections shall be consistent.
    - 3.1.5. Volume One shall contain the master index of all systems, the name of the Contractor, Electrical Subcontractors and the date of substantial performance for the Contract.
    - 3.1.6. Volume One shall contain a section with all necessary warranty information.
    - 3.1.7. Each binder shall have a complete index for all volumes.
    - 3.1.8. Each binder shall be no more than half filled.
    - 3.1.9. There shall be a separate section for all materials used on the project which fall under the WHMIS legislation. There shall be a hazard data sheet for each of the materials.
    - 3.1.10. There shall be a separate section for all Insurance Certificates, Test Certificates, Verification Forms and Test Forms.
    - 3.1.11. All relevant information relating to a system or product shall be contained within one binder.
    - 3.1.12. The manual sections shall follow the specification sections.
    - 3.1.13. Any diagrams, installation drawings, single line diagrams charts, etc. shall be mechanically reduced while maintaining full legibility to standard page size. If this cannot be achieved they shall be carefully folded and contained within a clear plastic wallet within the manual.



### 3.2. DATA FOR MANUALS

#### 3.2.1. Equipment data shall contain:

- .1 Operating instructions.
- .2 Operating conditions such as temperature and pressure.
- .3 Location of equipment.
- .4 Maintenance instructions and schedules for one year routine.
- .5 Recommended list of spare parts.
- .6 Maintenance schedule.
- .7 A trouble shooting table showing where to look for problems under various conditions of malfunction.
- .8 All wiring diagrams.
- .9 Equipment operating curves.
- .10 Equipment nameplate data and serial numbers.

#### 3.2.2. System data shall contain:

- .1 A listing of all systems.
- .2 All panel, mcc and fire alarm schedules and locations.
- .3 Equipment name tags.
- .4 Cleaning, maintaining and preserving instructions for all material, products and surfaces. Include warnings of harmful cleaning, maintaining and preserving practices.

#### 3.2.3. Sub-Contractor manuals are required for:

- .1 Switchboards and power distribution systems.
- .2 Lighting systems.
- .3 Emergency power systems.
- .4 Fire alarm systems.

#### 3.2.4. As-Built documentation shall contain:

- .1 Reviewed As-Built Shop Drawings.
- .2 As-Built Construction Drawings.
- .3 Originals of test forms.
- .4 Originals of test certificates.

### 3.3. OPERATING INSTRUCTIONS

3.3.1. Instruct the Owner's representative in all aspects of the operation and maintenance of systems and equipment.

3.3.2. Arrange for and pay for the services of engineers and other manufacturers representatives required for instruction on the systems and the equipment as requested by the Engineer's Representative and/or the Owner.

3.3.3. At the time of final review, provide a sheet for each system and piece of equipment showing the date instructions were given. Each sheet shall show the duration of instruction, name of persons receiving instruction, other persons present (manufacturer's representative, Engineer's Representative, etc.), system or equipment involved and signature of the Owner's staff stating that they understood the system installation, operating and maintenance requirements. This information shall be inserted in the manuals after all instructions have been completed.

- 3.3.4. Review information with the Owner's representative to ensure that all information required has been provided.
- 3.3.5. END OF SECTION 16061

1. General
    - 1.1. WORK INCLUDED
      - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
      - 1.1.2. Include for all cutting and patching for all Electrical services.
  2. Products
    - 2.1. NOT USED
  3. Execution
    - 3.1. INSTALLATION
      - 3.1.1. Cut all openings no larger than is required for the services. Core drill for individual services.
      - 3.1.2. Obtain approval from the structural consultant before cutting or core drilling any openings or holes.
      - 3.1.3. Patch all openings after services have been installed to match the surrounding finishes.
      - 3.1.4. In existing areas all cutting, core drilling for individual services, is part of this division work.
      - 3.1.5. The cost of cutting, patching and finishing is included in this division contract.
- END OF SECTION 16080

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.1.2. Section 16131 - SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
    - 1.1.3. Section 16132 - OUTLET BOXES, CONDUIT BOXES AND FITTINGS
  - 1.2. REFERENCES
    - 1.2.1. Canadian Standards Association (CSA)
      - .1 CAN/CSA C22.2 No.18- Outlet Boxes, Conduit Boxes, and Fittings.
      - .2 CSA C22.2 No.45- Rigid Metal Conduit.
      - .3 CSA C22.2 No.56- Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
      - .4 CSA C22.2 No.83- Electrical Metallic Tubing.
      - .5 CSA C22.2 No.211.2- Rigid PVC (Unplasticized) Conduit.
      - .6 CAN/CSA C22.2 No.227.3- Flexible Nonmetallic Tubing.
      - .7 CSA C22.2 No.227.1 - Electrical Non-Metallic Tubing
2. Products
  - 2.1. CONDUITS
    - 2.1.1. Rigid metal conduit: to CSA C22.2 No.45, galvanized steel or aluminum threaded.
    - 2.1.2. Epoxy coated conduit: to CSA C22.2 No.45, with zinc coating and corrosion resistant epoxy finish inside and outside.
    - 2.1.3. Electrical metallic tubing (EMT): to CSA C22.2 No.83, with couplings.
    - 2.1.4. Rigid PVC conduit: to CSA C22.2 No.211.2.
    - 2.1.5. Flexible metal conduit: to CSA C22.2 No.56, steel or liquid-tight flexible metal.
    - 2.1.6. Electrical non-metallic tubing (ENT): to CSA C 22.2 No. 227, with couplings.
  - 2.2. CONDUIT FASTENINGS
    - 2.2.1. One hole steel straps to secure surface conduits NPS 2 and smaller. Two hole steel straps for conduits larger than NPS 2.
    - 2.2.2. Beam clamps to secure conduits to exposed steel work.
    - 2.2.3. Channel type supports for two or more conduits at 1 m oc.
    - 2.2.4. Hot dipped galvanized threaded rods, 6 mm (1/4 in.) dia. minimum, to support suspended channels.
  - 2.3. CONDUIT FITTINGS
    - 2.3.1. Fittings: manufactured for use with conduit specified. Coating: same as conduit.
    - 2.3.2. Factory "ells" where 90 bends are required for 1" and larger conduits when a hydraulic bender is not used.

- 2.3.3. Connectors, couplings and straps for EMT conduit are to be set-screw steel type or cast. In a sprinklered environment, provide watertight fittings and "O" rings on all vertical conduit runs or when conduit is terminated at any piece of electrical equipment.
- 2.3.4. Provide plastic bushings for all connectors, rigid nipples and rigid conduit 1-1/4" or larger.
- 2.4. EXPANSION FITTINGS FOR RIGID CONDUIT
  - 2.4.1. Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm (3/4 in.) deflection in all directions.
- 2.5. FISH CORD
  - 2.5.1. Fish cord to be made of polypropylene.
- 3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
    - 3.1.2. Conceal conduits except in mechanical and electrical service rooms or in unfinished areas. Conduits to have their own support system and are to be supported independently of the ceiling grid or ceiling support system.
    - 3.1.3. Use electrical metallic tubing (EMT) conduit except where specified otherwise.
    - 3.1.4. Use rigid galvanized steel threaded conduit where conduit is subject to mechanical injury.
    - 3.1.5. Use rigid PVC conduit underground or in corrosive areas and where indicated.
    - 3.1.6. Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.
    - 3.1.7. Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations. Use only liquid tight fittings when using liquid tight flexible metal conduit. Liquid tight flexible metal conduit to have a jacket with an FT6 rating when used in plenums otherwise provide a minimum FT4 rating.
    - 3.1.8. Install EMT conduit from a raised floor branch circuit panel to junction box in sub-floor. Run flexible metal conduit from junction box to outlet boxes for equipment connections in sub-floor.
    - 3.1.9. Install fish cord in empty conduits.
    - 3.1.10. Run two 27mm (1") spare conduits up to ceiling space and two 27mm (1") spare conduits down to sub-floor space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm (6 in. x 6 in. x 4 in.) junction boxes or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.
    - 3.1.11. All cutting and patching of masonry/concrete floors, walls, and roof for electrical services shall be by this Division. Obtain approval from the Landlord and/or structural consultant before cutting any structural walls or floors. Cutting and drilling shall only be at times allowed by the Landlord. Check and verify the location of existing mechanical and electrical services in walls and below the floor slab in all areas requiring core drilling and cutting. Protect all tenant areas where core drilling occurs. Carefully chip top and bottom of slab to expose rebars to minimize cutting of rebars when core drilling. Provide x-ray study before drilling or cutting where required by the Landlord and/or structural consultant.

- 3.1.12. Provide sleeves for all new conduits passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.
- 3.1.13. Where cables and conduits pass through partitions and through floors that are not fire rated, provide an air-tight seal around the cables and conduits.
- 3.1.14. Where cables and conduits pass through floors and fire rated walls, pack space between conduit (or cable) and sleeve with an approved fire stop as specified in Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

### 3.2. SURFACE CONDUITS

- 3.2.1. Run parallel or perpendicular to building lines.
- 3.2.2. Group conduits wherever possible on suspended or surface mounted channels.
- 3.2.3. Do not pass conduits through structural members, except as indicated.
- 3.2.4. Conduits must not be used to support other conduits.

### 3.3. CONCEALED CONDUITS

- 3.3.1. Run parallel or perpendicular to building lines.
- 3.3.2. Do not install horizontal runs in masonry walls.
- 3.3.3. Do not install conduits in terrazzo or concrete toppings.

### ~~3.4. CONDUITS UNDERGROUND~~

- ~~3.4.1. Slope conduits to provide drainage.~~
- ~~3.4.2. For all non-PVC conduits run underground, provide waterproof joints with heavy coat of bituminous paint.~~

END OF SECTION 16111

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. REFERENCES
    - 1.2.1. CSA C22.2 No.0.3, Test Methods for Electrical Wires and Cables, latest edition.
    - 1.2.2. CSA C22.2 No. 38, Thermoset-Insulated Wires and Cables, latest edition.
    - 1.2.3. CSA-C22.2 No. 51, Armoured Cables, latest edition.
    - 1.2.4. CSA C22.2 No. 75, Thermoplastic-Insulated Wires and Cables, latest edition.
    - 1.2.5. CSA-C22.2 No. 123, Metal Sheathed Cables, latest edition.
    - 1.2.6. CSA-C22.2 No. 124, Mineral-Insulated Cable, latest edition.
    - 1.2.7. CSA-C22.2 No. 131, Type TECK 90 Cable, latest edition.
    - 1.2.8. CSA-C22.2 No. 174, Cables and Cable Glands for Use in Hazardous Locations, latest edition.
    - 1.2.9. CAN/ULC S139, Standard Method of Fire Test for Evaluation of Integrity of Electrical Power, Data, and Optical Fibre Cables, latest edition.
    - 1.2.10. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers, latest edition.
  - 1.3. PRODUCT DATA
    - 1.3.1. Submit product data in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
  - 2.1. BUILDING WIRES
    - 2.1.1. Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
    - 2.1.2. Contractor to provide copper conductors on conductors sizes up to and including #8AWG. Contractor to provide copper conductors for sizes larger than #8AWG unless identified as aluminium or NUAL on the drawings.
    - 2.1.3. All conductors to have size as indicated, with insulation of chemically cross-linked thermosetting polyethylene material rated RW90, T-90 or RWU90 to CSA-C22.2 No.38 rated as follows:
      - .1 Insulation rated at 1000V for 600V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current
      - .2 Insulation rated at 600V for the other 600V and 347/600V distribution systems not covered under item #1 above.
      - .3 Insulation rated at 600V for all systems rated at 480V and less.
    - 2.1.4. All aluminium or NUAL conductors to be an aluminium alloy with CSA certified as an Aluminium conductor material (ACM) and meet the requirements of the Aluminium Association Inc AA8030 and ASTM B800 standards.

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- 2.1.5. RWU-90 wiring is to be used for underground installations.
  
  - 2.2. TECK CABLE
    - 2.2.1. Cables to CSA-C22.2 No.131.
    - 2.2.2. Conductors:
      - .1 Grounding conductor copper.
      - .2 Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
    - 2.2.3. Insulation:
      - .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
    - 2.2.4. Inner jacket: polyvinyl chloride material.
    - 2.2.5. Armour: interlocking aluminum.
    - 2.2.6. Overall covering: thermoplastic polyvinyl chloride material rated at a minimum of FT-4. Provide FT-6 jacket when TECK cables are run in return air plenum.
  
  - 2.3. VARIABLE FREQUENCY DRIVE CABLES
    - 2.3.1. Variable frequency drives are also known as variable speed drives.
    - 2.3.2. Cables to CSA-C22.2 No. 123 and CSA-C22.2 No. 174.
    - 2.3.3. Conductors:
      - .1 Three (3) bare grounding conductor coppers sized to Table #16 of the Electrical Code.
      - .2 Circuit conductors: copper, size as indicated.
    - 2.3.4. Insulation:
      - .1 Chemically cross-linked thermosetting polyethylene type RW90, rated 1000 V.
    - 2.3.5. Inner jacket: polyvinyl chloride material.
    - 2.3.6. Armour: interlocking aluminum.
    - 2.3.7. Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.
  
  - 2.4. MINERAL-INSULATED CABLES
    - 2.4.1. Conductors: solid bare soft-annealed copper, size as indicated.
    - 2.4.2. Insulation: compressed powdered magnesium oxide to form compact homogeneous mass throughout entire length of cable.
    - 2.4.3. Overall covering: annealed seamless copper sheath, Type M1 rated 600 V, 250 C.
    - 2.4.4. Outer jacket: PVC applied over sheath.
    - 2.4.5. Two hour fire rating.
    - 2.4.6. Conform to requirements of CSA-C22.2 No. 124; and ULC S 139.
  
  - 2.5. ARMoured CABLES
    - 2.5.1. Cables to: CSA-C22.2 No. 51.
    - 2.5.2. Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
    - 2.5.3. Type: AC90 (BX).



- 2.5.4. Armour: interlocking type fabricated from aluminium strip.
- 2.5.5. Type: ACWU90 - PVC flame retardant jacket over armour meeting requirements of Vertical Tray Fire Test of CSA-C22.2 No.0.3 with maximum flame travel of 1.2 m (3 ft. 11 in.).
  
- 2.6. ALUMINUM SHEATHED CABLE
  - 2.6.1. Circuit conductors: copper, size as indicated unless aluminium or NUAL is identified on the drawings. Aluminium or NUAL conductor to be provided as per item 2.1.4.
  - 2.6.2. Insulation: type RA90 rated 1000 V.
  - 2.6.3. Sheath: aluminium applied to form continuous corrugated seamless sheath.
  - 2.6.4. Outer jacket of PVC applied over sheath for direct burial or wet locations.
  
- 3. Execution
  - 3.1. GENERAL
    - 3.1.1. Provide a minimum of one grounding wire for each three ungrounded conductors on all cable runs. Size grounding to Table 16 of the Canadian Electrical Code. Provide separate ground conductors for ground fault circuit interrupter circuits. All ground conductors to be copper and insulated with a green coloured insulation.
    - 3.1.2. All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be grounded through ground wires.
    - 3.1.3. Provide a variable frequency drive (VFD) cable from each VFD unit to each motor. Wiring to be installed in accordance with the VFD and motor manufacturer instructions.
    - 3.1.4. All cable terminations to be compression type fittings for wire sizes greater than #8AWG. All compression type fittings to be two-hole long barrel type. Where mechanical screw type lugs are allowed by the Consultant, they will be suitable for quantity of parallel runs of wire that are to be terminated under.
    - 3.1.5. Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to surface or recessed mounted light fixtures or where noted on the drawings where wiring is required to be installed within an existing wall. The maximum allowable distance of armoured cable is 3m. Contractor to receive written approval from the Consultant to run armoured cable further than 3m. Wiring in conduit is to be brought to a junction box to allow for the transition to armoured cable. Armoured cable is not to be installed directly into electrical panels.
    - 3.1.6. Branch circuit wiring to be upsized as follows to address voltage drop when:
      - .1 The entire length of the circuit wiring exceeds 25m – branch wiring to be a minimum of No. 10 AWG.
      - .2 The entire length of the circuit wiring exceeds 40m – branch wiring to be a minimum of No. 8 AWG.
      - .3 The entire length of the circuit wiring exceeds 60m – branch wiring to be a minimum of No. 6 AWG.
    - 3.1.7. Wire Splicing
      - .1 Splice up to and including No. 6 AWG with nylon insulated expandable spring type connectors.
      - .2 Splice larger conductors using compression type connectors wrapped in PVC insulation rated at the respective voltage.

3.2. INSTALLATION OF BUILDING WIRES

3.2.1. Install all building wiring in conduit unless otherwise noted. Conduit to be sized to the electrical code unless noted on the drawings or in the specifications.

3.2.2. All conductors are to be colour coded. Provide colour tape at all terminations to identify all conductors in each run.

3.3. INSTALLATION OF TECK90 CABLE, VARIABLE FREQUENCY DRIVE CABLE, ARMOURED CABLE OR ALUMINUM SHEATHED CABLE

3.3.1. Group cables wherever possible on channels.

3.3.2. Terminate cables in accordance with manufacturer's instructions.

3.3.3. Fastenings:

.1 One hole steel straps to secure surface cables 50 mm (2 in.) and smaller. Two hole steel straps for cables larger than 50 mm (2 in.).

.2 Channel type supports for two or more cables.

.3 Galvanized threaded rods: 6 mm (1/4 in.) dia. minimum to support suspended channels.

3.3.4. Connectors:

.1 Watertight, approved for respective cables.

END OF SECTION 16122

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. SCOPE
    - 1.2.1. These poke-thru devices provide the interface between power and communication cabling in an above grade concrete floor and the workstation or activation location where power and/or communication device outlets are required. These poke-thru devices provide flush device outlets that will not obstruct the floor area.
  - 1.3. CLASSIFICATION AND USE
    - 1.3.1. This poke-thru shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and/or UL514C and tested to Canadian Standard C22.2 and bear the cULus mark. This poke-thru shall conform to the standards set in the National Electrical Code, Section 300-21. This poke-thru device shall also have been tested by Underwriters Laboratories Inc. as to fire resistance and bear the fire classification mark. Devices shall be classified for use in 1-, 1 1/2-, or 2-hour rated, unprotected reinforced concrete floors and 1-, 1 1/2-, or 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the poke-thru fittings).
2. Products
  - 2.1. MATERIALS
    - 2.1.1. Poke-Thru Assembly. This assembly consists of an insert and an activation cover. Overall poke-thru assembly length shall be 413 mm (16¼ in.).
      - .1 Insert:
        - .1 The insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one 19.1 mm (3/4 in.) channel for power and two 12.7 mm (1/2 in.) channels for communication cabling. The channels shall be arranged such that communication cables can be conduit protected and connected to the insert body using a die-cast zinc conduit connector with two 12.7 mm (1/2 in.) threaded openings to accept both rigid and flexible conduit connections.
        - .2 The body will consist of an intumescent fire stop material to maintain the fire-rating of the floor slab. The intumescent material will be held securely in place in the insert body and shall not have to be adjusted to maintain fire-rating of the unit and the floor slab. The insert shall have a spring steel retaining ring that will hold the poke-thru device in the floor slab without additional fasteners. The poke-thru insert shall also consist of a 19.1 mm (3/4 in.) conduit stub that is connected to the insert body and a 402 ml (24.5 cu. in.) stamped steel junction box for wire splices and connections. The stamped steel junction box shall also contain the necessary means to electrically ground the poke-thru assembly.
      - .2 Activation Cover:

- .1 The activation cover shall be manufactured of die-cast aluminum alloy and be capable of being powder coated or plated. Coated finish to be textured, two-stage epoxy paint in gray, black, or ivory. Activation cover shall also be available in a solid brass forging. Brass finish shall be a brushed finish with a lacquer sealant. The activation cover shall be a total of 178 mm (7 in.) in diameter. The activation cover slide holder shall be manufactured from textured PVC and be available in black, ivory, and brass colors. The activation slide cover shall be a total of 102 mm (4 in.) in diameter. The activation shall also be supplied with a 20 amp duplex receptacle prewired with three #12 THHN AWG conductors for power applications. The activation shall provide a flush cover assembly with duplex receptacle covers with spring loaded slides that snap back in place when the power receptacle is not in use.
- .2 The activation shall have two locations to mount communication connectors. Connectors shall be mounted using a mounting bracket. Mounting brackets shall be provided to mount communication connectors. The activation cover shall also provide slide covers for the two communication locations. Each communication slide cover shall close and lock into place when connector is not in use. Each communication slide shall have a location to label the communication service on the surface of the slide cover.

## 2.2. MANUFACTURERS

### 2.2.1. The following are approved manufacturers:

- .1 Legrand - Wiremold
- .2 Hubbell
- .3 Wellmark

## 3. Execution

### 3.1. INSTALLATION

- 3.1.1. Unit shall permit all wiring to be completed at floor level. Unit shall mount in a 76 mm (3 in.) cored hole with a minimum diameter of 78 mm (3-1/16 in.).
- 3.1.2. Use is defined by the UL Fire Resistance Directory as a minimum spacing of 610 mm (2 in.) on center and not more than one device per each 6 sq. m. (65 sq. ft.) of floor area in each span.
- 3.1.3. Prior to and during installation, refer to system layout and/or approval drawings. Installer shall comply with detailed manufacturer's instruction sheet included with each device.

END OF SECTION 16130

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.1.2. Section 16060 – ACCESS DOORS AND ACCESSIBILITY.
  - 1.2. REFERENCE
    - 1.2.1. CSA 2.2.1 - Canadian Electrical Code - Part 1.
  - 1.3. SHOP DRAWINGS AND PRODUCT DATA
    - 1.3.1. Submit Shop Drawings and product data for cabinets in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
  - 2.1. SPLITTERS
    - 2.1.1. Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Provide CSA Type 1 enclosures in non-sprinklered environments and CSA Type 4/12 in sprinklered environments.
    - 2.1.2. Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
    - 2.1.3. At least three spare terminals on each set of lugs in splitters less than 400 A.
  - 2.2. JUNCTION AND PULL BOXES
    - 2.2.1. Welded steel construction with screw-on flat covers for surface mounting.
    - 2.2.2. Covers with 25 mm (1 in.) minimum extension all around, for flush-mounted pull and junction boxes.
  - 2.3. CABINETS
    - 2.3.1. Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
    - 2.3.2. Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing 19 mm (3/4 in.) plywood backboard for surface or flush mounting. The plywood backboard is to have a fire-resistant coating on the front.
3. Execution
  - 3.1. SPLITTER INSTALLATION
    - 3.1.1. Install splitters and mount plumb, true and square to the building lines.
    - 3.1.2. Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2. JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- 3.2.1. Install pull boxes in inconspicuous but accessible locations.
- 3.2.2. Mount cabinets with top not higher than 2 m (8 ft.) above finished floor.
- 3.2.3. Install terminal block as indicated in Type T cabinets.
- 3.2.4. Only main junction and pull boxes are indicated. Install pull boxes as follows:
  - .1 A conduit run exceeds 30 m (98 ft. 5 in.) and;
  - .2 360 degree of combined bends between pull boxes for power conduits or 180 degree of combined bends between pull boxes for communication and low voltage conduits.

3.3. IDENTIFICATION

- 3.3.1. Provide equipment identification in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.3.2. Install identification labels indicating system name voltage and phase.

END OF SECTION 16131

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. REFERENCES
    - 1.2.1. CSA C22.1-Canadian Electrical Code, Part 1.
    - 1.2.2. Ontario Building Code, latest edition.
    - 1.2.3. National Building Code, latest edition.
    - 1.2.4. CAN/ULC-S115, Fire Tests of Firestop Systems, latest edition.
2. Products
  - 2.1. OUTLET AND CONDUIT BOXES GENERAL
    - 2.1.1. Size boxes in accordance with CSA C22.1.
    - 2.1.2. Square or larger outlet boxes as required for special devices.
    - 2.1.3. Gang boxes where wiring devices are grouped.
    - 2.1.4. Blank cover plates for boxes without wiring devices.
    - 2.1.5. 347V outlet boxes for 347 V switching devices.
    - 2.1.6. Combination boxes with barriers where outlets for more than one system are grouped.
  - 2.2. SHEET STEEL OUTLET BOXES
    - 2.2.1. Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 75 mm x 50 mm x 38 mm (3 in. x 2 in. x 1-1/2 in.) or as indicated. 100 mm (4 in.) square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
    - 2.2.2. Provide electro-galvanized steel utility boxes for surface mounted boxes connected to surface-mounted EMT conduit, minimum size 100 mm x 54 mm x 48 mm (4 in. x 2-1/8 in. x 1-7/8 in.).
    - 2.2.3. Square or octagonal outlet boxes for lighting fixture outlets.
    - 2.2.4. Square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.
  - 2.3. MASONRY BOXES
    - 2.3.1. Electro-galvanized steel masonry single and multi gang boxes for devices flush mounted in exposed block walls.
  - 2.4. CONCRETE BOXES
    - 2.4.1. Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.
  - 2.5. FLOOR BOXES

- 2.5.1. Concrete tight electro-galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex receptacles. Minimum depth: 28 mm (1-1/8 in.) for receptacles; 73 mm (2-7/8 in.) for communication equipment.
- 2.5.2. Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12.7 mm (1/2 in.) and 19 mm (3/4 in.) conduit. Minimum size: 73 mm (2-7/8 in.) deep.
- 2.6. OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE
  - 2.6.1. Electro-galvanized, sectional, screw ganging steel boxes, minimum size 75 mm x 50 mm x 63.5 mm (3 in. x 2 in. x 2½ in.) with two double clamps to take non-metallic sheathed cables.
- 2.7. FITTINGS - GENERAL
  - 2.7.1. Bushing and connectors with nylon insulated throats.
  - 2.7.2. Knock-out fillers to prevent entry of debris.
  - 2.7.3. Conduit outlet bodies for conduit up to 31.75 mm (1-1/4 in.) and pull boxes for larger conduits.
  - 2.7.4. Double locknuts and insulated bushings on sheet metal boxes.
- 2.8. SERVICE FITTINGS
  - 2.8.1. 'High tension' receptacle fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for duplex receptacles. Bottom plate with two knockouts for centered or offset installation.
  - 2.8.2. Pedestal type 'low tension' fitting made of 2 piece die cast aluminum with brushed aluminum housing finish to accommodate amphenol jack connectors.
- 3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. Support boxes independently of connecting conduits.
    - 3.1.2. Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
    - 3.1.3. For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm (1/4 in.) of opening.
    - 3.1.4. Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
    - 3.1.5. Non-combustible electrical outlet boxes that penetrate a fire separation or a membrane forming part of an assembly required to have a fire-resistance rating, do not require fire stops provided,
      - .1 they do not exceed:
        - .1 100 cm<sup>2</sup> (15.5 in<sup>2</sup>) each in area, AND
        - .2 an aggregate area of 650 cm<sup>2</sup> (100.75 in<sup>2</sup>) in any 9.3 m<sup>2</sup> (100 ft<sup>2</sup>) of surface area, AND
      - .2 the annular space between the membrane and the box does not exceed 3 mm.
    - 3.1.6. Where the conditions of clause 3.1.5 are not met, provide fire stops for the outlet boxes.



- 3.1.7. Conform to the requirements of 3.1.9.3 of the building code: unless provided with a fire stop in accordance with CAN/ULC-S115, "Fire Tests of Firestop Systems", electrical outlet boxes on opposite sides of a vertical fire separation required to have a fire-resistance rating shall be separated by a horizontal distance of not less than 600 mm (24 in.), or be installed in adjacent stud cavities.

END OF SECTION 16132

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. SHOP DRAWINGS AND PRODUCT DATA
    - 1.2.1. Submit Shop Drawings and product data in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
2. Products
  - 2.1. SWITCHES
    - 2.1.1. 20 A, single pole, double pole, three-way, or four-way specification grade switches. Voltage rating of the switch to be as per the contract documents.
    - 2.1.2. Manually-operated general purpose ac switches with following features:
      - .1 Terminal holes approved for No. 10 AWG wire.
      - .2 Silver alloy contacts.
      - .3 Urea or melamine moulding for parts subject to carbon tracking.
      - .4 Suitable for back and side wiring.
      - .5 Décor Style specification grade Rocker switch.
      - .6 Colour to be selected by Architect/Engineer's Representative.
    - 2.1.3. Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.
  - 2.2. RECEPTACLES
    - 2.2.1. All receptacles to be specification grade.
    - 2.2.2. Duplex specifications receptacles, Décor style CSA type 5-15 R, 125 V, 15 A, U ground, with following features:
      - .1 Thermoplastic with impact-resistant nylon face moulded housing.
      - .2 Suitable for No. 10 AWG for back and side wiring.
      - .3 Eight back wired entrances, four side wiring screws.
      - .4 Triple wipe contacts and riveted grounding contacts.
    - 2.2.3. Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features
      - .1 Thermoplastic moulded housing.
      - .2 Suitable for No. 10 AWG for back and side wiring.
      - .3 Four back wired entrances, 2 side wiring screws.
    - 2.2.4. Other receptacles with ampacity and voltage as indicated.
    - 2.2.5. Receptacles to be coloured as follows:
      - .1 Normal Power – Colour to be selected by Architect/Consultant
      - .2 Emergency/Essential Power – Red

.3 Isolated Ground - Orange

## 2.3. MANUFACTURERS

2.3.1. The switches and wiring devices shall be of one manufacturer throughout the project.

2.3.2. The following are acceptable manufacturers:

- .1 Legrand
- .2 Hubbell
- .3 Cooper
- .4 Leviton

## 2.4. DIMMERS

2.4.1. Dimmers shall be 600W, 1500W, 2000 Watts.

- .1 Full range, continuously variable control of light intensity.
- .2 Vertical slider allowing the light level to be set by the user.
- .3 Slide to Off.
- .4 Capable of operating at rated capacity.
- .5 Power failure memory
- .6 Dimmers shall be available for direct control of incandescent, magnetic low voltage, electronic low voltage, electronic low voltage, fluorescent, and LED.

2.4.2. Incandescent dimmers.

- .1 Direct control of up to a full 20A lighting circuit.

2.4.3. Electronic (solid-state) Low Voltage (ELV) transformer dimmers (incandescent).

- .1 Circuitry designed to control the input of Electronic (solid state) Low Voltage transformers.
- .2 Control up to 600 Watts of Electronic Low Voltage load.
- .3 Reset-able overload protection when capacity is exceeded.

2.4.4. Magnetic Low-Voltage (MLV) transformer dimmers.

- .1 Designed to control and provide a symmetrical AC wave form to input of magnetic low voltage transformers per UL 1972 section 5.11.
- .2 Direct control of up to 1500VA of Magnetic Low Voltage load.
- .3 Dimmer shall be suitable to control dimming ballast as specified in Section 16505 – LIGHTING EQUIPMENT.

2.4.5. LED dimmers.

- .1 Slide to Off only. Must match driver and LED requirements.

2.4.6. Manufactures

- .1 Lutron Nov. T Series.
- .2 Leviton Monet Series.

## 2.5. COVER PLATES

2.5.1. Cover plates for wiring devices.

2.5.2. Cover plates from one manufacturer throughout project.

2.5.3. Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

- 2.5.4. Provide ~~stainless steel~~ cover plates, suitable for the respective device, for all devices mounted in flush-mounted outlet boxes located in finished areas.
  - 2.5.5. Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
  - 2.5.6. Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles located outside or as indicated.
  - 2.5.7. Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches located outside or as indicated.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Switches:
- .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height specified in Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS or as indicated.
- 3.1.2. Receptacles:
- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height specified in Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS or as indicated.
  - .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- 3.1.3. Cover plates:
- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
  - .2 Install suitable common cover plates where wiring devices are grouped.
  - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- END OF SECTION 16141

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. REFERENCE
    - 1.2.1. CSA C22.2 No. 4 – Enclosed Switches.
    - 1.2.2. CSA C22.2 No. 39 – Fuseholder Assemblies.
  - 1.3. PRODUCT DATA
    - 1.3.1. Submit product data in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  
2. Products
  - 2.1. DISCONNECT SWITCHES
    - 2.1.1. Fusible or non-fusible, horsepower rated disconnect switch in CSA Enclosure 2 sprinkler proof, size as indicated.
    - 2.1.2. Provision for padlocking in on-off switch position by three locks.
    - 2.1.3. Mechanically interlocked door to prevent opening when handle in ON position.
    - 2.1.4. Fuses: size as indicated, class J, current limiting, in accordance with Section 16478 – FUSES - LOW VOLTAGE.
    - 2.1.5. Fuseholders: suitable without adaptors, for type and size of fuse indicated.
    - 2.1.6. Quick-make, quick-break action.
    - 2.1.7. ON-OFF switch position indication on switch enclosure cover.
  - 2.2. EQUIPMENT IDENTIFICATION
    - 2.2.1. Provide equipment identification in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 2.2.2. Indicate name of load controlled on nameplate.
    - 2.2.3. Provide a lamacoid that indicates the replacement fuse size as well as the maximum allowable fuse size for that disconnect based upon the sizing of the feeder.
  - 2.3. MANUFACTURERS
    - 2.3.1. The following are acceptable manufacturers
      - .1 Schneider Electric
      - .2 Eaton Cutler-Hammer
      - .3 Siemens

3. Execution

3.1. INSTALLATION

3.1.1. Install disconnect switches complete with fuses if applicable.

END OF SECTION 16440

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. REFERENCES
    - 1.2.1. CSA C22.2 No. 29 – Panelboards and Enclosed Panelboards
    - 1.2.2. CSA C22.2 No. 5 – Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures.
  - 1.3. SHOP DRAWINGS
    - 1.3.1. Submit Shop Drawings in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.3.2. Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
2. Products
  - 2.1. PANELBOARDS
    - 2.1.1. Panelboards: product of one manufacturer.
    - 2.1.2. Install circuit breakers in panelboards before shipment.
    - 2.1.3. In addition to CSA requirements manufacturer's nameplate must show fault current that the panel including all breakers have been built to withstand.
    - 2.1.4. Panelboards to have the following minimum ratings for interrupting capacity or as indicated on the drawings or panel schedules.
      - .1 120/208V panelboards – 10kA
      - .2 347/600V panelboards – 22kA
    - 2.1.5. Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
    - 2.1.6. Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated. Provide an additional 20% of space within each panelboard in addition to what is shown on the drawings when a separate panel schedule is not provided for a specific panelboard.
    - 2.1.7. Two keys for each panelboard and key panelboards alike.
    - 2.1.8. Panelboards to be copper bus unless identified otherwise.
    - 2.1.9. Where identified on the drawings or schedules, provide a copper neutral bus sized to 200% of the mains rating for panels.
    - 2.1.10. Mains: suitable for bolt-on breakers.
    - 2.1.11. Trim with concealed front bolts and hinges.
    - 2.1.12. Trim and door finish: baked grey enamel.
      - .1 Drip hoods for sprinkler proofing.

- 2.1.13. Enclosure to be CSA Type 2 sprinkler proof.
- 2.1.14. TVSS protection as required.
- 2.1.15. Series ratings may be acceptable. Panels to be labeled as such. Manufacturing to supply supporting data.
  
- 2.2. MOULDED CASE CIRCUIT BREAKERS
  - 2.2.1. Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. (104 deg. F.) ambient.
  - 2.2.2. Common-trip breakers: with single handle for multi-pole applications.
  - 2.2.3. Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.
  - 2.2.4. Main breaker, where indicated: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
  - 2.2.5. Lock-on devices for 10 % of 15 to 30 A breakers installed. Turn over unused lock-on devices to Owner.
  - 2.2.6. Where breakers are identified to feed high intensity discharge (HID) lighting, provide breakers that are rated and designed for use with HID lighting.
  - 2.2.7. Provide one breaker per designated breaker space. Multiple breakers contained in one housing or twin breakers are not acceptable.
  
- 2.3. EQUIPMENT IDENTIFICATION
  - 2.3.1. Provide equipment identification in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 2.3.2. Complete circuit directory with typewritten legend showing location and load of each circuit.
  
- 2.4. MANUFACTURERS
  - 2.4.1. The following are acceptable manufacturers:
    - .1 Schneider Electric
    - .2 Eaton Cutler-Hammer
    - .3 Siemens
  
- 3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.
    - 3.1.2. Install surface mounted panelboards on galvanized unistrut stand-offs or on fire rated plywood backboards. The plywood backboards are to be as per Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 3.1.3. Mount panelboards to height specified in Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS or as indicated.
    - 3.1.4. Connect loads to circuits.
    - 3.1.5. Connect neutral conductors to common neutral bus with respective neutral identified.



END OF SECTION 16471

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. REFERENCES
    - 1.2.1. CSA C22.2 No. 248-00 – Low Voltage Fuses.
  - 1.3. SHOP DRAWINGS AND PRODUCT DATA
    - 1.3.1. Submit Shop Drawings and product data in accordance with Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.3.2. Submit fuse performance data characteristics for each fuse type and size above 100 A. Performance data to include: average melting time-current characteristics, I<sup>2</sup>t (for fuse coordination), and peak let-through current.
  - 1.4. MAINTENANCE MATERIALS
    - 1.4.1. Three spare fuses of each type and size installed 600 A and above.
    - 1.4.2. Six spare fuses of each type and size installed up to and including 400 A.
  - 1.5. DELIVERY AND STORAGE
    - 1.5.1. Ship fuses in original containers.
    - 1.5.2. Do not ship fuses installed in switchboard.
    - 1.5.3. Store fuses in original containers in moisture free location.
2. Products
  - 2.1. FUSES GENERAL
    - 2.1.1. Fuse type references L1, L2, J1, etc. have been adopted for use in this specification.
    - 2.1.2. Fuses: product of one manufacturer.
    - 2.1.3. Fuses to have an indicating window to identify when the fuse has been blown.
  - 2.2. FUSE TYPES
    - 2.2.1. Class L fuses.
      - .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
      - .2 Type L2, fast acting.
    - 2.2.2. Class J fuses.
      - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
      - .2 Type J2, fast acting.
    - 2.2.3. Class C fuses.
    - 2.2.4. Fuses for Motors:

- .1 All fuses for motor loads are to be time-delay type.

2.3. MANUFACTURERS

- 2.3.1. The following are acceptable manufacturers:

- .1 Ferraz Shawmutt
- .2 Cooper-Bussman
- .3 Littelfuse

3. Execution

3.1. INSTALLATION

- 3.1.1. Install fuses in mounting devices immediately before energizing circuit.
- 3.1.2. Ensure correct fuses fitted to assigned electrical circuit.

END OF SECTION 16478

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.1.2. Section 16031 – SUBMITTALS – SHOP DRAWINGS.
    - 1.1.3. Section 16122 – WIRES AND CABLES.
    - 1.1.4. Section 16506 – LUMINAIRE SCHEDULE.
  - 1.2. REFERENCES
    - 1.2.1. CSA C22.2 No. 74 – Equipment for Use with Electric Discharge Lamps.
    - 1.2.2. The Consortium of Energy Efficiency (CEE) guidelines.
    - 1.2.3. IESNA LM-79 and LM-80.
    - 1.2.4. The Certified Ballast manufacturers Association (CBM) standards.
  - 1.3. SUBSTITUTION
    - 1.3.1. The lighting equipment for this project and specified herein has been carefully selected for its ability to meet the project's luminous environment requirements. Manual and computer calculations have been performed to ensure that the lighting equipment that has been specified complies with established criteria. The Engineer's Representative reserves the right not to accept any alternates or substitutions. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide all information required herein and detailed layouts and lighting calculations demonstrating that the performance of the alternate luminaire meets or exceeds the original lighting design while not consuming any additional energy. The Contractor/Supplier is responsible to ensure the light levels provided in the alternate submittal package are achieved. Where the light levels are not achieved, the Contractor is responsible to replace the luminaire with a fixture that will meet the required levels with no increase in energy use at no cost to the Owner. Rather than replacing the fixtures, the Engineer's Representative may accept the installation of additional fixtures by the Contractor at no cost to the Owner in order to achieve the required light levels.
  - 1.4. SHOP DRAWING AND PRODUCT DATA
    - 1.4.1. Submit Shop Drawings in accordance with SECTION 16031 – SHOP DRAWINGS.
    - 1.4.2. Submit a shop drawing for each luminaire specified, including lamp.
    - 1.4.3. Luminaire submittals are to consist of a physical description, manufacturer's specification sheets, dimensioned drawings, and complete photometric data from an independent test laboratory in the form of IES computer files of the equipment being submitted and hard copy of the photometric report. Coordinate ceiling types to ensure proper supports and luminaire framing. Lamp submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, rated life, colour temperature, base type, lamp shape, CRI, and voltage. It must be submitted with a photometric modeling of the space with average, maximum, minimum and max to min values.
    - 1.4.4. Lamp submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, rated life, colour temperature, base type, lamp shape, CRI, voltage and mercury content.

- 1.4.5. LED submittals are to consist of manufacturer's technical data for diodes and drivers with respective luminaire shop drawing. Submittal to include operating wattage, voltage, maximum distance from drivers, wiring diagrams and lumen output at time of delivery. Where identified on the luminaire schedule, a luminaire sample is required to be submitted with the shop drawing submittals. LED Drivers must have a 50,000 hours warranty.
- 1.4.6. Ballast submittals are to consist of manufacturer's technical data with respective luminaire shop drawing. Submittal to include operating wattage, input voltage, ballast efficiency, maximum distance for remote ballasts, power factor, and operating temperature.
- 1.4.7. Where samples are indicated on the luminaire schedule, they are to be provided with shop drawings at time of shop drawing submittals unless noted otherwise.

## 2. Product

### 2.1. GENERAL

- 2.1.1. All products must be CSA or CUL approved.

### 2.2. LAMPS AND LEDS

- 2.2.1. All Lamps are to meet the standards of the Consortium of Energy Efficiency (CEE) guidelines.

- 2.2.2. Not all lamps could be used, refer to luminaire schedule for project specific details.

- 2.2.3. Incandescent, tungsten halogen, high intensity discharge, compact fluorescent and linear fluorescent lamps shall be manufactured by Osram/Sylvania, GE, Philips or Venture unless indicated otherwise on luminaire schedule. Lamps are to be in accordance with the lamp specifications detailed in the Luminaire Schedule and as noted below. Luminaire schedule shall take precedence where differences occur.

- 2.2.4. All lamps are to be new and are to be from the same batch to avoid colour differences. Replace lamps that exhibit colour shift or lumen intensity has prematurely declined at no cost to the owner.

#### 2.2.5. Incandescent and Halogen

- .1 Incandescent lamp rated life shall be minimum 4,000 hours at rated voltage.
- .2 Halogen lamp rated life shall be minimum 5,000 hours at rated voltage. All MR16 lamps shall be "Constant Colour" or "IR (Infrared) reflective".
- .3 Dichroic reflector lamps are to be provided with glass lens and shall not have spill at back of lamp unless noted in the luminaire schedule. Beam pattern and spread are as indicated on luminaire schedule.

#### 2.2.6. Linear Fluorescent

- .1 Linear T5 fluorescent lamps shall have a minimum average rated life of 20,000 hours. The peak lumen output will be at 35 deg. C. The CRI shall be 85 or better and the colour temperature will be 3500 deg. K. unless noted otherwise on the luminaire schedule. Lamp wattage as noted on Luminaire Schedule.
- .2 Linear T8 fluorescent lamps shall have a minimum average rated life of 20,000 hours. The peak lumen output will be at 35 deg. C. The CRI shall be 85 or better and the colour temperature will be 3500 deg. K. unless noted otherwise on the luminaire schedule. Lamp wattage as noted on Luminaire Schedule.
- .3 All linear fluorescents must be low content mercury lamps. The Standard of acceptance are Philips "Alto", Sylvania "Ecologic XP" for T8 lamps, Sylvania "Pentron" for T5 lamps and GE "Ecolux" series.

2.2.7. Compact Fluorescent

- .1 Compact fluorescent lamps are to be single end 4-pin with amalgam technology (lower mercury content) and shall have a minimum average rated life of 16,000 hours. The CRI shall be 82 or better and the colour temperature will be 3500 deg. K. unless noted otherwise on the luminaire schedule. Lamp wattage as noted on Luminaire Schedule, 32W compact fluorescents must not be used with of controls or sensors due performance issues.

2.2.8. High Intensity Discharge (HID)

- .1 Metal halide lamps shall have a minimum 10,000 hour life and a minimum CRI of 60.
- .2 Ceramic Metal halide lamps shall have a minimum 9,000 hour life and a minimum CRI of 81.
- .3 All metal halide lamps must be low content mercury lamps.

2.2.9. Light Emitting Diodes (LED)

- .1 LEDs are to meet the standards of IESNA LM-79 and LM-80.
- .2 LED's shall be manufactured by Luxeon or equal. Colour temperature shall be 3200 deg. K., lamps are to be binned with no visible colour variance (3100K to 3300K maximum range). Rated life for 1 watt white LED shall be 50,000 hours. Lumen output to be maximum based on latest technology at time of delivery.
- .3 All LED luminaires that present signs of failure on site, within the warranty period, must be replaced at no cost to the owner. If temporary luminaires are required to replace any failed LED luminaires, during the waiting time for parts (i.e. drivers, boards, heat sinks, etc.), the labour cost including installation, temporary luminaire supply, temporary luminaire removal and reinstallation of the LED fixture must be provided at no cost of the owner. Additional electrical costs, associated with higher Wattage temporary luminaires, must be reimbursed with interest to the owner by the manufacturer.
- .4 In case of failure of a LED luminaire complete or part there of the luminaire failure, a independent third party testing Laboratory (approved by Smith + Andersen) shall be commissioned by the manufacturer or vendor to perform tests on samples taken from the failed luminaires installed on corresponding site. All reporting including the test results must be submitted to Smith + Andersen for evaluation and final approval.
- .5 Any additional time involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.

2.2.10. Induction lamps

- .1 Induction lamps shall have a minimum 100,000 hour life. The Standard of acceptance are Osram/Sylvania and Philips. Minimum CRI of 80.

2.3. DRIVERS

2.3.1. All drivers are to be tested and comply with maximum in-rush current limits within NEMA 410 standards. This is to be clearly indicated on shop drawing submittal.

2.3.2. LED dimming shall be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.

2.3.3. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

- 2.3.4. Withstand up to a 1,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
- 2.3.5. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
- 2.3.6. Total Harmonic Distortion less than 20% percent and meet ANSI C82.11 maximum allowable THD requirements at full output. THD shall at no point in the dimming curve allow imbalance current to exceed full output THD.
- 2.3.7. Driver must support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
  - .1 Adjustment of forward LED voltage, supporting 3V through 55V.
  - .2 Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
  - .3 Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.
- 2.3.8. Driver must be able to operate for a (+/- 10%) supply voltage of 120V through 277VAC at 60Hz.
- 2.3.9. Driver should be UL Recognized under the component program and shall be modular for simple field replacement. Drivers that are not UL Recognized or not suited for field replacement will not be considered.
- 2.3.10. Driver shall include ability to provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and shall consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V shall be included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.
- 2.3.11. Over the entire range of available drive currents, driver shall provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0% relative light output, or 100 – 1% light output and step to 0% where indicated. Driver shall respond similarly when raising from 0% to 100%
  - .1 Driver must be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
- 2.3.12. Driver must be capable of configuring a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
- 2.3.13. Drivers to track evenly across multiple fixtures at all light levels, and shall have an input signal to output light level that allows smooth adjustment over the entire dimming range.
- 2.3.14. Driver and luminaire electronics shall deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10). At all points within the dimming range from 100-0.1 percent luminaire shall have:
  - .1 LED dimming driver shall provide continuous step-free, flicker free dimming similar to incandescent source.
  - .2 Base specification: Flicker index shall less than 5% at all frequencies below 1000 Hz.
  - .3 Preferred specification: Flicker index shall be equal to incandescent, less than 1% at all frequencies below 1000 Hz.
- 2.3.15. Control Input
  - .1 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
    - .1 Must meet IEC 60929 Annex E for General White Lighting LED drivers

- .2 Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
- 2.3.16. Must meet ESTA E1.3 for RGBW LED drivers
- 2.4. BALLASTS
- 2.4.1. All Ballasts are to comply with CSA C22.2 No. 74 and are to meet or exceed the standards of the Certified Ballast manufacturers Association (CBM).
- 2.4.2. Not all ballasts could be used, refer to luminaire schedule for project specific details.
- 2.4.3. All ballasts shall be manufactured by Osram/Sylvania, Philips, Advance, GE, Lutron or Magnetek unless indicated otherwise. Ballasts shall operate at voltage and control lamps as noted in the Luminaire Schedule.
- 2.4.4. Ballasts for T5 and T8 lamps will be programmed rapid start, will start at minimum 0 deg. C. (indoors) and minus 29 deg. C. (outdoors). Ballasts shall meet ANSI C62.41 Category A transient voltage protection requirements. PF shall be greater than .95, and shall meet FCC Class A specifications for EMI/RFI. The maximum case temperature will not exceed 70 deg. C.
- 2.4.5. Ballasts for compact fluorescent lamps to be universal input type electronic with end-of-lamp sensing. PF shall be greater than .98, BF shall be greater than .98, THD < 10%. Ballasts shall meet FCC Class A specifications for EMI/RFI.
- 2.4.6. Ballasts for HID lamps will be suitable for operation in 40 deg. C. temperatures, with a minimum starting temperature of minus 30 deg. C. at 90 % of line voltage. They shall be encapsulated in a steel enclosure. Insulation is to be Class H (minimum 180 deg. C.) vacuum impregnated with silica filled polyester compound. Coils are to be precision or bobbin wound. Sound rating is to be minimum class B. Continuous operation for 60,000 hours at maximum rated load and temperature. Ballast factor of 1.0, .95 minimum power factor, 1.8 minimum crest factor.
- 2.4.7. Electronic dimming ballasts for T5 and T8 lamped fluorescent luminaires are to be compatible with lamp type and quantity and shall meet the following requirements:
- .1 Dimming range from 100% to 1% illuminance level with continuous, flicker free output with ambient noise level  $\leq 27$ dB over the entire dimming range.
  - .2 Maximum lead length from ballast to lamp socket is seven feet for T-8 lamps, and 3 feet for T-5 lamps.
  - .3 PF > .95.
  - .4 BF  $\geq .85$ .
  - .5 THD < 10% at full light output.
  - .6 Lamp crest factor  $\leq 1.6$ .
  - .7 Inrush current to be internally limited to not exceed 3 amps at 347V or 7A at 120V.
  - .8 Preheating of lamp cathodes before applying arc voltage.
  - .9 Withstand 4000V surges as per ANSI C62.41.
  - .10 Improper line voltage and control wiring shall not damage ballast. Each ballast is to be tested at low, medium and high end of range by manufacturer.
  - .11 Meet FCC Class A specifications for EMI/RFI.
- 2.4.8. Electronic dimming ballasts for compact fluorescent luminaires are to be compatible with lamp type and quantity and shall meet the following requirements:



- .1 Dimming range from 100% to 1% illuminance level with continuous, flicker free output over the entire dimming range.
  - .2 Maximum lead length from ballast to lamp socket is 3 feet.
  - .3 PF > .95.
  - .4 BF ≥ .93.
  - .5 THD < 10% at full light output.
  - .6 Lamp crest factor ≤ 1.6.
  - .7 Inrush current to be internally limited to not exceed 3 amps at 120V.
  - .8 Preheating of lamp cathodes before applying arc voltage.
  - .9 Withstand surges as per ANSI C62.41.
  - .10 Improper line voltage and control wiring shall not damage ballast. Each ballast is to be tested at low, medium and high end of range by manufacturer.
  - .11 Meet FCC Class A specifications for EMI/RFI.
  - .12 Minimum starting temperature of 10 deg. C.
- 2.4.9. Ballasts shall contain no PCB's and audible rating will be class A or better.
- 2.4.10. Racks are to be provided for remote ballasts.
- 2.4.11. Ballasts with unacceptable noise levels are to be replaced at no cost to the owner.
- 2.5. LUMINAIRES
- 2.5.1. All luminaires are to be complete with mounting brackets, transformers, supports, trims, louvers, lenses and other accessories as required to make luminaire operational and allow it to be installed in the respective location.
- 2.5.2. Fixtures shall be suitable for environment, sealed and gasketed with corrosion resistant baked-on finish.
- 2.5.3. Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.
- 2.5.4. Poles and bases are to be designed to accommodate wind conditions to avoid damage due to wind-induced vibrations. Shop drawings are to be signed by a structural engineer registered in the local jurisdiction. Flat lens are our standard of acceptance.
- 2.5.5. The supply and installation of CASH ALLOWANCE luminaires to comply with all standards set forth in Electrical specifications. CASH ALLOWANCE excludes applicable taxes and includes lamps and distributor markups. Under base contract, Electrical Contractor is responsible for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all cash allowance items. A separate line item is to include applicable taxes.
- 2.5.6. The following is a list of generic type designation for luminaires. The project specific luminaire schedule is to be referenced for the specific types and designations and the respective specifications.
- .1 Designations beginning with the letter 'C' denote compact fluorescent type.
  - .2 Designations beginning with the letter 'D' denote incandescent or halogen type.
  - .3 Designations beginning with the letter 'F' denote fluorescent type.
  - .4 Designations beginning with the letter 'H' denote high intensity discharge type.
  - .5 Designations beginning with the letter 'L' denote LED type.
  - .6 Designations beginning with the letter 'J' denote Induction type.
  - .7 Designations beginning with the letter 'X' denote exit light.

3. Execution

3.1. INSTALLATION

- 3.1.1. The contractor will provide, receive, unload, uncrate, store, protect and install lamps, luminaires, and other related lighting equipment as specified herein. Lamps for all equipment will be provided and installed by the contractor according to equipment manufacturer's instructions.
- 3.1.2. Poles and bollards are to be installed on independent concrete bases unless indicated otherwise on the drawings or schedules. Coordinate brackets for cameras and supports for banners with pole manufacturer.
- 3.1.3. Install remote ballasts in racks and wire fixtures to ballasts in conduit cased on manufacturer's recommendations.
- 3.1.4. Locate luminaires in accordance with the Architect's Drawings. Coordinate exact locations on site. Refer to architects drawings for dimensions of coves and valences. . Fluorescent staggered coves must have a minimum of two inches overlap.
- 3.1.5. Install in accordance with Manufacturer's Instructions, Local Codes, Electrical Division Drawings and Specifications.
- 3.1.6. Suspend luminaires in mechanical rooms after all the mechanical equipment and ductwork are installed. Luminaires are not to be suspended from mechanical pipes, ductwork or other building services.
- 3.1.7. For suspended ceiling installations support luminaires from structural slab in accordance with local inspection requirements.
- 3.1.8. Where luminaires are mounted in tandem, Align luminaires mounted in continuous rows to form straight uninterrupted line.
- 3.1.9. Align luminaires mounted individually parallel or perpendicular to building grid lines.
- 3.1.10. Ensure light leakage does not occur from openings and trim rings. Contractor is responsible to repair the ceiling at no cost to the Owner if cut-out is too large.
- 3.1.11. Connect luminaires to lighting circuits.
- 3.1.12. Provide all wiring in conduit with junction boxes on a grid pattern to limit the run of flexible armoured cable drops from the ceiling mounted junction box to each luminaire to a maximum of 3 m (10 ft.) in length unless approved otherwise in writing from the Engineer's Representative.
- 3.1.13. Modular wiring systems shall be employed only where indicated or with approval of the Engineer's Representative.
- 3.1.14. Luminaires are not to be used as temporary construction lighting. After being tested to ensure acceptable operation, luminaires will not be used until substantial completion unless permission is received from the owner, architect or Engineer's Representative.
- 3.1.15. Lamps are to be installed after luminaire is cleaned. All fluorescent lamps shall be run through a minimum of 12 hours initial start to increase the lamp life and all lamps shall be run through a minimum of 100 hours initial start prior to any dimming.
- 3.1.16. Clean all luminaires, inside and out at time of substantial completion. Replace all scratched or damaged luminaires, lenses, louvers and diffusers at no cost to the owner.
- 3.1.17. Installation of exit signs
  - .1 Rough-in and installation of exit signs shall be carefully coordinated on site such that after installation of all equipment/services, including equipment/services from other trades (i.e. sprinkler lines, plumbing pipes, way-finding signs, etc), shall not interfere

with the line-of-sight visibility of the exit sign(s) from approach of the intended egress pathway(s).

- .2 If exit sign(s) have been installed and do not meet the satisfaction of the Engineer's Representative/Architect, the Contractor shall lower, raise or relocate the exit sign(s) such that proper and adequate visibility of the exit sign(s) is achieved at no additional cost to the Owner."

END OF SECTION 16505

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS and DIVISION 1.
  - 1.2. DESCRIPTION OF SYSTEM
    - 1.2.1. Low voltage control system is to be designed to provide remote switching of lighting loads by use of:
      - .1 Low voltage momentary contact switches.
      - .2 Low voltage relays.
      - .3 Control transformers.
      - .4 Low voltage rectifiers.
      - .5 Manual and automatic program control.
  - 1.3. SHOP DRAWINGS
    - 1.3.1. Submit Shop Drawings in accordance with Section 16031 – SHOP DRAWINGS and Division 1.
2. Products
  - 2.1. MATERIALS
    - 2.1.1. Control system: by one manufacturer and assembled from compatible components.
  - 2.2. REMOTE CONTROL SWITCHES
    - 2.2.1. Single pole, double throw, momentary contact, heavy duty, rated 15 A, 25 V, centre pivot rocker action with pilot lights.
  - 2.3. LOW VOLTAGE RELAYS
    - 2.3.1. Electrically operated by momentary impulse, mechanically latched until de-activated.
    - 2.3.2. Operating voltage: 24 V, ac.
    - 2.3.3. Load contacts: 20 A, 347 V, ac
    - 2.3.4. Auxiliary contacts for pilot light.
    - 2.3.5. Coloured pre-stripped leads.
  - 2.4. CONTROL TRANSFORMER
    - 2.4.1. Low voltage power Class 2, input 347 V, ac, 60 Hz, output 35 VA at 24 V.
  - 2.5. RECTIFIER
    - 2.5.1. Silicon type: 24 V, ac, 60 Hz input, 7.5 A continuous duty, 20 A intermittent duty output.

2.6. MANUAL CONTROL

2.6.1. Provide individual remote control switches, as indicated.

2.7. MICROPROCESSOR CONTROLLER

2.7.1. Field programmable.

2.7.2. Inputs for switches, photo electric cells, and connections to building automation systems (BAS).

2.7.3. Outputs to control relays.

2.7.4. Capable of time-of-day control, control by switches or BAS signal, or any combination.

2.7.5. Memory is to have battery back-up to prevent memory loss during power outages.

2.7.6. Microprocessor is to have a battery back-up for the memory to prevent memory loss during power outage.

2.8. MANUFACTURERS

2.8.1. The following are acceptable manufacturers:

- .1 GE – TLC – Total Lighting Control Level III
- .2 Douglas - PDM
- .3 Gentec - Kameleon K8 Series
- .4 Watt Stopper - Lighting Integrator
- .5 Hubbell - LX Networked Lighting Controls

3. Execution

3.1. INSTALLATION

3.1.1. Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

3.2. TESTS

3.2.1. Actuate control units in presence of Engineer's Representative to demonstrate lighting circuits are controlled as designated.

3.2.2. Demonstrate the operation of the system through the computer software and the BAS system.

END OF SECTION 16591

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 16010 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 1.2. REFERENCES
    - 1.2.1. CAN/ULC-S524, Installation of Fire Alarm Systems – latest edition.
    - 1.2.2. CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems – latest edition.
    - 1.2.3. CAN/ULC-S537, Verification of Fire Alarm Systems – latest edition.
    - 1.2.4. OBC - Ontario Building Code – latest edition.
    - 1.2.5. **NBC – National Building Code – latest edition**
    - 1.2.6. CAN/ULC-S1001 - Integrated Systems Testing of Fire Protection and Life Safety Systems – latest edition.
  - 1.3. SYSTEM DESCRIPTION AND INSTALLATION
    - 1.3.1. The fire alarm system and devices shall be installed according to CAN-CSA latest edition and the requirements of the local authorities having jurisdiction.
    - 1.3.2. All wiring shall be installed in conduit and to conform to the requirement of the Ontario Electrical Safety Code, 25th edition or local code having jurisdiction. Provide a ground wire in all conduits.
    - 1.3.3. Confirm the exact location of all system components with the architectural consultant prior to roughing-in.
    - 1.3.4. Contract base building fire alarm contractor to install all devices and make final connections to fire alarm panel.
    - 1.3.5. Ensure that the nomenclature of annunciator's identification nameplates, are verified with the owner and authorities prior to ordering.
    - 1.3.6. All work on the fire alarm system to be performed by a certified fire alarm technician.
    - 1.3.7. When the fire alarm system is complete, obtain the services of base building fire alarm manufacturer to make a complete inspection and verifications of all installed fire alarm equipment and devices.
    - 1.3.8. Perform any changes necessary as a result of the above verification and inspection in accordance with the manufacturer's directions.
    - 1.3.9. On completion of the verification, inspection and testing obtain the verification certificate and inspection reports from the manufacturer and forward to the owner.
    - 1.3.10. Fire alarm signaling devices to be installed and tested in compliance with Ontario Building Code (latest edition) section 3.2.4.20. (audibility).
      - .1 For speakers, set at 0.5 watt tap and modify up if required to achieve audibility. Tap setting shall not be set at or increased to cause the sound pressure level to be more than 100 dBA when measured 3m from the device.
      - .2 For horns with adjustable volume settings, set at mid volume and modify up if required to achieve audibility. Volume setting shall not be set at or increased to cause the sound pressure level to be more than 100 dBA when measured 3m from the device.

Audibility testing shall be performed with all walls, windows, ceilings, ceiling tiles, etc. installed in the space/area. If audibility is determined to be insufficient at time of occupancy, the Contractor shall be responsible for all costs associated with increasing the tap settings of the signalling device to achieve Code minimum audibility. Include for all costs in tender.

- 1.3.11. Ensure that all costs for the above testing, verification, inspection are included in the tender price.
- 1.3.12. Where the integrity of the existing life safety input and output devices are affected due to relocations, ceiling demolitions and/or re-installations onto new suspended ceiling, electrical contractor shall be responsible to maintain the system operation at all times. All suspension accessories required for the installation (e.g., mounting channels and frames, etc.) and verification of the system shall be included in the tender prices.
- 1.3.13. Testing and commissioning of the integration of all life safety and fire protection systems shall be required. Follow the guidelines as outlined in the CAN/ULC-S1001 standard. Where applicable, the testing of the integrated systems shall include, but not limited to the following systems:

- .1 Fire Alarm
- .2 Mass Notification
- .3 Elevators
- .4 Emergency Generators and/or Inverters
- .5 Audio/Visual
- .6 Lighting Control
- .7 Notification (i.e. "Fire Do Not Enter" signage, etc.)
- .8 Sprinkler
- .9 Standpipe
- .10 Water Supplies and/or Control Valves
- .11 Freeze Protection
- .12 Fixed Fire Suppression
- .13 Cooking Equipment Fire Suppression
- .14 Hold-Open Devices
- .15 Electromagnetic Locks
- .16 Smoke Control
- .17 Hazardous Protection Monitoring
- .18 Smoke Alarms
- .19 Emergency Lighting

The Contractor shall be responsible for performing and providing a commissioning report of all the applicable systems installed, that they have been tested as a whole to ensure the proper operation and inter-relationship between the systems. Include for all costs in the tender prices.

END OF SECTION 16721