

# **PROJECT MANUAL – Volume 2**

**Issued for Construction**

**UofT Robarts 5th Floor MDL Renovation**  
**Robarts Library**  
**130 St. George Street, Toronto, Ontario, M5S 1A5**

**Superkül Inc.**  
101 - 35 Golden Avenue  
Toronto, Ontario  
M6R 2J5

Tel: 416-596-0700

Project No. 2322

December 3, 2024

## 1.1 Document Responsibility

- .1 Refer to Project Manual, Section 00 01 10 - Table of Contents, for indication of document responsibility (DR). Abbreviations for entity responsible for document preparation are as follows:
  - .1 A - Denotes documents prepared by Architect.
  - .2 AC - Denotes documents prepared by Acoustical Consultant.
  - .3 E - Denotes documents prepared by Electrical Engineer.
  - .4 H - Denotes documents prepared by Architectural Hinge Hardware Consultant.
  - .5 M - Denotes documents prepared by Mechanical Engineer.
  - .6 O - Denotes documents prepared by Owner.
  - .7 S - Denotes documents prepared by Structural Engineer.
- .2 Professional seals if applied next to company names in the project directory (below) govern only those specification sections and schedules identified by the corresponding document responsibility (DR) abbreviation in Section 00 01 10.

## 1.2 Project Directory

- .1 Owner:

**University of Toronto**

255 McCaul Street, 5<sup>th</sup> Floor  
Toronto, Ontario  
M5T 1W7

**Robarts Library**

130 St. George Street  
Toronto, Ontario  
M5S 1A5

- .2 Architect (the *Consultant*):

**Superkül**

35 Golden Avenue, Suite 101  
Toronto, Ontario  
M6R 2J5

Tel: 416-596-0700

- .3 Structural Engineer:

**Entuitive Corporation**

200 University Avenue, 7th floor  
Toronto, Ontario  
M5H 3C6

Tel: 416-309-5832

Document Responsibility and Project Directory

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.4 Mechanical Engineer:

**Smith and Andersen Consulting Engineering**

1100 - 100 Sheppard Avenue East  
Toronto, Ontario  
M2N 6N5

Tel: 416-218-7019

.5 Electrical Engineer:

**Smith and Andersen Consulting Engineering**

1100 - 100 Sheppard Avenue East  
Toronto, Ontario  
M2N 6N5

Tel: 647-288-5479

.6 Costing Consultant:

**Marshall & Murray Inc.**

120 Carlton Street, Suite 413  
Toronto, Ontario  
M5A 4K2

Tel: 416-928-1993

.7 Code Consultant:

**Jensen Hughes Consulting Canada Ltd.**

2680 Skymark Avenue, Suite 411  
Mississauga, Ontario  
L4W 5L6

Tel: 416-762-3808

.8 Acoustics Consultant:

**Aercoustics Engineering Limited**

1004 Middlegate Road, Suite 1100  
Mississauga, Ontario  
L4Y 0G1

Tel: 647-951-1688

.9 Architectural Hardware Consultant:

**Hinge Hardware Inc.**

49 Fima Crescent, Unit C  
Etobicoke, Ontario  
M8W 3R1

Tel: 416-915-9960

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20 05 00.00 General Instructions for Mechanical Sections

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.
- 1.1.2. The Specification is divided into Sections which are not intended to identify contractual limits between Subcontractors nor between the Contractor and their Subcontractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.
- 1.1.3. Provide mechanical components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.
- 1.1.4. It is understood that hazardous materials may be present (e.g. asbestos, mould, PCB's, etc.) within the existing building. Review U of T abatement procedures and recommendations with respect to hazardous materials. Review testing reports and locations to determine affect on project scope and to be coordinated with U of T PM

1.2. INTENT

- 1.2.1. Mention in the Specifications or indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
- 1.2.2. The Specifications are an integral part of the accompanying Drawings. Consider any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, as properly and sufficiently specified.
- 1.2.3. Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.

1.3. SECTIONS AFFECTED

- 1.3.1. These instructions apply to and form a part of all Division 20 and 23 Sections referred herein as Mechanical.

1.4. DEFINITIONS

- 1.4.1. Where used on the Drawings or in the Specifications, the following words are given the meanings below.
  - .1 Provide: means supply, install, connect and test.
  - .2 Demolish: detach existing items and legally dispose of them off site.
  - .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
  - .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to Owner), or removed and reinstalled.
  - .5 Remove and Salvage: detach existing items and turn over to Owner.

1.5. REGULATIONS

- 1.5.1. Perform Work in accordance with codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- 1.5.2. Comply with all guidelines and standards issued by the authorities having jurisdiction.
- 1.5.3. Where names of codes and standards are referenced on the Contract Documents, comply with the latest in force edition in the jurisdiction of the Place of the Work.
- 1.5.4. Comply with regulations respecting plumbing made under the following legislation except as modified by rules, regulations and by-laws of authorities having jurisdiction:
  - .1 Ontario Building Code Part 7.
- 1.5.5. Provide materials and assemblies with flame-spread ratings and smoke developed classifications in conformance with CAN/ULC-S102 "Test for Surface Burning Characteristics of Building Materials and Assemblies." Compliance with ASTM E84 "Surface Burning Characteristics of Building Materials" in lieu of CAN/ULC-S102 is not acceptable.
- 1.5.6. These Specifications are supplementary to the requirements above.
- 1.5.7. Drawings and Specifications should not conflict with the above regulations but where there are apparent discrepancies, notify the Engineer's Representative.
- 1.5.8. Where equipment utilizing refrigerants is provided, comply with regulatory refrigerant phase out requirements and dates applicable in the jurisdiction where the Project is taking place. Where equipment not meeting refrigerant phase out requirements or dates is supplied to site, provide revised unit(s) operating on a new refrigerant at no additional cost to the Owner; cover all costs of any electrical, structural, mechanical, architectural, etc. changes required to accommodate the new refrigerant.

1.6. PERMITS, FEES AND INSPECTIONS

- 1.6.1. Obtain all permits, make submissions, pay all fees and arrange for all inspections required for the Work of this Division.

1.7. EXAMINATION OF SITE

- 1.7.1. Before submitting Bids, 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.

1.8. DRAWINGS, CHANGES AND INSTALLATION

- 1.8.1. The Drawings show the general character and scope of the Work and not the exact details of the installation. Install all equipment and systems complete with all accessories required for a complete and operational installation.
- 1.8.2. The location, arrangement and connection of equipment and material as shown on the Drawings represents a close approximation to the intent and requirements of the Work. 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 additional cost.
- 1.8.3. In order to show more clearly the arrangement of the Work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standard Details and to the Specifications to determine the requirements.
- 1.8.4. Install equipment in accordance with the manufacturer's written installation requirements. In the event of conflicts between the Drawings or Specifications and the manufacturer's written installation requirements, notify the Engineer's Representative for resolution.

- 1.8.5. Certain Details indicated 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 are applicable to every occurrence.
- 1.8.6. Conceal all piping and ductwork in finished areas in ceiling spaces and shafts or furred into walls. Do not install exposed piping or ductwork in such areas unless specifically reviewed and accepted by the Engineer's Representative. Do not install piping in outside walls.
- 1.8.7. Do not install vent pipes, exhaust hoods or other mechanical equipment mounted on the roof, or housing for such equipment, closer to the edge of the roof than a distance equal to the height of the pipe, hood or equipment, unless specifically reviewed and accepted by the Engineer's Representative.
- 1.8.8. The location and size of existing services shown on the Drawings are based on the best available information. Site verify the actual location of existing services before commencing Work. Pay particular attention to underground services.
- 1.8.9. Make changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other Trades, or to accommodate existing conditions, at no additional cost.
- 1.8.10. Leave areas clear of piping and ducts where space is indicated as reserved for future equipment and equipment for other Trades.
- 1.8.11. Allow adequate space and provisions for the removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.8.12. Where equipment is shown to be 'roughed-in only,' obtain accurate information from the Engineer's Representative before proceeding with the Work.
- 1.8.13. Before fabricating ductwork or piping for installation, make certain that such items can be installed as shown on the Drawings without interfering with the structure or the Work of other Trades. Submit any problems that cannot be solved in agreement with the other Trades affected, for resolution. If ductwork or piping is prefabricated prior to the investigation and reaching of a solution to possible interference problems, make necessary changes in such prefabricated items at no additional cost.
- 1.8.14. Location of diffusers, grilles, registers, thermostats, sprinklers and all other equipment shown on plans is diagrammatic. Layout of each device in finished areas is critical in terms of symmetry and location. Refer to Architectural Drawings and to Supplemental Instructions in all regards. Revise any Work not installed in the correct location (at the sole discretion of the Engineer's Representative) at no additional cost. Mark-out fully co-ordinated Work with all other trades, in sufficient time for review by Engineer's Representative prior to rough-in. Precisely locate all mechanical and sprinkler services.
- 1.9. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS
- 1.10. BID FORM AND SUBMISSIONS OF BIDS
  - 1.10.1. Submit with the bid, all information called for on the Bid Form. Bids not completed in full may, at the discretion of the Owner, be rejected.
  - 1.10.2. Where only one name appears in the Specification, include the specified equipment in the Bid.
  - 1.10.3. Where two or more names are shown in the Specifications as alternatives or equal to, this Division can select which manufacturer is to be carried, provided the choice is shown on the Bid Form. Where the choice is not indicated, supply the equipment described in the Specification or first named on the Bid Form.
  - 1.10.4. Substitute equipment may be offered as a price deduction to the Bid price. Acceptance of substitute equipment is at the discretion of the Owner whose decision is final.

- 1.10.5. Only propose alternative and/or substitute equipment that is equal in performance and quality to that specified. Include the cost of all changes required to accommodate alternative and/or substitute equipment, in the price shown on the Bid Form, including but not limited to space, power, structural or any other requirements that are different from the equipment specified.
- 1.10.6. The Owner reserves the right to accept or reject any substitution without question.
- 1.10.7. Include the cost of premium time in the Bid price for Work provided during nights, weekends or other times outside normal working hours, necessary to maintain all mechanical services in operation and to meet the Project schedule.
- 1.11. MATERIALS
- 1.11.1. Make and quality of materials used in the construction of this Work are subject to the approval of the Engineer's Representative.
- 1.11.2. Supply only new materials and equipment, free from defects and as specified by the manufacturer's name and catalogue reference.
- 1.11.3. Where a manufacturer's equipment has been specified by name and/or model number, ensure that the performance and quality of equipment provided by an acceptable manufacturer, meets the specified equipment performance, is inclusive of all standard and specified optional features, and can be installed in the planned location with access and maintenance clearances in accordance with the manufacturer's written installation recommendations. Provide all required piping, duct and electrical connections at no additional cost.
- 1.12. CO-OPERATION WITH ENGINEER'S REPRESENTATIVE
- 1.12.1. To assist in the successful execution of the Project, the Contractor will receive an initial job report that summarizes the expectations of the Engineer's Representative and the Contractor. This job report covers topics such as progress billings, shop drawing requirements, Change Order pricing, the commissioning process, installation drawings, the Specifications, as-built drawings and operations and maintenance manuals, along with a number of other items. This job report is intended to reiterate key items from the Contract Documents and is not intended to impose new requirements.
- 1.12.2. For mechanical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:
- .1 Air balancing report
- 1.12.3. For mechanical systems financial close, provide the following additional documents to the Engineer's office for review:
- .1 Copies of as-built drawings
  - .2 Operating and maintenance manual
  - .3 Warranty letter
  - .4 Training
- 1.13. SUBSTANTIAL PERFORMANCE
- 1.13.1. The Owner will not deem the Project "ready for use" as defined in the provincial or territorial lien legislation until the following minimum items are complete:
- .1 Everything required in the clauses above for occupancy.
  - .2 Submission of final, reviewed as-built documentation to the Engineer's Representative and Owner, as outlined in Specification Section 20 05 02.00 – AS-BUILT DRAWINGS. Note that this includes all final balancing reports.

1.14. CO-OPERATION WITH OTHER DIVISIONS

- 1.14.1. Pay particular attention to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.14.2. Maintain at least 150 mm (6 in.) separation between pipes transporting hot fluids and pipes carrying cold fluids, unless approval from the Engineer's Representative is obtained.
- 1.14.3. Do not allow Electrical conduits to touch or be supported from piping or ductwork.
- 1.14.4. Install all materials in the spaces shown without encroaching upon space for materials installed under other Sections or Divisions. Where the space allocated to another Section or Division is encroached upon, relocate the materials to their proper space allocation in such a manner to complete the Work using space allocated to the various Sections and Divisions. Relocate materials and Work involved at no additional cost.
- 1.14.5. Supply all items to be built in ample time for rapid progress of the Work. Schedule and proceed with Work as required to satisfy the construction schedule.
- 1.14.6. Confirm the available voltage for all single phase and three phase motors or other similar electrically driven equipment with the Electrical Division prior to ordering the equipment. Report any discrepancy between the requirements identified within the Contract Documents and those of the Electrical Division to the Engineer's Representative and supply equipment to suit the appropriate power requirements. Bear all costs associated with failure to perform this coordination prior to ordering of the motors or equipment.

1.15. TEMPORARY USE OF EQUIPMENT

- 1.15.1. Where systems, or a part thereof, are operated during construction, maintain the system and equipment in proper operating condition.

1.16. EXISTING SERVICES AND EQUIPMENT

- 1.16.1. Provide temporary filters, 1 in. thick disposable media type, over all return air openings in the base building HVAC systems that remain in operation during construction. Maintain and replace the temporary filter media as required to prevent construction dust from fouling the base building equipment. Remove same at the completion of construction. Replace filters in all base building air handling equipment i.e., Air Handling Units, Induction Units, Fan Coil Units, etc., after construction is completed.
- 1.16.2. Provide new materials and equipment as required to ensure a complete installation. Package and dispose of all existing materials not used in this contract. Include in the bid.
- 1.16.3. Schedule all changes and connections to existing services at a time approved by the Engineer's Representative so as to avoid any interruption of such services during normal working hours. If necessary, make changes and connections to existing services outside of normal working hours, without additional cost.
- 1.16.4. Prior to operating any existing or new equipment during any stage of construction, receive written approval from the Landlord and Engineer's Representative.
- 1.16.5. Whenever existing services or equipment are to be removed, remove all associated piping and ducts back to the main, nearest pipe or duct and securely cap or plug open ends in an approved manner. If necessary to facilitate installation of new Work, remove existing services and equipment and then replace without additional cost.
- 1.16.6. Whenever it becomes necessary to relocate existing piping, ducts or equipment to make possible installation of the Work under this Contract, make such relocation without additional cost.
- 1.16.7. Where connections are made to existing services, replace and make good existing insulation.

1.17. INTERRUPTION OF SERVICES

- 1.17.1. Schedule interruptions of the mechanical services to any part of the building at a time agreeable to the Landlord. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- 1.17.2. Perform all such overtime Work at no additional cost.

1.18. STATEMENT OF PRICES

- 1.18.1. For the purpose of progress applications, submit a summary statement of estimated prices for the various portions of the Work, including labour, materials and equipment shown separately. The total price of all portions of the Work must equal the total price of the Work covered under Divisions 20 and 23.
- 1.18.2. Submit the summary of Work for this Contract to the Engineer's Representative for review and approval. Provide sufficient detail in the summary to enable the Engineer's Representative to evaluate the progress of Work and identify all major equipment, components and sub trades.

1.19. METRIC CONVERSIONS

- 1.19.1. Take particular care with imperial versus SI metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- 1.19.2. Conform to CAN/CSA-Z234.1 "Metric Practice Guide."

1.20. DEMOLITION

- 1.20.1. The 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. Open shafts, walls and ceilings as required to examine the services.

1.21. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP

- 1.21.1. The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Conditions for all requirements.
- 1.21.2. There may be access restrictions to the site (location, time of day, days of week). Refer to Front End Specifications for more information and conform to all requirements stated within.
- 1.21.3. Refer to the security and protection requirements in the General Conditions and conform to all requirements. In particular:
  - .1 No smoking.
  - .2 Keep the site clean at all times.

1.22. ASHRAE 90.1

- 1.22.1. Provide mechanical equipment that complies with the minimum efficiency standards set out in ASHRAE 90.1 "Energy Standard for Buildings Except Low-rise Residential Buildings" and the National Energy Code of Canada for Buildings. Submit all necessary information to substantiate conformance.

1.23. HOISTING FACILITIES

- 1.23.1. Provide hoisting facilities for the Work of this Division.

1.24. INTELLECTUAL PROPERTY

1.24.1. The Contractor acknowledges, represents, warrants and agrees that the Owner, its Consultants, and the Engineer's Representative are not responsible, and are hereby indemnified against any action as a result of patent infringement made through the review, acceptance, or receipt of materials, equipment, Work, etc. provided by the Contractor or any of their Suppliers or manufacturers in the execution of this Contract.

1.25. MATERIALS AND EQUIPMENT

1.25.1. Use new materials and equipment as specified or shown that are free from defects that impair strength, durability, or aesthetics.

1.25.2. Manufacture in Canada wherever possible.

1.25.3. Labelled and/or Listed as required by the Authority Having Jurisdiction or Code.

1.25.4. Mechanical systems are designed and coordinated based on the manufacturer and model number and/or parameters indicated on the Equipment Schedules. Accept all costs for differences in physical properties or performance between scheduled equipment and acceptable alternative equipment manufacturers or models identified in these Specifications. Differences may include, but are not limited to, size, layout, arrangement of components, connection sizes, maintenance access, locations and/or quantity of service connections, and performance differences such as noise, power consumption, flow rates, etc.

.1 Electrical coordination: accept all extra costs to revise the electrical provisions, including but not limited to feeder/wiring sizes, breaker sizes, fuse sizes, starters and equipment, to supply power to the non-basis of design piece of equipment.

1.25.5. Be responsible for all design costs associated with differences between scheduled equipment and alternate manufacturers or models identified in these Specifications.

1.26. VALUATION OF CHANGES

1.26.1. Further to Contract requirements, use the following method in determining the value of a change to the Work, by either Change Order or Change Directive:

.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.

1.26.2. Provide the Engineer's Representative with a detailed cost analysis of the proposed change including:

.1 Quantity of each material.

.2 Unit cost of each material.

.3 Labour units based on Mechanical Contractors Association of America (MCAA) Labour Estimating Manual.

.4 Labour (hours) involved.

.5 Suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.

.6 Sub-trade quotations including a complete cost breakdown of the proposed change meeting the requirements of this section.

.7 Sub-trade's suppliers' quotation or credit memo for equipment noted in proposed change, with detailed breakdown.

.8 Mark-ups, if applicable.

.9 Value of GST or HST, as applicable.

.10 Proposed change in contract time, if any.

- .11 S+A proposed change number in every quotation to facilitate record keeping.
- 1.26.3. Comply with requirements of Contract Documents for all materials included in quotations for proposed changes.
- 1.26.4. List material and labour separately for each item/clause of the proposed change, on the detailed cost breakdown.
- 1.26.5. Not be entitled to any additional compensation arising out of changes to the Work other than the amounts determined and agreed to under CCDC 2-2020 GC 6.2.
- 1.26.6. 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.
- 1.26.7. Charge special equipment rental rates at cost. Provide an official quotation of the equipment rental with the proposed change quotation as backup, otherwise special equipment rentals will not be accepted by the Owner/Consultant.
- 1.26.8. All changes, change notices, proposed changes, revisions to contract, Supplemental 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.
- 1.26.9. Use material costs based on a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The Owner and/or Engineer's Representative reserve the right to negotiate material pricing to a value that is fair and reasonable to the Owner. Indicate on the Bid Form or Supplementary Bid Form: which pricing guide is proposed to be used and discount rate compared to list price.
- 1.26.10. Base the hourly labour rate for all changes on a Journeyperson rate as listed on the Bid Form and/or Supplementary Bid Form. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit.
- 1.26.11. At the request of the Owner or the Engineer's Representative, 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.
- 1.26.12. When pricing additional work for proposed changes, only price new materials that are required for the proposed change. Where existing materials and/or infrastructure can be re-used for the proposed change, utilize these items in the valuation of the change at no extra cost.
- 1.26.13. Where a proposed change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.26.14. When pricing proposed changes containing both additions and credits, and where no work and/or materials have been installed on site, only price the net new materials and net new labour that are required for the proposed change. Utilize equal per unit labour and material costs for credits and additions.
- 1.26.15. Utilize equal per unit labour and material costs for credits and additions.
- 1.27. STATEMENT OF PRICES
- 1.27.1. Ensure that the total price of all portions of the work equals the total price of the work covered under the Mechanical Division. Present cost for as-built drawings and O&M manuals as separate line items as shown below. Present line items from Section 20 08 00.00 – COMMISSIONING as shown below.

- 1.27.2. List and track each of the approved changes on separate lines on the progress draw.
- 1.27.3. Amortize costs of temporary facilities and utilities over the duration of the Work. Claims for 'mobilization,' 'bidding costs,' or similar lump sums at or before start of Work are not acceptable.

END OF section

20 05 02.00 As-built drawings

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RECORD OF REVISIONS ON SITE

1.2.1. Print and maintain two complete sets of white prints to mark the Project progress, changes and deviations.

1.2.2. Maintain an updated copy of plans and schematics in the digital format for which the Project is provided (i.e. AutoCAD ) and be capable to produce documents in Adobe PDF upon request.

1.3. SUBMITTALS

1.3.1. Submit as-built drawings in CAD format and PDF format for all other areas of the building prior to request for occupancy.

1.3.2. Comply with Section 20 05 03.00 - SHOP DRAWINGS for all submittals.

2. Products

2.1. NOT USED

3. Execution

3.1. DOCUMENTATION REQUIREMENTS

3.1.1. As the Project progresses record all changes and deviations.

3.1.2. Maintain an accurate dimensional record of revisions. Specifically record:

.1 Duct revisions.

.2 Locations of access doors and panels. Identify the equipment and components they serve.

3.1.3. Keep revisions up-to-date during construction including Change Orders, Change Directives, and Supplemental Instructions. Documentation shall be available for review at all times.

3.1.4. Final as-built documents shall not contain markings or corrections electronically or by hand (i.e. marker, pen, pencil, etc.). Drawings submitted that contain mark-ups will not be accepted.

3.2. SUBMISSION REQUIREMENTS

3.2.1. On completion of the Work, submit the draft documentation indicating all such changes and deviations for review by the Engineer's Representative. Submit all documents in PDF format.

3.2.2. Upon return of the "Reviewed" draft submittal, transfer "as-built" information and any additional submittal comments to the final software submission requirement (i.e. Autodesk AutoCAD).

- .1 Request the acceptable version(s) of the software that may be used. Owner shall confirm the acceptable software version upon receipt of request. If the Owner has no preference, the latest published version shall apply.
  - .2 Conform to the Owner/Engineer's Representative's standards.
  - .3 The Mechanical Contractor may request from the Engineer's Representative the most current electronic documentation in AutoCAD. Documents to be forwarded via a secure file transfer (at a nominal charge of \$500.00).
  - .4 Clearly label electronic files with Engineer's Representative and Owner, Contract number, file names and the Drawing number.
- 3.2.3. Submit the documents in PDF along with the submission of the completed electronic source software documentation on an approved electronic storage device for review by the Engineer's Representative.
- 3.2.4. The Project will remain incomplete and monies retained until a satisfactory as-built submission is provided.
- 3.3. AUTOCAD SPECIFIC SUBMISSION REQUIREMENTS
- 3.3.1. Make special effort to ensure that drafting is accurate, i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and that entities are placed on correct layers.
- 3.3.2. Use the standard fonts available in the software. Do not use custom fonts, shape files, etc.
- 3.3.3. Provide all drawings in the same scale of measurement and units as issued on Bid Documents.

END OF SECTION

20 05 03.00 Shop Drawings

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
2. Products
  - 2.1. SHOP DRAWINGS
    - 2.1.1. Submit Shop Drawings organized by Specification Section. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate Shop Drawings for the same Specification Section. Do not combine more than one Specification Section into one submission. Incorrect submissions will be returned without review.
    - 2.1.2. Submit Shop Drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:
      - .1 S+A Project number and Contractor Shop Drawing Identifier in Subject Line
      - .2 Attachments shall be limited to 20MB
      - .3 Provide FTP hyperlink for all attachments in excess of 20MB with appropriate information for downloading the file (as required)
      - .4 Shop Drawing Submission to the following email address:
        - .1 ContractAdmin.Toronto@smithandandersen.com
    - 2.1.3. Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.
    - 2.1.4. 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 as noted in the documents of the specific pump, fan, etc. for which it was prepared.
    - 2.1.5. 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.
    - 2.1.6. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation. The Engineer's Representative may also request that this information be added to the maintenance and operating manual.
    - 2.1.7. Provide a cover sheet with the Project name, issue date, issue number, Specification section number, title of section and with space for Shop Drawing review stamps for the Contractor and Engineer's Representative.

3. Execution

3.1. SUBMISSIONS

3.1.1. Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the submission for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have 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 Shop Drawings for review.

3.1.2. Scanned PDF versions are not acceptable.

3.1.3. Manufacturing of equipment, installation of equipment or connecting services shall not start until after final review of Shop Drawings by the Engineer's Representative has been completed.

END OF SECTION

20 05 29.00 Hangers and Supports

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Submit Shop Drawings in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

2. Products

2.1. MATERIALS

2.1.1. Provide hangers and supports manufactured by Anvil ASC Engineered Solutions, Taylor Pipe Supports, or E. Myatt & Co.

2.1.2. All drilling for hangers, rod inserts and Work of similar nature shall be done by this Division.

2.1.3. Depending on the type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts. Submit proposed hanger details for review and acceptance by the Structural Engineer's Representative. Make adjustments as necessary to satisfy the requirements of the Structural Division.

2.1.4. Suspension from metal deck shall not be allowed unless specifically accepted by the Engineer's Representative. Drawings of the proposed method of suspension must be submitted for review.

2.1.5. Suspending one hanger from another shall not be permitted.

2.1.6. For insulated ducts, ensure supports are on the outside of the insulation so as to not be directly connected to the duct creating a vapour barrier issue. Provide high density insulation in the area of the supports and spread the load.

END OF SECTION

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20 05 48.00 Vibration and Noise Control

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Concrete Work on grade or cast integrally with a floor is provided under Division 3.

1.3. SUBMITTALS

1.3.1. Shop Drawings: Supply Shop Drawings of the vibration and noise control equipment being supplied in accordance with Section 20 05 03.00 - SHOP DRAWINGS. Provide Shop Drawings showing completely the various acoustic assemblies. Include on the Shop Drawings the equipment weight at each isolator and the isolator proposed to be used complete with its weight rating. Submit Shop Drawings after all major equipment (e.g. chillers, cooling towers, etc.) has been reviewed and isolators have been coordinated.

1.4. PERFORMANCE REQUIREMENTS

1.4.1. Adequately isolate all equipment to maintain acceptable noise levels in the occupied area of the building as specified below. Take noise measurements over the complete audible frequency range in each of the occupied zones under, above and beside Mechanical Equipment Rooms, and where indicated by the Engineer's Representative. Noise levels due to mechanical equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall not exceed sound pressure levels in all 8 octave bands corresponding to the NC levels per ASHRAE handbook as indicated.

2. Products

2.1. MATERIALS

2.2. INTERNAL ACOUSTIC DUCT LINING

2.2.1. Natural fibre duct lining manufacturer: Bonded Logic.

2.2.2. Provide acoustic duct lining with a minimum density of 24 kg/m<sup>3</sup> (1.5 lbs/ft<sup>3</sup>).

2.2.3. Provide acoustic duct lining that complies with the requirements of NFPA 90A "Standard for the Installation of Air-Conditioning and Ventilation Systems" and the "Duct Liner Materials Standard" of the Thermal Insulation Manufacturer's Association.

2.2.4. Provide internal acoustic duct lining that incorporates means to prevent fiber entrainment in the air stream, such as airstream surface and long edges complete with acrylic polymer surface coating.

3. Execution

3.1. INSTALLATION

3.2. ACOUSTICAL LINING OF DUCTS

3.2.1. Acoustically line ductwork where shown on the Drawings and as Specified.

3.2.2. Provide a minimum of 25 mm (1 in.) thick acoustical duct lining in all internally lined sheet metal ducts, unless otherwise specified or shown on the Drawings.

3.2.3. Install acoustic lining using both pins and a minimum of 50 % coverage of a fire-resistant adhesive. Install pins on maximum 450 mm (18 in.) centres on all sides and tack weld to the duct or plenum. Mechanical fasteners that pierce the duct are unacceptable. Seal all edges of acoustic lining to prevent air erosion with sheet metal nosing that overlaps the insulation by 19 mm (3/4 in.) minimum. Coat all ends of the liner with a fire resistant cementing material to prevent delamination, leakage or erosion. Firmly butt all joints and coat ends with an adhesive to ensure that the lining is smooth across all joints.

3.2.4. Where acoustical duct lining is installed, increase the dimensions of the sheet metal to include the thickness of the lining material. Dimensions shown on the Mechanical Drawings are the clear internal dimensions after the liner has been installed.

3.2.5. Internally insulate the following ductwork:

- .1 All return air transfer ductwork.
- .2 All ductwork specifically identified in Specifications and/or on the Drawings.

END OF SECTION

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20 05 63.00 Access Doors and Accessibility

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
  - 1.2. SUBMITTALS
    - 1.2.1. Submit Shop Drawings showing size, type and location of all access doors, for review, before installation in accordance with Section 20 05 03.00 – SHOP DRAWINGS.
    - 1.2.2. Have Balancing Contractor review proposed access door sizes and locations to ensure that sufficient access is available. Confirm in writing that this review has occurred.
2. Products
  - 2.1. MATERIALS
    - 2.1.1. Provide access doors that comply with Section 08 31 00 - ACCESS DOORS AND PANELS from the Architectural Specification. Where the Architectural Specification section is silent on a required access door type, comply with the Part 2 clauses in this section.
    - 2.1.2. Provide access doors by Acudor, Bauco or Mifab Manufacturing Inc. Steel thickness (US Gauge) indicated as minimum acceptable.
    - 2.1.3. For doors in drywall partitions or ceilings, provide a minimum 22 US gauge, prime painted steel recessed door panel for the acceptance of a drywall insert, concealed hinges, drywall bead frame, and screwdriver operated lock. Bauco Plus II, Acudor model DW-5015 or Mifab Model CAD-DW.
    - 2.1.4. For access doors in fire rated walls or ceilings, provide ULC labeled with insulated door panel, concealed hinge, self-closing, self-latching, flanged frame, and prime painted. Provide master key operated catch in areas accessible to the public. Acudor Model FW-5050 or Mifab MPFR.
3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. Provide access doors of minimum 600 mm x 600 mm (24 in. x 24 in.) size. Custom size access doors may be required to allow combining access doors in close proximity and to ensure maintenance and accessibility of all parts requiring periodic maintenance.
    - 3.1.2. Ensure all parts of the installation requiring periodic maintenance are accessible. Wherever valves, dampers and other appurtenances are concealed by building construction, provide access doors and install under the respective Trade Sections (i.e. masonry, plaster, drywall, tile, etc.). Be responsible for the proper location of the access doors.
    - 3.1.3. For all mechanical equipment located above drywall and other inaccessible ceilings, provide access doors that will allow for full removal and replacement.
    - 3.1.4. Wherever possible, locate items requiring access in easily accessible areas (i.e. exposed or T-bar ceilings).

- 3.1.5. Group items in order to minimize the number of access doors required.
- 3.1.6. Install each access door to provide complete access to equipment for maintenance and servicing.
- 3.1.7. Make any changes to locations of access doors as directed by the Engineer's Representative.
- 3.1.8. Show the final installed locations of all access doors on the as-built drawings.

END OF SECTION

20 05 88.00 Cutting and Patching

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. All services and materials used for the cutting and patching shall meet all requirements specified in Section 01 60 00.00 - PROJECT FORMS, and shall be carried out by professional workers experienced in the cutting and patching Work to be done.

3. Execution

3.1. INSTALLATION

3.1.1. Locate all openings in non-structural elements requiring cutting and patching in cooperation with the applicable Trades in a timely manner to avoid unnecessary cutting. All openings shall be shown on drawings and submitted to the Engineer's Representative for review. No holes through structure shall be permitted prior to review by the Structural Engineer's Representative.

3.1.2. Core drilling for individual services shall be by this Division. Cut all openings no larger than is required for the services.

3.1.3. Locate all openings in structural elements requiring cutting and patching (concrete walls or floors) and x-ray the structure to obtain Structural Engineer's Representative's approval prior to cutting or core drilling of structure. Make adjustments to location of openings as required to minimize cutting of rebar and completely avoid electrical conduit.

- .1 Cut holes through slabs or walls only.
- .2 Do not cut holes through beams.
- .3 Holes to be cut are 200 mm (8 in.) diameter or smaller only.
- .4 Maintain at least 100 mm (4 in.) clear from all beam faces. Space at least 3 hole diameters on Centre.
- .5 For holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.
- .6 For holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.
- .7 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity.

3.1.4. Obtain written approval from the Landlord and the Structural Engineer's Representative before cutting or core drilling openings or holes.

3.1.5. Patch all openings after services have been installed to match the surrounding finishes.

END OF SECTION

20 07 00.00 Insulation

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Provide Shop Drawings with technical data on all types of insulation to be installed, in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

2. Products

2.1. GENERAL

2.2. DUCT INSULATION

2.2.1. Type D2 - Inorganic mineral fibre board:

- .1 To ASTM C612 “Standard Specification for Mineral Fiber Block and Board Thermal Insulation.”
- .2 Semi-rigid board, with factory applied foil scrim kraft (FSK) facing jacket vapour barrier.
- .3 Suitable for temperature range of duct application in question.
- .4 Density: 48 kg/cu.m. (3 lbs/cu.ft.).
- .5 Acceptable manufacturers:
  - .1 Johns Manville
  - .2 Knauf
  - .3 Owens-Corning
  - .4 Rockwool

2.3. SECUREMENT

2.3.1. Banding

- .1 Aluminum or Stainless steel.

2.4. CEMENTS AND ADHESIVES

2.4.1. Where cements or adhesives are required, provide those that are compatible with insulation and jacket, per insulation and jacket manufacturer’s written recommendations / instructions.

3. Execution

3.1. INSTALLATION

3.1.1. Install insulation in accordance with the manufacturer’s written installation instructions unless noted otherwise.

- 3.1.2. Insulation thicknesses and conductivities shall meet or exceed the minimum standards set out in ASHRAE 90.1 "Energy Standard for Buildings except Low-rise Residential Buildings" and in National Energy Code of Canada for Buildings (NECB), (refer to Table 2 below), and as specified herein for the services covered.
- 3.1.3. Apply insulation to clean, dry surfaces only while ambient temperature is at least 10 Deg. C. (50 Deg. F.).
- 3.1.4. Commence application of insulation following required testing of ductwork, and apparatus where such items are to be covered. Do not commence insulation installation until testing report is submitted to Engineer's Representative and is reviewed by Engineer's Representative without requesting a resubmit.
- 3.1.5. Where ducts are specified to be insulated, insulate complete duct system with no gaps in insulation.
- 3.1.6. Repair missing or damaged insulation to allow for new work only.

END OF SECTION

20 08 00.00 Commissioning

4. General

4.1. WORK INCLUDED

- 4.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 4.1.2. Conform to Section 20 05 02.00 - AS-BUILT DRAWINGS.
- 4.1.3. Conform to Section 20 05 03.00 - SHOP DRAWINGS.
- 4.1.4. Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.
- 4.1.5. Conform to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 4.1.6. The commissioning process for the Mechanical Systems shall include:
  - .1 Verification that the installation meets the requirements of the Contract Documents.
  - .2 Verification that the system's performance meets the design intent.
  - .3 Provision of building operator training.
  - .4 Provision of as-built documentation, operating and maintenance manuals, and systems operating manuals.
- 4.1.7. Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- 4.1.8. The Owner will hire a Commissioning Agent who will provide services identified in the Commissioning Agent articles within this Section.

4.2. SUBMITTALS

- 4.2.1. Submittals requested in this Section shall be submitted in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

5. Products

5.1. MATERIALS

- 5.1.1. The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Mechanical Sections. The Contractor shall advise the Engineer's Representatives or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

6. Execution

6.1. INSTALLATION

- 6.1.1. This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.
- 6.1.2. The commissioning process shall consist of:
  - .1 Shop Drawings/as-built drawings
  - .2 Installation review and equipment verification

- .3 Testing of air systems
- .4 Testing of equipment and systems
- .5 Building Automation System Commissioning
- .6 Commissioning Agent performance testing
- .7 Operating and maintenance manuals
- .8 Training
- .9 Systems acceptance

6.2. INSTALLATION REVIEW AND EQUIPMENT VERIFICATION

- 6.2.1. The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Engineer's Representative for review and be included in the operating and maintenance manuals.

6.3. TEST FORMS AND VERIFICATION FORMS

- 6.3.1. The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the General Contractor and the Engineer's Representative.
- 6.3.2. The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Engineer's Representative for review on a monthly basis.
- 6.3.3. The forms shall be signed by either the Authorities Having Jurisdiction, the Engineer's Representative or the Commissioning Agent where applicable.
- 6.3.4. Test forms and verification forms have been included with this Section. Obtain approval from the Engineer's Representative if the Contractor wishes to use different forms.

6.4. PLUMBING AND DRAINAGE SYSTEM TESTING

- 6.4.1. The plumbing and drainage system shall be tested in accordance with Section 23 05 93.13 - TESTING AND BALANCING PIPING SYSTEMS.
- 6.4.2. The Contractor shall notify the Building Inspector when systems are available for testing. The Contractor shall document all tests performed and shall arrange for the Building Inspector to sign the forms for tests completed.

6.5. TESTING OF AIR SYSTEMS

- 6.5.1. Conform to Section 23 05 93.23 - TESTING AND BALANCING AIR SYSTEMS.

6.6. TESTING OF EQUIPMENT AND SYSTEMS

- 6.6.1. Should equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Engineer's Representative or the Commissioning Agent.
- 6.6.2. Tests which have not been witnessed shall not be accepted and shall be repeated.

6.7. COMMISSIONING MEETINGS AND SCHEDULING

- 6.7.1. The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.

6.8. OPERATOR TRAINING

6.8.1. Training will begin when the operating and maintenance manuals have been delivered to the Owner and reviewed by the Engineer's Representative.

6.8.2. Each training session will be structured to cover:

- .1 Operating procedures
- .2 Trouble-shooting procedures

6.8.3. The training sessions will be scheduled and co-ordinated by the Commissioning. The Commissioning Agent Training shall be provided for the following systems:

System	Minimum Training Times
Air handling units	2 hours
BAS Controls System	Conform to 23 09 00.00

6.8.4. Refer to Section 23 09 00.00 - BUILDING AUTOMATION SYSTEMS (BAS).

6.8.5. The training requirement for the mechanical system shall include a walk-through of the building by the Contractor. During the walk through the Contractor shall:

- .1 Identify equipment
- .2 Identify access doors
- .3 Review general maintenance of equipment

6.8.6. When each training session has been completed with the Owner's representative, the Commissioning Agent will sign the associated form to verify completion.

6.9. COMMISSIONING AGENT

6.9.1. A Commissioning Agent will be hired by the Owner.

6.9.2. The Commissioning Agent responsibilities shall include:

- .1 Preparing the commissioning plan
- .2 Co-ordinating with the Contractor to schedule tests
- .3 Preparing a test form manual
- .4 Witnessing selected tests
- .5 Receiving all test forms
- .6 Conducting performance test
- .7 Co-ordinating the Contractor's training

6.9.3. The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

6.10. PERFORMANCE TESTING

6.10.1. The Commissioning Agent will conduct performance tests on each mechanical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes. The Commissioning Agent will visit the building in six months to retest the systems.

6.10.2. The Contractor shall conduct performance tests on all mechanical systems and document the results on the performance forms. Request form from the Engineer's Representative.

- 6.10.3. The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- 6.10.4. Performance testing will begin when all mechanical systems have been completed, tested by the Contractor, reviewed by the Engineer's Representative and Substantial Completion has been achieved.

6.11. COMMISSIONING PROCESS ALLOCATION

- 6.11.1. The commissioning process shall be allocated a value equal to 8% of the contract. This value shall be itemized in the Statement of Prices which forms the basis for progress payment for the various portions of Work. The Contractors may draw from this allocation as the commissioning process is completed.
  - .1 The Contractors shall submit all test and verification forms. The Engineer's Representative will use these forms to calculate a percentage complete.
  - .2 The Contractor may claim up to 5% of the contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 3% shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.

6.11.2. The commissioning process allocation shall be broken down as follows:

Shop Drawings	0.50%
Installation review and equipment verification	0.50%
Testing of air systems	0.50%
Testing of equipment and systems (system start-up)	0.50%
BAS commissioning	1.00%
Commissioning Agent Performance Testing	2.00%
Training	0.50%
As-built drawings	0.50%

END OF SECTION

20 08 02.00    Cleaning and Protection

1.            General

1.1.         WORK INCLUDED

1.1.1.      Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2.            Products

2.1.         NOT USED

3.            Execution

3.1.         INSTALLATION

3.1.1.      Any dirt, rubbish, or grease on walls, floors or fixtures accumulated from the Work of the Mechanical Division shall be removed promptly from the premises by this Division.

3.1.2.      During construction protect all services and equipment from dirt and debris, by using temporary caps over the open ends of pipes ductwork and equipment connections.

3.1.3.      All equipment installed or stored on site shall be maintained in accordance with manufacturer's recommended instructions (i.e. rotate shafts on fans, pumps, etc).

3.1.4.      Refinish and restore to the original condition and appearance all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and work quality shall be equal to the manufacturer's original.

END OF SECTION

23 05 93.26 Testing and Balancing Air Systems

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 20 05 00.00 – GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
  - 1.2. QUALITY ASSURANCE
    - 1.2.1. Acceptable balancing companies are limited to the following:
      - .1 Enviro Balance Inc.
      - .2 Design Test
      - .3 Pro-Air Testing Inc.
      - .4 VPG Associates
      - .5 Dynamic Flow Balancing Ltd.
      - .6 Vital Canada Group Inc.
2. Products
  - 2.1. NOT USED
3. Execution
  - 3.1. SYSTEM BALANCING
    - 3.1.1. Balance the complete air system including air volumes and control settings under maximum system pressure drop conditions (filter at replacement condition). Test the entire system for noise, tightness of joints and proper functioning of the system. Make noise tests under minimum system pressure drop conditions (highest air velocities and clean filter conditions). Make necessary alterations and repeat the tests until satisfactory operation is achieved.
    - 3.1.2. Adjust minimum outside air controller and adjust return air and exhaust air damper linkages to ensure correct air quantities.
    - 3.1.3. Employ one of the qualified Independent Balancing Companies to balance the air systems.
    - 3.1.4. The Independent Balancing Company measures and reports upon the air volume at each diffuser, register and grille. Report shall also show the air quantity handled by each fan, the static pressure upstream and downstream of the fan, the fan speed and the motor current. Also to be reported upon are the air flow at outdoor, return and exhaust air dampers under conditions of minimum outdoor air.
    - 3.1.5. Provide assistance to the air balancing company and shall provide control settings, new filters, and other incidentals and equipment required for the measurements.
    - 3.1.6. Air volumes measured by the balancing company shall be within plus or minus 5% of those shown on Drawings for diffusers, grilles and registers and within 10% for fans.

- 3.1.7. In all cases where measurements by the balancing company show failure to comply with the Drawings and Specifications, engage the balancing company to rebalance the system at no increase to Contract Price.
- 3.1.8. Provide a digital copy of the final testing and balancing reports for review by the Engineer's Representative. Include 2 copies of the final testing and balancing reports in the O&M Manual. Ensure reports are complete with index pages and index tabs, and certified by the Independent Company.
- 3.1.9. Balancing company to review Mechanical Contractor's proposed access door locations and sizes per Section 20 05 63.00 – ACCESS DOORS AND ACCESSIBILITY and ensure that sufficient access is available.

END OF SECTION

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23 09 00.02 Building Automation System (BAS)

1. General

1.1. WORK INCLUDED

- 1.1.1. Provide all labour, materials, Products, equipment and services to supply, install, test and commission new additions and integrate into existing Building Automation System (BAS) with Direct Digital Control (DDC) for building mechanical and electrical systems as indicated on Drawings and described herein.
- 1.1.2. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.
- 1.1.3. Conform to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS.
- 1.1.4. Conform to University of Toronto – Building Automation System – Design Standards and Guidelines. Including building standard temperature sensors, cabling colours, system hierarchy, maximum cable distances, point nomenclature, As-built requirements etc.
- 1.1.5. Conform to University of Toronto F&S Standards and submit all forms required, refer to U of T website for more information.
- 1.1.6. Conform to University of Toronto F&S Standards and submit all forms required, refer to U of T website for more information

1.2. RELATED SECTIONS

Section 20 08 00.00 - COMMISSIONING

1.3. PROJECT SCOPE PHASE 1

- 1.3.1. Input/output wiring, if it is installed per this Specification, can be reused.
- 1.3.2. Install new controls for all floor by-pass boxes and connect to the BAS. Acceptable control contractor is Johnson's Controls

1.4. SYSTEM OUTLINE

1.4.1. General

- .1 The documentation contained in this section and other Contract Documents pertaining to Building Automation System (BAS) is schematic in nature. The Contractor shall provide all required hardware and software necessary to implement the functions shown or implied in the Contract Documents.
- .2 Control system to consist of microprocessor based DDC controllers.
- .3 DDC controllers shall be based on open type protocols, BACnet as defined by ANSI/ASHRAE standard 135-2012 for potential future connection to Building Automation System (BAS).
- .4 Control system to consist of high-speed, peer-to-peer network of microprocessor based DDC controllers and integrate with existing BAS.
- .5 Each system, building floor plan and control device shall be displayed through point-and-click graphics.
- .6 BAS to operate on building LAN communication infrastructure.

1.4.2. Functional Principals

- .1 Controls to control mechanical and electrical equipment as specified in CONTROL SEQUENCES
  - .2 System architecture to be modular permitting expansion of application software, system peripherals and field hardware.
  - .3 Each controller to operate independently by performing its own specified control, alarm management, operator I/O and historical data collection receiving information from input field devices and controlling output field devices to perform the control sequences.
  - .4 DDC controller may control more than one system provided that points associated with those systems are connected to that same controller.
  - .5 DDC controllers to be configured so that main inputs and outputs from any control loop are located in that same controller.
  - .6 Global points used for control loop reset such as outdoor air temperature are exempt from this requirement.
  - .7 DDC controllers to be capable of operating with local closed loop programming, independent from the server if communication is interrupted.
  - .8 Where PID control loops are called for in the sequences, they are to be implemented within the controller.
  - .9 BAS server shall perform global control programs and data consolidation and storage, communicating and obtaining data from all controllers and transmitting instructions to all controllers.
  - .10 The supplied system must incorporate the ability to access all data including graphics, reports and alarm detection using standard Web Browsers without requiring proprietary operator interface and configuration programs. An Open Data Base Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a Supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable
  - .11 Support for the exchange of Comma-Separated Value (CSV) files must be provided.
- 1.4.3. Mechanical Contractor to carry the cost of Controls Contractor.
- 1.5. BASE BUILDING BAS PROVIDER
- 1.5.1. Approved Suppliers And Manufacturers  
JCI (Johnson's Controls international)
- 1.6. OPEN PROTOCOL STANDARD
- 1.6.1. Intention of this Specification is to provide an integrated, open protocol BAS, BACnet as defined by ANSI/ASHRAE Standard 135.
- 1.6.2. BACnet devices on the lower tier network to support all BACnet functional groups, standard application services and standard object types necessary, but not limited to provide reading and writing functionality of all analog and binary inputs and outputs and change-of-value initiation and reporting between BACnet devices on the network.
- 1.6.3. All BACnet devices to be BTL tested. Provide Protocol Implementation Conformance Statement (PICS) for all BACnet devices.

1.7. BAS PERFORMANCE

- 1.7.1. Graphic Display: Display the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.7.2. Graphic Refresh: Update the selected graphic representation at Operator Interfaces with current point object data at a minimum rate of twenty points in ten seconds.
- 1.7.3. Data Scan: Update point object data at controllers and Operator Interfaces with current point object data at a minimum rate of once every ten seconds.
- 1.7.4. Binary Object Command: Controlled device will react within five seconds of an operator initiated command on a binary point object.
- 1.7.5. Analog Object Command: Controlled device will start to react within five seconds of an operator initiated command on an analog point object.
- 1.7.6. Alarmed Object Display: Alarm will annunciate visually and audibly at Operator Interfaces within five seconds on local area networks and within forty-five seconds on wide-area networks from the time the object entered the alarmed state.
- 1.7.7. Program Execution Rate: Provide ability to execute programs at a minimum rate of once every five seconds. Provide execution rates suitable for processes controlled.
- 1.7.8. PID Execution Rate: Provide adjustable execution rates for proportional-integral-derivative (PID) loops; update the controlled variable and command the controlled device at this same rate. Provide execution rates suitable for processes controlled.
- 1.7.9. Display and Report Accuracy: Provide minimum accuracy for point object data displayed at Operator Interfaces, reported to printers, reported to data files to Table 1: Display and Report Accuracy.

Table 1: Display and Report Accuracy.	
Point Object	Accuracy
Room Air Temperature	+/-0.2 deg. C (+/-0.36 deg. F) from actual
Air Flow, Terminal Unit	+/-5.0 % of actual
Electrical (current, voltage, power)	+/-1.2 % of actual (see Note 2)
Note 1: For both absolute and differential pressure.	
Note 2: Does not include utility grade meters.	

- 1.7.10. Control Tolerance: Maintain controlled variable to control tolerance from set point to Table 2: Control Tolerance.

Table 2: Control Tolerance.		
Controlled Variable	Range	Control Tolerance from Set Point
Room Temperature		+/-0.6 deg. C (+/-1.1 deg. F)
Air Flow		+/-1.0 % of scale length

1.8. SUBMITTALS

- 1.8.1. Product Data and Shop Drawings:
  - .1 Within 30 days of award of contract, before start of construction, submit completely engineered and coordinated shop drawing package.

- .2 Before start of construction, submit completely engineered and coordinated shop drawing package including graphics samples
  - .3 Submittals in printed format and as amended below.
  - .4 Provide drawing files through Email to Client and S+A Representative.
  - .5 System Flow Diagrams: Indicate: control devices, control device designation, control device range, control device fail-safe position, point object type, point object name, point object address. Indicate flow directions for gases and liquids relevant to the controlled process. Indicate hardwired interlocks between control devices and equipment. Indicate the location of field control devices.
  - .6 Products Schedule: Indicate: Product designation, Product name, Product manufacturer, Product model number, Product data sheet reference number, quantities. Provide quantities required under the Work.
  - .7 Room Schedule: Indicate: controller object name, controller address, controller model number, application designation, room designation, VAV air volume set points, and sensor model numbers.
  - .8 Cabinet Layouts: Interior: Indicate: orientation of contents including controllers, transformers, cable trays, terminal strips, relays, control devices, labels. Exterior: Indicate: orientation of gauges, displays, switches, labels.
  - .9 Wire Details: Indicate: connections between control devices, controllers and equipment; connections to sources of power and grounds; control device designations, control device terminal designations, control device location; equipment terminal designations; cabinet terminal strip designations; wire designations. For control devices shown on multiple Drawings, indicate the control device with the same designation on all Drawings. Differentiate between manufacturer installed wire and field installed wire.
  - .10 Sequence of Operation: Provide a complete description of operation to Section 23 09 23.00 - SEQUENCE OF OPERATION FOR BAS. Provide description of operation for interlocks that directly connect to the Work. Indicate references to the system flow diagram by control device designation or point object name.
  - .11 Points Schedule: Indicate: input points, output points and virtual points for each controller. Indicate: point object address, point object name, point object description, point object alarm limits. List points in ascending order based on point object address.
  - .12 Submit floor plan drawing indicating the coverage of Thermostats sensors where applicable or a spreadsheet to convey the same information..
- 1.8.2. Work Schedule:
- .1 Provide a schedule of the Work within four weeks of contract award. Indicate: intended sequence of tasks, start dates, task durations, and delivery dates for material and equipment requiring long lead times, restraints on Work by other trades or situations.
  - .2 Provide monthly updated Work Schedule indicating percentage complete and revisions to expected delivery dates.
- 1.8.3. Project as-built documents:
- .1 As-built Product data and Shop Drawings:
    - .1 Provide drawing files through Electronic File Transfer.
    - .2 Points Schedule: For points schedule generated under Part 1: Submittals, Product Data and Shop Drawings, indicate operating conditions for point object data; list point objects by system designation and alphabetically by point object name.

- .3 Time-of-Day (TOD) Schedules: Indicate: objects assigned to the TOD Schedule, Occupied Mode times.
- .2 As-built floor plans:
  - .1 Maintain on the Project site as-built conditions on one full-size set of Contract Drawings, referred to as marked-up drawings; indicate on these drawings as-built locations for: control devices, cabinets, network devices with network address, communication networks by type and address, connection points to communication networks for Operator Interfaces, power networks, conduit paths, junction boxes, Operator Interfaces.
- 1.9. WARRANTY
  - 1.9.1. Warrant the Work free from defects for a period of 12 months and in accordance with the General Conditions and as amended below.
  - 1.9.2. Provide a single warranty start date even when the Owner has received beneficial use prior to acceptance of the Work. For Work split into multiple contracts or for a multi-phase contract, provide a separate warranty start date and period for each contract or phase.
  - 1.9.3. Adjust, repair or replace defects and failures in the Work at no additional cost during the warranty period and without reduction in service to the Owner. Provide warranty service during normal business hours and within 24 hours of the Owner's request for service.
  - 1.9.4. Provide warranty service by factory trained service representatives of the Supplier.
  - 1.9.5. Replace Operator Interface software, Controller Resident Software, controller firmware and database files with revisions that correct deficiencies or defects during the warranty period at no charge to the Owner. Notify the Owner of changes and schedule the installation. Update Operation and Maintenance Manuals with firmware release notes.
  - 1.9.6. Warrant Products that are reconditioned under the Work to the same requirements as new Products.
- 2. Products
  - 2.1. MATERIALS
    - 2.1.1. Existing Products: To Part 3: Execution, Existing Products.
    - 2.1.2. New Products: Non-beta versions currently under manufacture and have been applied in similar installations for a minimum period of one year.
    - 2.1.3. Revisions: Latest available revision for Operator Software, Controller Resident Software and controller firmware at start of Warranty.
    - 2.1.4. Revisions: Latest available revision for Controller Resident Software and controller firmware at start of Warranty.
    - 2.1.5. Replacement Parts: Readily available and not scheduled for discontinuation at time of Total Project Completion.
  - 2.2. CONTROL DEVICES
    - 2.2.1. Temperature Sensors:
      - .1 General Requirements:

- .1 Temperature sensors shall be of the resistance type, two-wire 1000 ohm nickel RTD, two-wire 1000 ohm platinum RTD or two-wire 10,000 ohm thermistor.
  - .2 Space Temperature Sensors:
    - .1 Stainless Steel plate sensors or white-plate sensors For installation throughout the facility where local control is not required (such as corridors or lobby) unless otherwise noted.
  - .3 Averaging Temperature Sensors:
    - .1 Minimum 1.5 m (5 ft) of capillary per 1 sq m (10 sq ft) of duct cross-section.
    - .2 Provide multiple sensors where single averaging element is unable to be positioned to provide complete duct or plenum traverse.
- 2.3. WIRE AND CONDUIT
- 2.3.1. Conduit: Electrical metallic tubing EMT with compression type fittings in dry locations; cold rolled steel zinc coated or zinc coated rigid steel with threaded fittings in wet locations or where exposed to weather.
  - 2.3.2. Outlet boxes: Dry locations: sheradized or galvanized drawn steel 100 mm (4 in.) square or octagon with suitable raised cover; Exposed to Weather: threaded hub cast aluminum boxes with gasket plate.
  - 2.3.3. Junction boxes: Sized according to number, size and position of entering raceway; type: suitable for the environment.
  - 2.3.4. Wire:
    - .1 Network:
    - .2 Analog Input, Output: Stranded 18 gauge copper twisted shielded.
    - .3 Binary Input, Output: 18 gauge, minimum insulation rating of 600 volts.
    - .4 Class 2: FT-6 without conduit in ceiling plenums; FT-4 in conduit for all other cases.
    - .5 Plenum rated wiring to be used.
3. Execution
- 3.1. GENERAL WORKPERSONSHIP
    - 3.1.1. Install Products to manufacturer's installation instructions.
    - 3.1.2. Install parallel to building walls and floors unless indicated or specified or required by manufacturer's installation instructions.
  - 3.2. COORDINATION
    - 3.2.1. Submittals: To Part 1: General, Submittals.
    - 3.2.2. Integrate and coordinate Work under this section to controls and control devices provided or installed by others.
    - 3.2.3. Resolve compatibility issues between control Product provided under this section and those provided under other sections or divisions of this Specification.
  - 3.3. EXISTING PRODUCTS
    - 3.3.1. This scope only applies to the Products that have become redundant as a result of this scope

- 3.3.2. Performance: During construction check and verify reused existing Products are operational. For existing Product that is not operational submit a proposal to replace existing Product for approval by the Consultant. Generally, Products which will potentially become redundant as a result of this scope of Work will only be reused if it meets the standards of this Specification.
- 3.3.3. Existing Sensors and Transmitters: Reuse.
- 3.4. WIRING AND CONDUIT
- 3.4.1. Wire shall be neatly tie wrapped to conduit mounted to the building structure but must be installed at right angles or parallel to the building. Loose wiring shall only be allowed over a distance of 1500 mm (5 ft.) but must not pass over lighting fixtures.
- 3.4.2. Should it become necessary to splice field wiring it shall be soldered. If soldering is not possible, approved B type crimp connectors are an acceptable alternative. Wire nuts and Marr connections are not acceptable. Provide a 500 mm (20 in.) loop length at all splices.
- 3.4.3. Conceal conduit within finished shafts, ceilings, and walls as required. Install exposed conduit parallel with or at right angles to the building walls.
- 3.4.4. Plug or cap unused conduit openings and stubs with compatible fittings.
- 3.4.5. Route all conduit to clear beams, plates, footings and structural members except through column footings and grade beams.
- 3.4.6. Provide watertight seals at penetrations through outside foundation walls.
- 3.4.7. Support conduit 25 mm (1 in.) and smaller to the building with one-hole non-perforated malleable iron or steel pipe straps. Suspend conduits larger than 1 in. on pipe racks with splitting hangers and rods.
- 3.4.8. Maintain caps on conduit openings throughout construction.
- 3.4.9. Where conduit is attached to vibrating or rotating equipment, install and anchor flexible metal conduit with a minimum length of 450 mm (18 in.) and a maximum length of 900 mm (36 in.) in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.
- 3.4.10. Where exposed to weather or in damp or wet locations, provide waterproof flexible conduit.
- 3.4.11. Fill conduit to maximum of 60% of its capacity. Provide a pull rope within the conduit when the installation is complete. Bend conduit to a radius of greater than 3 times the conduit diameter to a maximum of three 1/4 bends permitted between pull boxes.
- 3.4.12. Wire within cabinets shall be installed in a plastic tray with a cover. Terminate wires to field-removable, modular terminal strips.
- 3.4.13. All field sensors shall be provided with a flexible conduit connection minimum length of 450mm (18 in.) and an enclosure for the electrical connections.
- 3.5. POWER WIRING
- 3.5.1. Where power for equipment is fed from MCC, 120 VAC power for Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS) shall also be fed from the MCC from the 120 VAC section. Wiring and conduit from the MCC to control devices being electrically powered to be provided by section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 3.6. COMMUNICATION WIRING
- 3.6.1. Install communication wiring per controls manufacturer recommendations as to type of wire used and segment lengths.
- 3.6.2. Install communication wiring in conduit and raceways separated from other wiring.

- 3.6.3. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- 3.6.4. Each run of communication wiring to be continuous length without splices.
- 3.1.10. Provide data cables in conduit back to the closest data/telecom closet/room to allow all BAS head end equipment to connect to the network and all BAS controllers in the building as applicable to the project.
- 3.1.11. Ensure data cables are coordinated with requirements of BAS equipment based on submitted Shop Drawings.
  
- 3.7. IDENTIFICATION
  - 3.7.1. All wires shall be tagged at both ends. The tagging shall identify the device it is connected to. Use of the point object name is acceptable.
  - 3.7.2. All wires passing through a junction box shall be tagged with the device identity or its termination point.
  - 3.7.3. The junction boxes shall be tagged "BAS" with a sequential number suffix.
  - 3.7.4. Label wires, control devices, controllers.
  
- 3.8. TESTING AND COMMISSIONING
  - 3.8.1. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to insure that the system is functioning in full accordance with these Specifications.
  - 3.8.2. Device tests shall identify and confirm successful completion of the following:
    - .1 Device installation.
    - .2 Device identification.
    - .3 Device calibration.
    - .4 Device operation.
    - .5 Wiring to device, connection details and wire type.
    - .6 Validation of the device signal at the controller.
  - 3.8.3. Controller tests shall identify and confirm successful completion of the following:
    - .1 Controller installation.
    - .2 Power source and grounding.
    - .3 Make, model and serial number, software revisions.
  - 3.8.4. Software tests shall identify and confirm successful completion of the following:
    - .1 Custom application programs.
    - .2 Alarm reporting.
    - .3 Trending and reports.
    - .4 Energy management programs.
  - 3.8.5. Loop tuning tests shall identify and confirm successful completion of the following:
    - .1 Loop input signal.
    - .2 Loop output signal.
    - .3 Set point adjustment.

- .4 Device response.
- .5 Control response.
- 3.8.6. Network communication tests shall identify and confirm successful completion of the following:
  - .1 Primary network communication function.
  - .2 Secondary network communication function.
  - .3 Alarm reporting function.
  - .4 Operator communication.
- 3.8.7. Dynamic graphics tests shall identify and confirm successful completion of the following
  - .1 All graphics.
  - .2 All point objects per graphic.
  - .3 All set-points per graphic.
- 3.9. DEMONSTRATION
- 3.9.1. When all tests have been completed and the documentation completed, request a meeting with the Consultant and Owner. Provide at this meeting a demonstration that all systems on the controls are operating.
- 3.9.2. At the discretion of the Consultant and Owner, demonstrate up to 10% of the tests described in Part 3: Execution, Testing and Commissioning and witnessed by the Consultant and Owner. Should any test fail then the BAS Contractor shall retest the failed components or functionality.
- 3.10. INSTRUCTION AND TRAINING
- 3.10.1. Provide one day of instruction during the BAS installation. This instruction shall include: identification of devices, power sources, conduit and wire installation, the operation of controlled devices and how they interface with the mechanical systems.
- 3.10.2. Provide one day of instruction that shall cover the operation and maintenance of the control systems.

END OF SECTION

23 09 23.00 Sequence of Operation for BAS

1. General

1.1. WORK INCLUDED

- 1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS and SECTION 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).
- 1.1.2. The locations of all sensors shall be discussed with and approved by the Owner and/or Engineer's Representative, before installation. Locations shown are approximate only, and are given to assist the Contractor in pricing only, and shall not be construed as being the final approved location.
- 1.1.3. The control sequence descriptions are complementary. Provide detailed sequences of operation and all points required to implement the sequences.
- 1.1.4. All settings and set points listed in this Section shall be variable and Operator adjustable without the need to create or modify Custom Application Programs.
- 1.1.5. All set points and reset schedules shall be visual on the associated dynamic graphic.
- 1.1.6. Where the project includes an existing BAS, ensure that any upgrades to the existing BAS for this project scope does not negatively impact existing BAS infrastructure. Maintain the functionality of existing controls not revised by this scope of work.

2. Products

2.1. GENERAL APPLICATION PROGRAMS

- 2.1.1. Provide a specific set of programs to achieve automated, operator independent control of facility sub-systems.
- 2.1.2. Refer to SECTION 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS) for software programs.

3. Execution

3.1. BYPASS AIR TERMINAL

- 3.1.1. Applicable Systems:
- 3.1.2. System Start:
  - .1 The bypass terminal box shall be enabled when the associated air handling unit is started.
- 3.1.3. Normal Operation:
  - .1 The Bypass Damper (BD) shall modulate to maintain Space Temperature (SPCT) at set-point (adjustable).
- 3.1.4. System Stop:
  - .1 The bypass terminal box shall be disabled when the associated air handling unit is stopped.
- 3.1.5. Schedule:

.1 To be determined by the Owner.

3.1.6. Alarms:

.1 Space Temperature (SPCT) out of range.

END OF SECTION

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23 31 13.00 Ductwork and Specialties

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. SUBMITTALS

1.2.1. Shop Drawings

- .1 Submit Shop Drawings of all catalogued components to be supplied. Include manufacturer's data sheets for certification, performance criteria, ratings, and physical dimensions and finishes.

2. Products

2.1. MATERIALS

2.1.1. Fabricate all ductwork unless specifically noted otherwise, of galvanized sheet steel with Z180 coating to A653/A653M.

2.1.2. Sealing compound: Minnesota Mining and Manufacturing or other approved manufacturer. Duct tape shall be Duro-Dyne or other approved manufacturer.

2.1.3. Flexible ducting:

- .1 Flexible metal ducting shall be Flexmaster Triple-Lock Aluminum Flexible ducting T/L. ULC listing S110.
- .2 Fabricate manual duct dampers as shown on Standard Details from galvanized steel 1.26 mm thick (0.048 in - 18 GSG gauge) or heavier. Dampers for ducts up to 300 mm (12 in.) deep shall be one blade carried on a 9 mm (3/8 in.) square steel rod mounted inside the duct. Dampers for ducts of greater depth than 300 mm (12 in.) shall be multi-blade, opposed-acting type, and shall have blades mounted in 38 mm (1-1/2 in.) steel channel frame, and interconnected for operation from one locking type hand quadrant. Dampers for right angle take-off of branch from vertical riser shall have operator extended to an accessible location. For externally insulated ducts, mount quadrant on a bracket, designed to clear the insulation. All dampers shall have indicator to show position of damper blade.

2.1.4. Interior Duct Protective Coating: Chlorinated rubber base paint or Eisenheiss Black.

2.1.5. Hardware and Accessories:

- .1 Spin-in connections shall be specifically built for that purpose. Dampers shall be a minimum 1 gauge heavier than the ductwork in which it is installed and shall have a full length shaft pivoted at two diametrically opposed points. An indicator shall be attached to the shaft to indicate the damper position.
- .2 Hardware for balancing or splitter dampers shall be rattle-free and leak resistant. Bearing rods shall be sized to suit the damper size. Neoprene seals shall be used to minimize leaks. Hardware shall be Dyn-Air or equal.

- 2.2. FABRICATION Fabricate ductwork in accordance with applicable duct construction requirements of SMACNA.
3. Execution
- 3.1. INSTALLATION
- 3.1.1. Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
- 3.1.2. Brace and stiffen all ducts, and make tight so that they will not breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 300 mm (12 in.) or larger.
- 3.1.3. Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option, provided there is sufficient room. Conversion from rectangular to round duct, sizing shall be as shown on charts in ASHRAE.
- 3.1.4. Hang all ductwork securely and in a rigid manner. Provide hangers in accordance with SMACNA Standard "HVAC Duct Construction Standards Metal and Flexible."
- 3.1.5. The following low pressure, medium pressure and high pressure duct construction is based on an ASHRAE method of construction, and gives a minimum standard of construction. Alternative ASHRAE or SMACNA duct construction is acceptable, provided it meets the minimum standards as outlined by these Specifications. Submit proposed alternatives for review prior to fabrication.
- 3.1.6. Low pressure ductwork 0.5 kPa (2 in. wg) static pressure and less as follows:
- .1 Rectangular/round duct location:
    - .1 Ductwork serving fans with an external static pressure of 0.5 kPa (2 in. wg) or less.
  - .2 Seal ducts to Seal Class C in accordance with SMACNA "HVAC Duct Construction Standards Metal and Flexible" and "HVAC Air Duct Leakage Test Manual."
  - .3 SMACNA leakage class:
    - .1 Rectangular ductwork: 16
    - .2 Round ductwork: 8
  - .4 Refer to tables for low pressure rectangular duct construction and round duct construction below for further duct construction requirements.

3.1.7. Comply with the tables below in conjunction with the clauses above.

TABLE 1: LOW PRESSURE RECTANGULAR DUCT CONSTRUCTION

MAX. DUCT DIMENSION	SHEET METAL US GAUGE	TRANSVERSE JOINT CONNECTION AND BRACING
Up to 300 mm (12 in.)	26	Flat drive or flat 'S' no bracing
325 mm to 425 mm (13 in. to 18 in.)	24	Flat drive or flat 'S' no bracing
475 mm to 750 mm (19 in. to 30 in.)	24	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
775 mm to 1050 mm (31 in. to 42 in.)	22	25 mm (1 in.) standing 'T' bracing 25 mm x 25 mm x 3 mm (1 in. x 1 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
1075 mm to 1200 mm (43 in. to 48 in.)	22	38 mm (1-1/2 in.) standing 'T'; bracing 38 mm x 38 mm x 3 mm (1-1/2 in. x 1-1/2 in. x 1/8 in.) at maximum 1500 mm (60 in.) centres.
.1 Bracing spacing shown is maximum spacing between two bracings or between bracing and joint. .2 Locate bracings mid-way between joints. .3 Make longitudinal joints Pittsburgh lock seam at edge of duct, and grooved seam on face of duct.		

TABLE 4: ROUND DUCT CONSTRUCTION

1. Round ducts up to 750 mm (30 in.) diameter factory fabricated, helically wound galvanized iron strips with spiral lock seam.			
DIAMETER	STRIP METAL US GAUGE	STRIP JOINT	GIRTH JOINT
Up to 200 mm (8 in.)	26	100 mm (4 in.)	50 mm (2 in.) long slip
225 mm to 550 mm (9 in. to 22 in.)	24	100 mm (4 in.)	50 mm (2 in.) long slip

Join with galvanized iron coupling sleeves or conduit fittings of welded construction.

- 3.1.8. Seal all joints of all ducts. Brush joints with the compound before and again after assembly. Seal any leaks causing noise.
- 3.1.9. Seal the bottom and side joints of outside air ducts or plenums water-tight.
- 3.1.10. Flexible duct shall be connected to sheet metal duct and diffusers using duct sealer, minimum of two screws separated by 180 degrees and metal draw bands. Duct tape is not acceptable.
- 3.1.11. Flexible ductwork may be used under the following conditions:
  - .1 Where shown on Drawings to allow easy location of diffusers.
  - .2 Except where indicated otherwise in clauses below, minimum length of flexible duct used to connect diffusers and interior troffers: 2,400 mm (84 in.).
  - .3 Except where indicated otherwise in clauses below, maximum length of flexible duct: 3,000 mm (120 in.).
  - .4 Do not pass flexible ductwork through floors or fire walls.
  - .5 Install flexible ductwork as a single section of duct (no joints). In the event that building construction requires connection between lengths of flexible duct, use a rigid section of duct as the joint. Secure flexible duct to the rigid section using ties and sealant.
  - .6 Support flexible duct lengths greater than 2,400 mm (84 in.) at the midpoint with strap hangers.
- 3.1.12. Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and airtight joint.
- 3.1.13. If changes of size of ducts are necessary because of building construction, maintain the same circular equivalent for the new size. Ratio of the longest side of the duct to the least shall not exceed 4 to 1 unless specifically authorized by the Engineer's Representative.
- 3.1.14. Select the gauge of metal and method of construction for the new size. Notify the Engineer's Representative of any change before such changes are incorporated into the Work.
- 3.1.15. If changes of location of duct are required because of building construction, review with the Engineer's Representative before the locations indicated are changed in any way.
- 3.1.16. Make changes of direction of horizontal ducts with elbows having an inside radius not less than 3/4 the width of the duct. Make change of direction from horizontal to vertical duct with elbows having an inside radius equal to the depth of the duct. Where this is not possible due to the building construction, use turning vanes.
- 3.1.17. Install manual duct dampers as shown on Standard Details. Ensure dampers for right angle take-off of branch from vertical riser have operator extended to an accessible location. Adjust quadrants to clear duct insulation.
- 3.1.18. Provide splitter dampers as shown on Standard Details.

- 3.1.19. Where a fire damper is required to be installed behind a wall mounted grille, provide damper, angles, and retaining devices as required to provide a smooth, flat to wall installation.
- 3.1.20. Paint visible internal surface behind each grille or register flat black.
- 3.1.21. Where duct is acoustically lined, duct dimensions shown are net, inside of lining, free area dimensions.
- 3.1.22. Provide internal acoustic duct lining in accordance with Section 20 05 48.00 – VIBRATION AND NOISE CONTROL.
- 3.1.23. Spin-in connections shall only be used downstream of variable volume boxes.
- 3.1.24. Ductwork shall be run parallel to the closest wall. Coordinate with piping and structural elements.
- 3.1.25. Supply air ductwork to By Pass variable volume boxes shall be rigid duct of size shown in schedules. If the length exceeds 3000 mm (10 ft.) or if there are 2-45 deg. elbows or 1-90 deg. elbow or more increase the supply air ductwork to the variable volume box one size. If the length exceeds 6000 mm (20 ft.) increase the duct by two sizes. Under no conditions shall the supply ductwork exceed 9000 mm (30 ft.) or have more than 3-90 deg. elbows or the equivalent. Transition to variable volume box inlet sizes a minimum of 4 duct diameters upstream of the terminal unit.

END OF SECTION

23 36 32.00 By Pass Boxes

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Actuator for damper and controller furnished under Section 23 09 00.00 - BUILDING AUTOMATION SYSTEM (BAS).

1.3. SUBMITTALS

1.3.1. Shop Drawings: Submit Shop Drawings of all components in accordance with Section 20 05 03.00 – SHOP DRAWINGS.

1.3.2. Manufacturer's Data: Submit manufacturer's certified sound power ratings with an octave band analysis when tested in accordance with ASHRAE Standard 36B-63. Where a second sound attenuator is required in the system or where attenuators with outlets are used in conjunction with rated outlets and not as straight attenuators without outlets, submit certified data for review.

2. Products

2.1. MATERIALS

2.1.1. The low pressure by-pass boxes shall be E.H. Price, Titus, Nailor, or Environmental Technologies equal to E.H. Price units as shown and specified below. Boxes shall be low pressure by-pass terminal boxes having unit casings fabricated of galvanized steel of sufficient thickness to prevent drumming or rattling, and lined with 1/2" (12 mm) thick thermal and sound attenuating insulation. The units shall be end outlet. Leakage through the unit casing shall be less than 0.3% of the design volume. Damper actuator shall be supplied and installed by Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

2.1.2. The units shall have a field adjustable minimum volume stop, integral inlet and by-pass balancing dampers. The supply/by-pass gate valve damper shall have polyethylene linear bearings operating in stainless steel tracks.

2.1.3. Acoustically line ductwork downstream from boxes as shown. Lengths of 1 in. (25 mm) thick acoustic lining, shall be as designated in following Schedule:

BOX VOLUME	LENGTH
1601 to 2500 cfm (755,5 to 1180 L/s)	20 ft. (6100 mm)
601 to 1600 cfm (283.5 to 755 L/s)	15 ft. (4600 mm)
201 to 600 cfm (95 to 283 L/s)	10 ft. (3000 mm)
Under 200 cfm (94.5 L/s)	5 ft. (1500 mm)

2.1.4. Where outlets are provided they shall be complete with manual dampers in each outlet.

- 2.1.5. The box radiated noise level shall meet the criteria for specific room noise levels as specified under Section 20 05 48.00 - VIBRATION AND NOISE CONTROL.
- 2.1.6. Pressure drop for cfm (L/s) ranges shown for each box size shall be 0.2 in WG (0.047 kPa) maximum.
  
- 3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. Install By Pass VAV boxes in accordance with reviewed Shop Drawings and to manufacturer's written instructions.
    - 3.1.2. Air velocity sensor, actuator for damper, controller and interconnecting tubing and cable are installed by terminal box manufacturer at its manufacturing facilities; the costs for installation labour are paid for by this Section. Make control devices readily accessible from the access panel in the suspended ceiling.
    - 3.1.3. Where a By PassVAV box does not meet specified sound ratings, field enclose with (0.80 mm thick (1 lb.) lead sheeting over a 25 mm thick (1 in.) glass fibre blanket wrap, as part of the Work.

END OF SECTION

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23 37 13.00 Diffusers, Grilles and Registers

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 20 05 00.00 - GENERAL INSTRUCTIONS FOR MECHANICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.3. SUBMITTALS

1.3.1. Shop Drawings: Submit detailed Shop Drawings of all components furnished under this Section. Manufacturer to indicate ceiling installation type for each type of diffuser specified.

2. Products

2.1. MATERIALS

2.1.1. Diffusers, registers and grilles shall be Price, Nailor, Krueger, Titus or Carnes equal to the units specified.

2.1.2. Select all diffusers to provide uniform air coverage without overlap. Air velocity up to a height of 1800 mm (6 ft.) above the floor shall be 0.127 to 0.254 m/s (25 to 50 fpm).

2.1.3. Noise generated by diffusers shall be such that room sound pressure level does not exceed noise criteria 32 with an 8 db room attenuation, the sound power level reference to 10 to -12 power watts.

2.1.4. All volume and air pattern devices shall be fully adjustable from the face of the diffuser, register or grille.

2.1.5. In T-bar ceilings, manufacturer shall coordinate diffuser compatibility with t-bar ceiling specified by the architectural division. Colour shall match colour of ceiling tile in lay-in ceilings. Diffusers to suit ceiling grid as required imperial or metric.

2.1.6. Diffusers shall meet test requirements of ASHRAE Standard 36B-63, including air pattern and noise levels for air quantities from 10 % to 110 % of the required maximum air flow. Sound power tests shall be measured in accordance with ASHRAE Standards 36B-63 and NC ratings shall be determined using an 8 db room attenuation factor.

2.2. SQUARE SUPPLY DIFFUSERS

2.2.1. All diffusers shown as type "P" shall be steel square plaque diffuser 600 mm x 600 mm (24 in. x 24 in.) face size and shall be square, coned metal. Diffusers shall consist of a precision formed back cone of one piece seamless construction which shall incorporate a round (or square) inlet collar of sufficient length for connecting rigid or flexible duct as shown. An inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance. The inner plaque assembly shall be completely removable from the diffuser face to allow full access to any dampers or other ductwork components located near the diffuser neck. E.H. Price SPD, Nailor UNI, Krueger PLQ, Carnes SFPA.

### 2.3. LINEAR SUPPLY AND RETURN DIFFUSERS

2.3.1. All diffusers shown as type "T" shall be T-bar plug-in, 1 slot diffuser modified with square ends to limit side spread, and of lengths shown. Diffuser shall be installed with manufacturer plenum to match the length of the diffuser shown. Provide diffuser with mounting clips to suit in continuous T-bar openings. Pattern controllers shall be split mid length to allow each half of diffuser shall be set for different throw patterns. Throw patterns shall be fully adjustable from vertical to horizontal and variations in between. Provide blank-off panels between diffusers. Pattern controllers and blank-off panels shall be finished matte black. Plenum shall be fabricated from coated steel. Refer to Architectural Details for installation of continuous supply air slot. Duct connection to diffuser shall be of sufficient height to allow for 175 mm (7 in.) clearance from ceiling to underside of duct. EH-Price TBD3 series, Nailor 5800, Krueger PTBA, Carnes DASC.

### 2.4. WALL AND DUCT GRILLES

2.4.1. All supply registers shown as type "B" shall be standard double deflection type with adjustable horizontal face bars and vertical rear bars. Frame shall be gasketed. Construction shall be aluminum with prime coat. Registers larger than listed sizes shall be shop fabricated in Sections such that the Sections will appear as one integral register when installed. The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. The damper shall be operable from the register face. The damper shall be coated or galvanized steel. E.H. Price 620D, Nailor 5100 Series, Krueger 5880 Series, Carnes RNGM.

### 2.5. RETURN, EXHAUST AND TRANSFER GRILLES

2.5.1. Return grilles shown shall be size as shown and shall be egg crate type with aluminum construction. Egg crate shall be 12 mm (1/2 in.) deep, formed of 12 mm (1/2 in.) wide aluminum strips on 12 mm (1/2 in.) centres. Strips shall be approximately 0.64 mm (0.025 in.) thick. Grilles shall be enclosed in a channel frame for inverted T-bar mounting or with a flanged frame for plaster or gypsum ceiling mounting. Grilles shall lay on inverted T-bar ceiling suspension system. Colour shall match adjacent ceiling tiles. E.H. Price Series 80, Nailor 5100 Series, Krueger EGC5 Series, Carnes RAPAHA.

2.5.2. Return registers shown as type "K" shall be standard return grilles with horizontal fixed bars set at approximately 45 deg. for wall returns and set straight for ceiling return. Key operated damper shall be mounted behind. General appearance, type of material and finish shall match the type "..." supply register. E.H. Price 530, Nailor 6100 Series, Krueger S80, Carnes model RSBAH.

## 3. Execution

### 3.1. INSTALLATION

3.1.1. Refer to the Architectural Drawings for actual locations of diffusers, grilles and registers and install to suit these Drawings. The Mechanical Drawings show intent and number of diffusers, grilles and registers required.

3.1.2. Provide transfer grilles in all finished spaces where air is transferred through a ceiling or partition.

3.1.3. For exposed ductwork installations, all connections to grilles shall be oversized and shall have in-turned flanges to meet the flange of the grilles and the duct. Out-turned or exposed flanges with screw mounting shall not be accepted.

- 3.1.4. For special mounting of diffusers, grilles and registers refer to Architectural Drawings.
- 3.1.5. Where rigid duct is connected to the diffuser, grille or register all devices used for flow pattern adjustment, flow balancing and flow equalizing shall be accessible from the face of the diffuser.
- 3.1.6. Install mounting frame tied into plaster and gypsum board ceilings to allow lay in type diffusers to rest on the frame.
- 3.1.7. Diffusers for installation in lay-in ceiling shall lay on inverted T-bars.
- 3.1.8. Contractor shall be responsible for mounting concealed flange linear diffusers in heated environment and following manufacturers' instructions.
- 3.1.9. Contractor shall caulk around edges of linear diffusers in installations with imperfect walls.

END OF SECTION

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END OF SECTION

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26 01 00.00 Operating and Maintenance Instructions

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 03.00 – AS-BUILT DRAWINGS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.4. Section 26 08 00.00 – COMMISSIONING.
- 1.1.5. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

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 USB stick or sent via electronic transfer. As-Built Drawings to be included on the USB stick or sent via electronic transfer.
- 3.1.2. The contractor to identify the cost of AS-BUILT 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 26 05 03.00 – AS-BUILT 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 “5<sup>th</sup> Floor Library Reno.”
- 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 Material Safety Data Sheet (MSDS), 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.
  - .5 Cyber Security Report Letter and backup schedule as required by Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 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. Where commissioning is a requirement of the project, the Contractor shall comply with all requirements of Section 26 08 00.00 – COMMISSIONING, for duration of tests.

- 3.3.3. Instruct the Owner for a minimum of five (5) working days.
- 3.3.4. All instruction sessions to be video-taped and copy must be provided to the Engineer's Representative/owner.
- 3.3.5. 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.
- 3.3.6. 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.
- 3.3.7. Review information with the Owner's representative to ensure that all information required has been provided.
- 3.3.8. Electrical equipment and systems included in the instruction requirements, include but not limited to the following:
  - .1 Switchboards and related power distribution equipment.
  - .2 Emergency generator.
  - .3 Automatic transfer switches.
  - .4 Fire alarm systems.
- 3.4. TRIAL USAGE
  - 3.4.1. The Owner shall be permitted trial usage of systems or parts of systems for the purpose of testing and learning operational procedures. Trial usage shall not affect the warranties nor be construed as acceptance, and no claim for damage shall be made against the Owner for any damage or breakage to any part or parts due to the tests, where such injuries or breakage are caused by a weakness or inadequacy of parts, or by defective materials or workpersonship of any kind.

END OF SECTION

26 05 01.00 General Instructions for Electrical Sections

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. DEFINITIONS

1.4.1. Where used on the Drawings or in the Specifications, the following words are given the meanings below.

- .1 Provide: means supply, install, connect, and test.
- .2 Demolish: detach existing items and legally dispose of them off site.
- .3 Remove and Reinstall: Detach existing items, prepare them for reuse, and reinstall them where indicated.
- .4 Existing to Remain: existing items that are not removed and that are not otherwise indicated as being removed, removed and salvaged (turned over to Owner), or removed and reinstalled.
- .5 Remove and Salvage: detach existing items and turn over to Owner.

1.5. SCOPE

1.5.1. Provide all labour, materials, equipment and services to complete the work of the electrical division as further specified and as shown on the drawings.

1.5.2. 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 more expensive/onerous alternative will be deemed as included in the contract.
- .2 Where a discrepancy occurs in the drawings the more expensive/onerous alternative will be deemed as included in the contract.
- .3 Where a discrepancy occurs in the specifications the more expensive/onerous alternative will be deemed as included in the contract.

- 1.5.3. For any equipment/device where circuit numbers and/or panel designation labels are missing and not indicated on the drawings or specifications, a clarification shall be obtained from the Engineer's Representative before submitting the tender. If this is not done the Contractor shall power the equipment/device from the respective 120 V/208 V or 600 V electrical panel serving the equipment in that area at no additional cost to the Owner.
- 1.6. REGULATIONS
- 1.6.1. All work shall be performed in accordance with the latest codes, rules, regulations, by-laws and requirements of all authorities having jurisdiction except where the requirements of the drawings and specifications exceed the codes, rules, regulations, by-laws and requirements of the authorities having jurisdiction.
- 1.6.2. These specifications are supplementary to the requirements above.
- 1.6.3. Comply with all guidelines and standards issued by the authorities having jurisdiction.
- 1.6.4. Drawings and specifications should not conflict with the above regulations but where there are apparent discrepancies the contractor shall notify the Engineer's Representative.
- 1.7. PERMITS, FEES, AND REVIEWS
- 1.7.1. 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.
- 1.7.2. If required by code, plans and specifications have been previously submitted to the Authority Having Jurisdiction.
- 1.7.3. Furnish certificates of Acceptance from the Authority Having Jurisdiction and include them in the Operation and Maintenance manual.
- 1.8. VOLTAGE RATINGS
- 1.8.1. Operating voltages are as specified in CAN3-C235 (latest edition).
- 1.8.2. Motors, electric heating, control and distribution devices and equipment are to operate satisfactorily at 60 Hz within operating limits established by the above standard.
- 1.9. COORDINATION WITH MECHANICAL DIVISIONS.
- 1.9.1. Unless indicated otherwise on the Electrical Drawings, Electrical Contractor will be responsible for the supply and installation of the following:
- .1 Starters.
  - .2 Line and load side wiring for starters.
  - .3 Reduced voltage starters including "Soft Start" starters.
  - .4 Line and load side wiring to variable speed drives, including but not limited to wiring of associated harmonic filters, AC line input reactors, dV/dT filters, and output filters.
    - .1 Where harmonic filter is complete with a capacitor switching system, route a harmonic filter output conductor through the current transformer window within the harmonic filter. Coordinate with Mechanical Contractor and follow harmonic filter manufacturer's written instructions.
  - .5 Disconnect switches for all mechanical equipment.
  - .6 All power wiring (120 V & above) to all mechanical equipment.
  - .7 Electrical ramp heating cables and controls.
  - .8 All motorized damper power connections (120 V & above).

- .9 Fire alarm devices.
- .10 Wiring to electric space heaters.
- 1.9.2. Mechanical Divisions will be responsible for the supply and installation of the following:
  - .1 All variable speed drives and control wiring to starters.
  - .2 Pipe tracing and related controls.
  - .3 Electric hot water heaters.
  - .4 All electrical heaters including baseboard heaters, cabinet heaters, force flow heaters and radiant heaters.
  - .5 All interposing relays, relays, contactors and 120 V control devices.
  - .6 All 120 V and low voltage control wiring and conduits.
- 1.9.3. 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 strut channel 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.
- 1.9.4. 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/wiring, breakers, fuses, starters and equipment to supply power to the revised piece of equipment.
- 1.9.5. Should the Mechanical Contractor provide alternates to any mechanical equipment selection by deviating from the make and model identified on the Mechanical Schedules and Drawings, the Mechanical Contractor will incur all extra costs to revise the electrical provisions including but not limited to feeders/wiring, breakers, fuses, starters and equipment to supply power to the alternate piece of equipment.
- 1.9.6. Where power for any flush valves, hands-free faucets, or other powered plumbing fixtures are shown on the Drawings, provide either a hard wired direct connection or a duplex receptacle, as required for the valve/faucet/fixture in question, based on coordination with the Mechanical Contractor.
- 1.9.7. Where large smoke dampers or large combination smoke and fire dampers, with multiple actuators per damper, are supplied by the Mechanical Contractor, extend the power connections and fire alarm monitoring and control connections shown on the Drawings to each and every actuator.
- 1.10. PLYWOOD BACKBOARDS, EQUIPMENT MOUNTING, & HOUSEKEEPING PADS
  - 1.10.1. 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, urea-formaldehyde (UF) free and shall be either, Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI) or CSA Z809 - (latest edition) certified. Plywood to be either fire rated with the appropriate label displayed once installed or coated with fire retardant paint. Do not paint over plywood fire rating certification stamp. All Certification not to be painted.
  - 1.10.2. For clause above, submit documentation as a shop drawing for review by the LEED Representative prior to ordering.

- 1.10.3. Surface mounted electrical equipment boxes are to be installed on galvanized strut channel stand-offs. Electrical equipment boxes shall include, but not be limited to electrical panels, low voltage lighting control, fire alarm, security, communication, electrical sub-metering, etc. Panels are to be grouped on common base wherever practical.
- 1.10.4. Provide steel re-enforced concrete housekeeping pads under all floor mounted electrical equipment.
- 1.10.5. Provide pre-cast steel re-enforced concrete pads under all outdoor ground mounted electrical equipment, unless a different support structure is detailed on the Drawings.
- 1.10.6. Additionally, provide steel re-enforced concrete housekeeping pads where shown on the Drawings.
- 1.10.7. Provide all housekeeping pads with a minimum height of 100 mm above finished floor and do not extend beyond 50 mm beyond the electrical equipment unless shown otherwise on the Drawings. Ensure concrete pads fully cured for 28 days before installing equipment.
- 1.11. FINISHES
- 1.11.1. Metal enclosure surfaces are to be finished by the application of rust resistant primer on both the inside and outside, with at least two coats of enamel.
- 1.11.2. Clean and touch up all surfaces of equipment scratched or marred during shipment or installation. Match the original paint.
- 1.11.3. Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- 1.11.4. 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.
- 1.12. SAFETY
- 1.12.1. Protect exposed live equipment during construction for personnel safety.
- 1.12.2. Shield and mark all live parts "LIVE 120 VOLTS", or with appropriate voltage in English.
- 1.12.3. 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.
- 1.13. FIRE STOPS
- 1.13.1. Provide fire stops in accordance with front end, and Division 1 documents and as described herein. Contractor to coordinate fire stops with General Contractor.
- 1.13.2. 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.
- 1.13.3. Fire stops and smoke seal systems: in accordance with CAN/ULC-S115 (latest edition).
- .1 Asbestos free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN/ULC-S115 (latest edition) and not to exceed opening sizes for which they are intended.
  - .2 Fire stop system rating for service penetrations: to suit the latest edition of the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
  - .3 Fire stop system rating for sealing junction of rated walls to rated floors and ceilings: to suit the National Building Code of Canada with local amendments or the

Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.

- 1.13.4. Service penetration assemblies: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.
- 1.13.5. Service penetration fire stop components: certified by ULC in accordance with CAN/ULC-S115 (latest edition) and listed in ULC Guide No. 40 U19.13 and ULC Guide No. 40 U19.15 under the Label Service of ULC.
- 1.13.6. Fire resistance rating of installed fire stop assembly not less than the fire resistance rating of surrounding floor and wall assembly, and in accordance with the National Building Code of Canada with local amendments or the Local/Provincial Building Code, and meet requirements of local authority having jurisdiction.
- 1.13.7. Fire stops 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.
- 1.13.8. Fire stops and smoke seal all electrical penetrations through rated assemblies as per ULC Standards.
- 1.13.9. Where sound and vibration control is required, use an elastomeric seal; do not use a cementitious or rigid seal at such locations.
- 1.13.10. Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- 1.13.11. Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- 1.13.12. Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- 1.13.13. Sealants for vertical joints: non-sagging.
- 1.13.14. Colour: if range available to Engineer's Representative's choice of standard colours, generally to match background colour where visible in finished spaces.
- 1.13.15. Through non-fire or non-smoke separations or where waterproof membrane is field applied, where pipes are insulated, sleeves shall be sized to accommodate the insulation and vapour barrier.
- 1.13.16. Where-holes are core drilled in existing structures, sleeves shall be provided as specified complete with fire stopping as noted above.
- 1.13.17. Submit a complete fire stop 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.
- 1.13.18. Installation
  - .1 Install fire stops and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
  - .2 Seal-holes or voids made by through penetrations, poke through termination devices, and un-penetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
  - .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
  - .4 Tool or trowel exposed surfaces to a neat finish.
  - .5 Remove excess compound promptly as work progresses and upon completion.

1.14. ACOUSTIC TREATMENT

- 1.14.1. Electrical Contractor will be responsible for coordinating the electrical installation with the recommendations of the acoustic consultant and their report where one has been included in the contract documents.
- 1.14.2. Refer to the recommendations of the acoustic report where provided, and provide and install acoustic treatments as necessary. This may include separation of receptacles in stud bays, sealing of junction boxes, application of sound insulating materials etc. Coordinate the installation of these materials with the General Contractor and Drywall/Partition Subtrade.
- 1.14.3. Do not install back to back receptacles/back boxes within the same stud bay wherever possible. Where it is not possible to stagger receptacles, provide acoustic seal around receptacle/back box to provide acoustic isolation/separation of spaces.

1.15. HOISTING

- 1.15.1. Electrical Contractor will be responsible for the hoisting of all the equipment in the contract. Contractor to coordinate with General Contractor for use of the general hoisting facilities. If hoist facilities are inadequate, then subcontractors must provide their own. Subcontractors must inform general contractors in writing of requirements before tender closing date. Any hoisting required in addition to that provided by the General, will be included in the bid price.
- 1.15.2. Electrical Contractor to include for the qualified millwrights to move and place all equipment over 1000 lbs. Contractor to provide proof of millwright certification.

1.16. CLEANING AND WASTE REMOVAL

- 1.16.1. Clean all electrical equipment that has been exposed to construction dust and dirt.
- 1.16.2. 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.
- 1.16.3. Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.

1.17. SPRINKLERS

- 1.17.1. All electrical equipment shall be suitable for installation in a sprinklered environment and enclosures are to be CSA Type 1 with drip hood, sprinkler proof enclosure unless otherwise noted.

1.18. TEMPORARY LIGHT AND POWER

- 1.18.1. 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.
- 1.18.2. All temporary light to be fluorescent or LED. Provide adequate lighting to meet all health and safety standards.

1.19. EXAMINATION AND PROTECTION OF SITE

- 1.19.1. 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.

- 1.19.2. Contractor to document any existing conditions on site and submit a pre-condition survey including pictures. Contractor will be responsible to return the site back to its original form, which includes but is not limited to ground repair including grading and new sod and repair of damaged walls, doors and/or floors.
- 1.19.3. Contractor is to protect trees and plants on site and on adjacent properties. Plants to be protect with burlap. Trees and roots within construction area to be protected by the erection of temporary 2 m high plywood hoarding at the drip line of the tree. Contractor to avoid unnecessary traffic, dumping and storage of materials at or near trees or plants.
- 1.19.4. 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.
- 1.20. DRAWINGS AND INSTALLATION
- 1.20.1. 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.
- 1.20.2. 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.
- 1.20.3. Certain details indicated 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.
- 1.20.4. The actual location of switches, outlets and luminaires, etc. shall be reviewed by the Engineer's Representative before installation.
- 1.20.5. 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. Particular attention shall be paid to buried services.
- 1.20.6. 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.
- 1.20.7. Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades.
- 1.20.8. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.20.9. Where equipment is shown to be 'roughed-in only' obtain accurate information from the Engineer's Representative before proceeding with the work.
- 1.20.10. Contractor is to review Architect's specifications, drawings and details to confirm locations of devices and equipment.
- 1.20.11. This Contractor is responsible to mark-out his work, fully coordinated with all other trades, in sufficient time for review by Architectural Consultant prior to rough-in. Prepare dimensioned layouts of each room prior to rough-in for review by Architectural Consultant. Do not proceed with any work until the Architectural Consultant has reviewed the layout drawings.
- 1.20.12. 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.

- 1.21. INSTALLATION, INTERFERENCE AND SETTING DRAWINGS
- 1.21.1. The Contractor is to complete installation, interference and setting drawings, dimensioned and to scale for all systems. They shall be made available for review by the Engineer's Representative, if requested. The drawings are required to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division.
- 1.21.2. Slab layout drawings are to be submitted for review by the Structural Engineer's Representative. These slab layout drawings are to be included in the as-built drawings. Refer to Section 26 05 03.00 – AS-BUILT DRAWINGS.
- 1.21.3. 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 features.
- 1.21.4. This Division shall prepare sleeving drawings indicating the size and locations of openings required in concrete floor slabs, roof slabs/decks and walls for conduit, bus ducts and equipment for review by the Structural Engineer and Architect. In case of failure to provide information in time (i.e. before the concrete is poured) any extras incurred shall be at the expense of this Division.
- 1.22. SUPPLEMENTARY BID FORM AND SUBMISSIONS OF BID
- 1.22.1. Submit with tender, if included in the documents, a complete Electrical Supplementary Bid Form. Tenders not completed in full may, at the discretion of the Owner be rejected.
- 1.22.2. Several alternative, separate and itemized prices may have been requested. These shall be completed on the Electrical Supplementary Bid Form. Refer to the specific sections of the specifications and to the drawings for details.
- 1.23. Approved Manufacturers
- 1.23.1. Where only one name appears in the specification, the bid shall include for the specified equipment.
- 1.23.2. 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.
- 1.23.3. The Contractor is to list substitute equipment as a price deduction to the Bid Price on the Electrical Supplementary Bid Form. Space has been provided to show manufacturers not specifically mentioned. Acceptance of substitute equipment shall be at the discretion of the Owner and/or Engineer's Representative. Any substitutes not listed on the Electrical Supplementary Bid Form will not be entertained.
- .1 The proposed substitution shall show product name and complete description and also what difference, if any, will be made in the amount of the Bid Price for each substitution, should it be accepted.
  - .2 Materials and products specified by the name of the manufacturer, the brand or trade name, or catalogue reference, shall be the basis of the Bid Price.
  - .3 Any alternate and/or substitute equipment listed shall be equal in performance and quality to that specified. If space, power, structural or any other requirements are different from the equipment specified, the cost of any changes shall be included for in the price shown on the Electrical Supplementary Bid Form.
  - .4 The Owner reserves the right to accept or reject any substitution without question.
  - .5 The "Base and Alternate Equipment" is for North American manufactured products. Where a listed manufacturer can offer either North American or non-North American

source for the equipment, the country of origin shall be shown under "Substitute Equipment" and the cost savings shown under "Deduct from Tender Price".

1.24. PRODUCTS AND MATERIALS

- 1.24.1. Make and quality of materials used in the construction of this project shall be subject to the approval of the Engineer's Representative.
- 1.24.2. 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.
- 1.24.3. Factory assemble control panels and component assemblies.
- 1.24.4. 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.
- 1.24.5. 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.
- 1.24.6. 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.
- 1.24.7. 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 without any mark-ups applicable by the Contractor, subcontractors, sub-subcontractors 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.

1.25. CO-OPERATION WITH CONSULTANTS

- 1.25.1. To assist in the successful execution of the project, the Contractor shall receive a job report that summarizes the expectations of the Consultant and the Contractor. This document covers topics such as progress billings breakdowns, shop drawing requirements, change order pricing breakdowns, the commissioning process, installation drawings, the specifications, as-built drawings and O+M manuals, along with a number of other items. This job report is intended to reiterate and elaborate on key items of the Contract Documents and is not intended to impose new requirements.

- 1.25.2. At the appropriate time during construction the Contractor shall submit the applicable documentation listed in the "Mechanical/Electrical Unfinished Building Occupancy Checklist". The list shall be issued by the Consultant during the course of the project; however, a sample checklist can be provided at any time upon request. The checklist shall be completed by the Contractor when the information required for occupancy is submitted. The Consultant shall review the information and checklist and shall identify when the information is complete. The Consultant's general review letter (required for building occupancy) shall only be issued when all the information requested in the checklist is submitted by the Contractor and deemed to be complete by the Consultant.
- 1.25.3. For electrical systems occupancy, provide a PDF copy of the following documents to the Engineer's office for review:
- .1 Electrical inspection authority inspection certificate/report with no deficiencies.
  - .2 Fire alarm verification report with no deficiencies.
  - .3 CAN/ULC-S561 "Standard for Installation and Services for Fire Signal Receiving Centres and Systems" certificate.
  - .4 Maglock test and verification report with no deficiencies.
  - .5 CAN/ULC-S1001 "Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems" reports for electrical systems with no deficiencies.
  - .6 Letter confirming that all emergency lighting and exit signs are installed and illuminated.
  - .7 Letter confirming that all unit equipment for emergency lighting (batteries, heads, exit signs) are installed and powered and have been tested to demonstrate that they last for the run time indicated in the Specifications or on the Drawings.
  - .8 Emergency generator testing and commissioning reports with no deficiencies.
  - .9 Emergency generator TSSA inspection report with no deficiencies.
  - .10 Fire pump testing and commissioning reports with no deficiencies.
  - .11 Emergency power (inverter) testing report with no deficiencies.
  - .12 Letter confirming that all openings in walls and floors for electrical services have been fire stopped.
  - .13 Cyber Security Report Letter and backup schedule as required by Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - .14 Lighting control commissioning documentation.
  - .15 Hood fire suppression certificate of acceptance by third party testing agency or signed and sealed letter of assurance from hood fire suppression engineer.
  - .16 Letter confirming that all breaker trip unit/protective relays settings have been set in accordance with the power system study.
  - .17 Additional items as indicated by the Engineer's Representative.
  - .18 Additional items as indicated on the Occupancy of Unfinished Buildings Checklist issued by Engineer's Representative.
- 1.26. CO-OPERATION WITH OTHER DIVISIONS
- 1.26.1. Particular attention must be paid to the proximity of electrical conduit and cable to mechanical piping and equipment.
- 1.26.2. Electrical conduits shall not touch or be supported on pipe or duct walls.

- 1.26.3. Each section shall confine itself to installing all materials in the spaces shown without encroaching upon space for materials installed under other sections or divisions. Where the space allocated to another section or division is encroached upon, the materials shall be relocated to their proper space allocation in such a manner to complete the work using space allocated to the various sections and divisions. Relocation of materials and work involved shall be paid for by the section responsible for the encroachment at no extra cost to the Owner.
- 1.26.4. 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.
- 1.26.5. The Electrical Contractor shall coordinate the exact breaker/fuse sizes with all mechanical equipment shop drawings prior to rough-in and ordering of the electrical distribution equipment. Size of breakers/fuses shown on drawings are based on generic equipment manufacturers and sizes may change depending on successful equipment manufacturer. No additional costs shall be allowed for non-coordinated mechanical shop drawing reviews by the Electrical Contractor.
- 1.27. TEMPORARY USE OF EQUIPMENT
- 1.27.1. Where the electrical systems are operated during construction, the Electrical Contractor shall maintain the system and equipment in proper operating condition.
- 1.27.2. 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.
- 1.27.3. 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.
- 1.28. TESTING
- 1.28.1. General
- .1 Refer to the testing requirements outlined in each individual specification section and provide all required staffing, materials, tools and expertise to perform the required testing. Where specification Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE has been included, ensure all testing is performed accordingly by the Technical Services Division Startup Service trade.
  - .2 This specification is intended to capture the requirements for factory testing, factory witness testing, site startups, site testing and training of electrical equipment. This specification represents a minimum requirement and does not absolve the equipment manufacturers from performing any tests required by the standards referenced in the individual specification sections.
  - .3 The testing process for the Electrical Systems shall include:
    - .1 Verification that the installation meets the requirements of the contract documents.
    - .2 Verification that the system's performance meets the design intent.
    - .3 Building operator training.
    - .4 As-Built documentation, operating and maintenance manuals, and systems operating manuals.
  - .4 The Contractor, Engineer's Representative, Technical Services Division Startup Service (where called for in the Specification) and Commissioning Agent (where identified as part of the project) shall provide the services to complete the process. See further explanation below defining the areas of responsibility.

- .5 Provide labour, equipment and material to conduct the testing process as outlined in this Section.
- 1.28.2. Factory testing
- .1 All equipment is to have factory testing performed by the equipment manufacturer. These tests are to include the manufacturers standard factory testing, and any required testing to conform to the standards, and any additional testing referenced in the individual specification sections.
  - .2 The manufacturer is to perform the required testing and submit test reports recording the results of all tests to the Electrical Contractor for review and if found acceptable submit to Engineer's Representative for Shop Drawing review and the final copy included in the O&M Manuals. Test reports are to be submitted and reviewed by the Electrical Contractor and Engineer's Representative prior to shipment to site.
  - .3 Any deficiencies noted in the factory testing are to be corrected prior to shipment of electrical equipment unless otherwise agreed to by the Electrical Contractor.
- 1.28.3. Factory Witness Testing
- .1 For all factory witness testing, the manufacturer is to act as the test leader and is responsible for all required organization, coordination, performance of testing and documentation of test results. The manufacturer is to ensure the tests being performed are in alignment with the requirements of the Specification in advance of the testing and provide hard copies of the latest Shop Drawings and test scripts for each attendee of the witness test. Any deviations to the tests being requested in the Specifications and Drawings must be communicated to the Electrical Contractor and Engineer's Representative in advance and must be accompanied with a rationale and/or an alternate test method that demonstrates that the intent of the specified test would be met.
  - .2 Each factory witness test is to include at a minimum:
    - .1 Introductions.
    - .2 A walkthrough of the latest Shop Drawing and review of latest Shop Drawing commentary with discussion on any remaining open items.
    - .3 A walkthrough of the test script.
    - .4 A walkthrough of the Design Specifications and Drawings noting/reiterating any required deviations from the design documents in terms of testing requirements.
    - .5 Performance of tests
    - .6 At the conclusion of all factory witness tests, the manufacturer is to produce signed factory test results recording all noted results and documenting any remaining deficiencies. Report to include record of the testing instruments used along with calibration dates (where required) and serial numbers.
  - .3 Factory witness testing shall be attended by the persons as listed below, attendance at the witness testing is at the discretion of each representative and is to be confirmed by all parties prior to witness testing.
    - .1 One (1) Electrical Contractor Representative
    - .2 One (1) Engineer Representative
    - .3 One (1) Commissioning Agent Representative
    - .4 One (1) Technical Services Division Startup Service Representative
  - .4 Manufacturers to include for the complete cost of the attendees listed above to attend the factory witness testing for the equipment. Cost to include but not limited to all travel, food and lodging costs. Manufacturer to note, attendees may be coming from different locations within Canada.

- .5 Manufacturer to provide factory witness test scripts to the Contractor as a formal Shop Drawing in advance of the factory witness test for review by the Contractor, Engineer and Commissioning Agent through the formal Shop Drawing review process. Factory witness test shall not be scheduled without a reviewed test script.
  - .6 Manufacturer to notify the attendees minimum two (2) weeks prior to the date the tests are to be performed. Where travel out of province is required, provide minimum four (4) weeks notice.
  - .7 Manufacturer to perform their own internal quality assurance and control check prior to any factory witness test such that the manufacturer is prepared to perform the complete demonstration of the equipment.
  - .8 Any deficiencies noted in the factory testing is to be corrected prior to shipment of the electrical equipment.
- 1.28.4. Site Startup
- .1 Manufacturer to include for the costs of technician(s) to perform initial system startup on site as required by the Specifications and Electrical Contractor. Extent of technician(s) involvement to be coordinated with the needs of the Specifications and the Electrical Contractor.
- 1.28.5. Site tests
- .1 Manufacturer to include for the costs of technician(s) to perform site tests as required by the Specifications and Electrical Contractor. Refer to tests identified in the individual Specification sections and include all personnel and equipment to perform testing.
- 1.28.6. Materials
- .1 The Contractor and Manufacturer shall provide all instrumentation and equipment necessary to conduct the tests as specified in the specifications. The Contractor shall ensure the instrumentation to be used are properly and adequately calibrated and if required by the Engineer's Representative or Commissioning Agent to provide the dates the instrumentation was last calibrated.
- 1.29. TRAINING
- 1.29.1. The Manufacturer is to include for qualified technician(s) with project specific knowledge to perform in depth training for facility management team members.
- 1.29.2. Training may include up to ten (10) attendees and may be video recorded by others.
- 1.29.3. Training program to include:
- .1 One site 'in class' introduction session covering the basics of system operation.
    - .1 Manufacturer to submit a course outline before training commences.
    - .2 Manufacturer to provide course training documentation (if required) for attendees.
  - .2 On site 'hands on' session covering the specific equipment design and operation details, including:
    - .1 All operating procedures including automatic and manual intervention procedures.
    - .2 All regular maintenance procedures.
    - .3 Troubleshooting procedures.
    - .4 Spare parts required.

- 1.29.4. Timing of training to be coordinated with Electrical Contractor and Owner/Facility Management staff and is to be provided in advance of systems supporting critical loads to allow for full ability to operate the systems. The Electrical Contractor/Manufacturer to notify the Owner/Facility Management team a minimum two (2) weeks prior to the date of training.
- 1.30. LIFE SAFETY INTEGRATION TESTING
- 1.30.1. Provide testing of the integration of all life safety and fire protection systems.
- 1.30.2. The Integrated Testing Coordinator (ITC) will complete an Integration Testing Plan (ITP). Carry out the testing as described by the ITC in the ITP, and in accordance with CAN/ULC-S1001 as it relates to any electrical systems.
- 1.30.3. The ITC and development of the ITP are not the responsibility of this Contractor.
- 1.30.4. The testing of the integrated systems shall include, but not be limited to the following systems and all associated components:
- .1 Fire Alarm System
  - .2 Fire Signal Receiving Centre
  - .3 Mass Notification
  - .4 Elevators
  - .5 Emergency Generators and/or Inverters
  - .6 Audio/Visual Systems
  - .7 Lighting Control Systems
  - .8 Notification Systems (Public Address)
  - .9 Sprinkler Systems
  - .10 Standpipe Systems
  - .11 Fire Pumps
  - .12 Water Supplies
  - .13 Water Supply Control Valves
  - .14 Heat Tracing for Life Safety Systems
  - .15 Fixed Fire Suppression Systems
  - .16 Cooking Equipment Fire Suppression Systems
  - .17 Automatic Door Operators for Stair Relief
  - .18 Hold-Open Devices
  - .19 Electromagnetic Locks
  - .20 Smoke Control Systems and Associated Dampers
  - .21 Venting to Aid Firefighting
  - .22 Smoke Alarms
  - .23 Hazardous Protection Monitoring
  - .24 Gas / CO Detection Systems
  - .25 Prevention of Smoke Recirculation (AHUs)
- 1.30.5. Coordinate with all other trades to carry out the appropriate testing.
- 1.30.6. Be responsible for carrying out and coordinating the testing work associated with the ITP. All work shall be coordinated with the ITC and shall include but not be limited to:

- .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
- .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
- .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."
- .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001 "Integrated Systems Testing of Fire Protection and Life Safety Systems."

1.31. STATEMENT OF PRICES

- 1.31.1. To form a basis for progress payments the successful bidder shall submit a sample progress draw for the various portions of the work. The format of the sample progress draw shall be as shown in the example progress draw below. The sample progress draw shall include a breakdown which illustrates all categories shown on the example progress draw which are relevant to the project. The categories shall be broken down to clearly illustrate the value of the material being supplied as the first subcategory and the value of the labour being supplied as the second subcategory, as shown on the example progress draw. The electrical Engineer's Representative reserves the right to request that additional categories be added to the progress draw if the Engineer's Representative feels that doing so will aid in assessing the contractor's progress on site, thereby expediting contractor payment. Progress draws not including the categories shown on the example progress draw where relevant to the project and / or not providing separate labour value and separate material value subcategories will be rejected.
- 1.31.2. 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-built drawings and manuals to be carried as a separate line item.
- 1.31.3. Contractor to list and track all fixed per unit cost luminaires as part of Light Fixtures - Materials on the progress draw.
- 1.31.4. Contractor to list and track each of the approved changes on separate lines on the progress draw.
- 1.31.5. 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.

**EXAMPLE PROGRESS DRAW**

**Electrical Contractor Name**  
**Billing Application Electrical Division**  
**Project Name**

<b>Description</b>	<b>Application Number – xx</b>		<b>Date – xxxx to xxxx</b>					<b>Balance to Complete</b>
	<b>Contract Value</b>	<b>%</b>	<b>Billed To Date</b>	<b>%</b>	<b>Prev. Billed</b>	<b>%</b>	<b>This Billing</b>	
Permits / Mobilization	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demolition & Removals	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Duct Banks – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx

Feeder Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Feeder Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Ltg. Branch Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Power & Lighting Branch Wire – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Conduit – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Comms / Security / AV Cable – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Distribution Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Generator / Inverter – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Material†	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Light Fixtures – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Lighting Controls – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Fire Alarm Equipment – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Wiring Devices – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Material	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Hand Dryers – Labour	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Commissioning / Training	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Demobilization / Clean-up	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Manuals / As-Built Drawings	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Subtotal	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
<b>Additions to Contract</b>								
CO # / PC # / CCN #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
Cash Allowance #	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----

Subtotal	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xxx	xx,xxx.xx	xx,xxx.xx
	-----		-----		-----		-----	-----
	-----		-----		-----		-----	-----
Total Contract	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx	xxx,xxx.xx	xxx,xxx.xx
Less Holdback			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	
			-----		-----		-----	
Total			xxx,xxx.xx		xxx,xxx.xx		xxx,xxx.xx	

<sup>†</sup> Inclusive of fixed per unit cost luminaires. Refer to luminaire schedule and/or electrical supplementary bid form for luminaire fixed unit costs.

1.32. METRIC CONVERSIONS

1.32.1. Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, conduit and site services in both new and existing installations.

1.33. INTERRUPTION OF SERVICES

- 1.33.1. 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.
- 1.33.2. Testing and operation of major equipment shall be approved by the Engineer's Representative to avoid excessive electrical utility charges. Such testing to be generally carried out after normal working hours or on weekends.
- 1.33.3. All such overtime work shall be carried out without additional cost to the Owners.
- 1.33.4. 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 utility 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.
- 1.33.5. 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.
- 1.33.6. The Contractor is responsible for co-ordination and isolating of all existing services at all voltage levels required for 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.
- 1.33.7. The Contractor is responsible for any damages caused to existing systems when making connections.
- 1.33.8. 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.

1.34. PRE-PURCHASED EQUIPMENT

- 1.34.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-purchased equipment and its associated equipment as if it had been purchased by the Contractor, with the single exception of payment.
- 1.34.2. The Electrical Trade shall provide a warranty for all pre-purchased equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-purchased equipment at no cost to the Owner during the warranty period.
- 1.34.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.
- 1.34.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-purchased equipment into a working system whether or not shown on the Drawings or specified herein.
- 1.34.5. The following list of equipment is pre-purchased:
  - .1

1.35. PRE-TENDERED EQUIPMENT

- 1.35.1. The Electrical Trade shall assume complete responsibility for the Owner's pre-tendered equipment and its associated equipment as if it had been purchased by the Contractor, including payment.
- 1.35.2. The Electrical Trade shall provide a warranty for all pre-tendered equipment during the warranty period and shall include for all labour, material and shipping charges not covered in the manufacturer's warranty to completely repair or replace any defective pre-tendered equipment at no cost to the Owner during the warranty period.
- 1.35.3. The Electrical Trade shall take complete responsibility for the co-ordination of delivery of the separate items of equipment and their proper placement as required by jobsite conditions.
- 1.35.4. The Electrical Trade shall provide all materials and labour required to incorporate pre-tendered equipment into a working system whether or not shown on the Drawings or specified herein.
- 1.35.5. The following list of equipment is pre-tendered: Insert the list of Owner Pre-tendered equipment or delete this if none are being included in the project
  - .1

1.36. VALUATION OF CHANGES

- 1.36.1. 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.
- 1.36.2. 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.
- 1.36.3. 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.
- 1.36.4. The following shall not be included in the cost of the work but are covered by the hourly labour rate:
  - .1 The Contractor's payroll, administrative, 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/hand tools, storage, and site office consumables, etc., including but not limited to 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, all government payroll burdens, variable labour factors and union or association funds.
  - .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 a PDF electronic copy of change notice documentation.
  - .8 The cost of preparing As-Built, layout and working drawings and shop drawings. This includes any and all AutoCAD/BIM costs related to interference drawings or other associated drawings that may be required as part of the changes.
  - .9 The cost of clean-up and disposal of waste material.
  - .10 Parking, travel, coffee break/rest periods, warranties, safety training, WHMIS and health and safety committee, and non-productive time.
  - .11 Rentals, additional bonding, project financing.
- 1.36.5. 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 CCDC 2-2020 GC 6.2.
- 1.36.6. 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.
- 1.36.7. Special equipment rental rates will be charged at cost. The Contractor shall provide an official quotation of the equipment rental with the Proposed Change quotation as backup, otherwise special equipment rentals will not be accepted by the Owner/Consultant.
- 1.36.8. The maximum percentage fee for mark-ups shall be as stated in the Division 0/1 specifications or the Contract Supplementary Conditions.
- 1.36.9. All changes, change notices, revisions to contract, Supplemental 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.

- 1.36.10. The material costs used shall be a discount to nationally available pricing guides (i.e. Trade Service, Allpricer, etc.) to reflect a value with a fair and reasonable markup to the actual cost of the materials purchased from distributors. The Owner and/or Engineer's Representative reserve the right to negotiate material pricing to a value that is fair and reasonable to the Owner.
- 1.36.11. 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 as listed on the Bid Form and/or Electrical Supplementary Bid Form. The Owner and/or Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, markup and profit. The labour rate will be inclusive of all labour burden charges as stated in this 'Valuation of Changes' section above.
  - .3 The following labour burdens are not part of the hourly labour cost, but are covered under the NECA labour unit rates: safety measures and regulations; drawing and specification study; layout, measuring and marking the installation location; material unloading, jobsite storage and delivery to the installation area; inspection, uncrating and shipping support removal; tool acquisition and return to storage; clean-up of excess material; and testing circuits for continuity.
  - .4 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.
- 1.36.12. When pricing additional work for Proposed Changes, the Electrical Contractor shall only price new materials that are required for the Proposed Change. Where existing materials and/or infrastructure (i.e. homerun conduits back to electrical panels) can be re-used for the Proposed Change, the Electrical Contractor shall utilize these items in the valuation of the Change at no extra cost.
- 1.36.13. Where a Proposed Change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.36.14. When pricing Proposed Changes containing both additions and credits, and where no work and/or materials have been installed on site, the Electrical Contractor shall only price the net new materials and net new labour that are required for the Proposed Change. Per unit labour and material costs shall be equal for credits and additions.

## 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		xxx.xx C		5.00 C	
¾' EMT STL SS CONN		xx.xx C		10.00C	
¾' EMT STL SS CPLG		xx.xx C		5.00 C	
¾' EMT STRAO 1-H		xx.xx C		4.00 C	
#10 x 1" SELF TAPPING SCREW		x.xx C		5.50 C	

TOTALS

### Description

#### Material

General Materials		
Permitted Mark-up	(@ xx.xx %)	
<b>Material Total</b>		

#### Labour

Journeyman	(xx Hrs. @ \$xx.00)	
Foreman @ 10%	(xx Hrs. @ \$xx.00)	
<b>Labour Total</b>		

#### Material and Labour Total

#### Final Amount

1.37. DEMOLITION

- 1.37.1. 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.
- 1.37.2. 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.
- 1.37.3. 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.
- 1.37.4. Make safe and disconnect all power and systems, as and when, and to the extent required to facilitate the demolition.
- 1.37.5. If applicable, review the mechanical, architectural, and other related discipline drawings, and include for removing and making safe all power connections to demolished equipment and devices, back to the source panel, except where indicated otherwise on the drawings.
- 1.37.6. 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.
- 1.37.7. 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.
- 1.37.8. Remove and replace any electrical equipment on walls or ceilings that will be demolished and rebuilt.
- 1.37.9. Disconnect and remove existing light fixtures, devices, outlets, CCTV, security devices, etc. which are not to be reused. Such items shall be packaged and turned over to the Owner at a place designated by the Owner. Cut back and cap unused raceway and outlets and remove unused wiring back to panelboard in an approved manner.
- 1.37.10. Ensure that all existing equipment which is to be reused and/or relocated is thoroughly reviewed 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.
- 1.37.11. Carry out the work with a minimum of noise, dust and disturbance.
- 1.37.12. Provide tools and clean up equipment. Obtain the Owner's permission for the use of electrical, plumbing or drainage outlets.
- 1.37.13. 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.
- 1.37.14. 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.

1.38. CYBER SECURITY

- 1.38.1. Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.
- 1.38.2. Definitions
  - .1 Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).

- .2 Critical Cyber Assets: Cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
  - .3 Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
  - .4 Cybercrime: Any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
  - .5 Cyber Hygiene: Practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
  - .6 Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
  - .7 Cyber Security: Technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
  - .8 Cyber Threat or Cyber Security Threat: Malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS / DoS) attacks and other attack vectors.
  - .9 Cyber Threat Actors: Broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
  - .10 IP Multicast: Technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.
  - .11 Endpoint: Remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.
  - .12 Network Certificates: Also known as a Digital Certificates, which are an electronic "password" that allows a person or organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
    - .1 Secure Socket Layer Certificate (SSL) Digi-SSL
    - .2 Software Signing (Code Signing Certificate) Digi-Code
    - .3 Client Certificate (Digital ID) Digi-ID
  - .13 Social Engineering: Exploitation methods that target human vulnerabilities, such as carelessness and trust.
  - .14 Technical Vulnerabilities: Weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- 1.38.3. Cyber Security Measures
- .1 Implement at minimum the following multi-layered Cyber Security measures to limit and / or reduce the Owner's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
  - .2 Password Management
    - .1 Employ password management best practices such as:
      - .1 Do not use default passwords.

- .2 Use strong and unique passwords for all applications. Use a minimum of 8 characters where there is no password policy inherent in the software; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ? ]).
- .3 Reset passwords at regular intervals.
- .4 Configure two-factor authentication for all accounts where possible in the system software.
- .5 Do not use System Admin logins for simple tasks; create separate User accounts with rights levels appropriate for the job function. Create and define user accounts as appropriate such as Role based, Individual logins or assigned roles.
- .6 Use different passwords for every account.
- .7 Enforce secure password policies within the business environment.
- .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.
- .3 Port and Interface Management
  - .1 Employ Port Management techniques such as:
    - .1 Restrict access on network switch ports to assigned devices addresses.
    - .2 Lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
    - .3 Shut off all unused communication services and hardware interfaces.
    - .4 Advise Owner on use of 3<sup>rd</sup> party port security monitoring.
- .4 Physical and Virtual Networks
  - .1 Provide a dedicated VLAN for network connected systems where a dedicated LAN has not been provided.
- .5 Encryption
  - .1 Use minimum TLS 1.2 for all network attached equipment and use TLS 1.3 where available.
- .6 Network Certificates
  - .1 Ensure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
  - .1 Use the latest stable Firmware / Software version on all devices / equipment as well as implement a Firmware / Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
  - .1 Provide the Manufacturer's System hardening guides for the equipment being installed and implement as many recommendations / features as possible.
- .9 External Memory
  - .1 Restrict the use of external memory. Restrict or eliminate the use of devices such as external USB Thumb drives unless expressly allowed by the Owner's Information Technology representatives.
- .10 Log Off
  - .1 Enable auto-log off timer for all software, websites and logins. Set auto-log off timer on local Workstation(s) being used to access the equipment with a

reasonable timer in the case that an employee leaves the workstation unattended.

- .11 Anti-Virus Software
  - .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.
- .12 Filtering Techniques
  - .1 Apply filtering techniques including the types listed below where possible:
    - .1 Web Filtering: A Web filter adds another layer to anti-phishing defences by blocking the web based component of phishing and malware attacks.
    - .2 Multicast Message Filtering: Filters the packets sent to multicast groups users are not subscribed to.
    - .3 Content Filtering: Is the use of a program to screen and / or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content.
- .13 Back up Regularly
  - 1. Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible.
  - 2. Identify files that require manual backup and the backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.

#### 1.38.4. IT Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above in part or in full, as possible, to a wide range of Information Technology (IT) Devices including:
  - .1 Firewalls
  - .2 Routers
  - .3 Network switches (Core and Edge Devices)
  - .4 Servers and databases
  - .5 Workstation computers
  - .6 Network connected system devices and controllers
  - .7 Wireless Access Points and wireless controllers
  - .8 Mobile phones and tablets
  - .9 Any IT System or endpoint connected to the network

#### 1.38.5. Operational Technology (OT) Devices and Systems

- .1 Apply the Cyber security measures listed in the clauses above, in part or in full, as possible, to a wide range of OT Network devices including:
  - .1 Industrial Control Systems such as:
    - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
    - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.

- .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
  - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
  - .2 Building Management Systems (BMS) and Building Automation Systems (BAS)
  - .3 HVAC equipment
  - .4 Lighting controls for both internal and external applications
  - .5 Energy monitoring and metering equipment
  - .6 Transportation and parking systems
  - .7 Scientific equipment
  - .8 Any other OT System or endpoint that can be connected to the network
- 1.38.6. Report Cybercrime
- .1 Advise the Owner and / or their representatives of any indication of a Cyber Incident of a criminal nature when performing any work on a network connected system.
- 1.38.7. Cyber Security Report Letter
- .1 Provide a Cyber Security Report Letter in the closeout documents to the client stating which Cyber Security measures have been implemented, when implementing any and / or all of the Cyber Security Measures mentioned in this Specification.
2. Products
- 2.1. NOT USED
3. Execution
- 3.1. NOT USED
- END OF SECTION

26 05 03.00 As-Built Drawings

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. RELATED WORK SPECIFIED ELSEWHERE

1.2.1. Refer to As-built Drawings in Section 01 70 00 (01 72 29.00) – CLOSEOUT SUBMITTALS.

1.3. RECORD OF REVISIONS ON SITE

1.3.1. Print and maintain two complete sets of white prints to mark the project progress, changes and deviations.

1.3.2. Maintain an updated copy of plans and schematics in the digital format for which the project is provided (i.e. AutoCAD or Autodesk Revit MEP) and be capable to produce documents in Adobe PDF upon request.

2. Products

2.1. AS-BUILT DRAWINGS

2.1.1. Request in writing from the Engineer's Representative all electrical AutoCAD drawings. Complete release form provided by Engineer's Representative and pay the Engineer's Representative directly the costs identified in this section below prior to receiving the drawings. After the final as-built drawings have been reviewed, send the Engineer's Representative a copy via electronic transfer for their records and send a minimum of one copy on USB key with each set of maintenance manuals. Provide additional copies if required under the General Conditions. Use the same version of AutoCAD software that the drawings were created in and provide electronic files saved in a version acceptable to the end user and engineer.

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

\$5,000	For Electrical Contracts up to \$250,000
2% of Electrical Contract	For Electrical Contracts from \$250,000 to \$1,500,000
\$30,000	For Electrical Contracts over \$1,500,000

2.1.3. 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.

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

2.1.5. Final as-built drawings to include all revisions made to the drawings during construction, including all approved changes. 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 to show as-built conditions, quantity of wires in each conduit, and circuit numbers of wires in each conduit. Include slab layout drawings in as-built drawing package.

2.1.6. CADD Requirements.

- .1 A complete list of layer names and brief description of each layer's use shall accompany all files.
- .2 Fonts for text shall be Autodesk standard. Custom fonts, shape files, etc., are not to be used.
- .3 Final as-built drawings shall be returned on USB stick.
- .4 Each USB stick shall include a file containing Engineer's Representative and Owner, Contract number, file names and Drawing number. Provide a "readme.txt" file in ASCII format. A printed copy of the readme file shall accompany each USB stick.
- .5 All drawings shall be in the same units as issued on Bid Documents.
- .6 Provide a complete list of symbol (block) names with a description of each symbol.
- .7 Special effort shall be made to ensure that drafting is accurate: i.e. appropriate lines are indeed horizontal and vertical; lines that should intersect do but not over-intersect and ensure that entities are placed on correct layers.

2.1.7. Maintain records on site, as the job progresses, and record all changes and deviations from that shown on Contract Drawings. After review and approval of service lines in trenches, take "as-built" measurements, including all depths, prior to commencement of backfilling operations. Show the location of buried electrical ducts and conductors on the drawings and dimensioned from fixed points. Keep drawings up-to-date during construction and in addition to field measurements include Change Orders, Supplemental Instructions and all other changes.

2.1.8. On completion of the building, forward to the Engineer's Representative the digital drawings indicating all such changes and deviations for review by the Engineer's Representative.

2.1.9. If required, the Engineer's Representative will provide a quotation to this Contractor to transfer "As-Built" information from the mark-up documentation to the acceptable software.

- .1 Include a cost of \$400.00 per sheet for the transfer of marked up "As Built" information to AutoCAD and forwarding of the electrical information by the Engineer's Representative to the Owner

2.1.10. The Electrical Contractor may request from the Engineer's Representative the most current electronic documentation (Electrical Drawings) in AutoCAD sent via electronic transfer. The Engineer's Representative will provide the Drawings one time at no charge. Where the Drawings are requested more than one time throughout the course of the project, a nominal charge of \$500.00 will apply to the second and subsequent requests.

2.1.11. The AutoCAD as-built documents shall meet all the Owner's and Engineer's Representative's requirements.

3. Execution

3.1. NOT USED

END OF SECTION

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26 05 04.00 Submittals/Shop Drawings

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. RELATED WORK

1.2.1. Comply with Div. 00 for submittal requirements and as amended below.

2. Products

2.1. SHOP DRAWINGS

2.1.1. Shop Drawings shall be organized by Specification Section. Ensure shop drawing package for a given Specification Section is complete, including all equipment, products, materials, and systems to be used as part of that Specification Section, and submit as a single shop drawing package. Do not submit numerous separate shop drawings for the same Specification Section. Do not combine more than one section into one submission. Incorrect submissions will be returned without review.

2.1.2. 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. SWBD-1A).

2.1.3. Submit shop drawings electronically, by email, in PDF format. Submissions that are not electronic without prior approval from the Engineer's Representative shall be returned as not reviewed. Provide the following information in the email submission:

- .1 S+A project number and Contractor Shop Drawing Identifier in Subject Line
- .2 Attachments shall be limited to 10 MB
- .3 Provide FTP hyperlink for all attachments in excess of 10 MB with appropriate information for downloading the file (as required)
- .4 Shop Drawing Submission to the following email address:
  - .1 ContractAdmin.Toronto@smithandandersen.com

2.1.4. Shop drawings submitted directly to Smith + Andersen personnel (and not copied to the email address provided above) without advanced permission will not be processed nor considered as received.

2.1.5. 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.

2.1.6. When requested, Shop Drawings shall be supplemented by data explaining the theory of operation – for example: lighting control sequence of operation – the Engineer's Representative may also request that this information be added to the maintenance and operating manual.

2.1.7. Provide a cover sheet with the project name, issue date, issue number, specification section number, and title of section with space for Shop Drawing review stamps for the Contractor and Engineer's Representative.

3. Execution

3.1. SUBMISSION

- 3.1.1. Each Shop Drawing or catalogue sheet shall be in original PDF format stamped and signed by the Contractor to indicate that they have checked the drawing for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have 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 and mechanical co-ordination is complete before submitting drawings for review.
- 3.1.2. Scanned PDF versions are not acceptable.
- 3.1.3. Equipment shall not be released for manufacture until the shop drawing has been reviewed by Engineer's Representative. Contractor shall assume responsibility and cost for field changes. Installation of any equipment shall not start until after final review of Shop Drawings by the Engineer's Representative has been obtained.
- 3.1.4. Should equipment or materials that arrive on site differ from those shown on the Shop Drawings, bear all costs for:
- .1 Revising the equipment and materials.
  - .2 Revising the Work of other contractors impacted.
- 3.1.5. As part of the electrical Engineer's Representative's scope of the work, shop drawings shall be reviewed no more than twice. Should three or more reviews be required due to reasons of Contractor omissions causing resubmission requests, the Contractor shall reimburse the electrical Engineer's Representative for time expended in these extra reviews.

END OF SECTION

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26 05 05.00 Mounting Heights

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. NOT USED

3. Execution

3.1. MOUNTING HEIGHTS

3.1.1. Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

3.1.2. If mounting height of equipment is not specified or indicated, verify with the Consultant before proceeding with installation.

3.1.3. Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights.

.1 Local switches: 1100 mm.

.2 Wall receptacles:

.1 General: 400 mm.

.2 Above top of continuous baseboard heater: 200 mm.

.3 Above top of counters or counter splash backs: 100 mm.

.1 Where these receptacles are located adjacent to and in close proximity to local switches, mount receptacles at the same elevation as the local switches to provide a neat, aligned, installation.

.4 In mechanical rooms: 1200 mm.

.5 In equipment storage rooms: 900 mm.

.3 Receptacles for maintenance of equipment located on rooftops:

.1 Not less than 750 mm above the finished roof, per Electrical Code.

.4 Panelboards: 2000 mm to top of panel.

.5 Telephone and interphone outlets: 450 mm.

.6 Wall mounted telephone and interphone outlets: 1050 mm.

.7 Fire alarm stations: 1200 mm, measured to the top of the manual pull station.

.8 Wall Mounted Fire alarm audible devices: 2300 mm and not less than 150 mm from the ceiling, measured to the top of the device.

.9 Television outlets not mounted behind a wall mounted television: 450 mm.

.10 Wall mounted speakers: 2100 mm.

.11 Clocks: 2100 mm.

- .12 Power Door Operator push buttons: Refer to architectural for exact location and mounting height.
  
- .13 Wall mounted Exit Signs
  - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
  - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .14 Wall mounted Battery Packs and Emergency Heads
  - .1 For 2400 mm to 2500 mm ceiling heights: 2100 mm.
  - .2 For all ceilings heights greater than 2500 mm: 2400 mm.
- .15 Wall mounted occupancy sensors: 1050 mm.
- .16 Wall mounted visible signal devices: 2100 mm to centre of lens; or as allowed by CAN/ULC-S524 "Standard for Installation of Fire Alarm Systems" except where facility accessibility standards require otherwise.
- .17 Top of remote annunciator and passive graphic panels shall be no more than 1800 mm above finished floor.
- .18 Wall mounted emergency telephone (Fireman's Handset): 1350 to 1500 mm.

END OF SECTION

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26 05 21.00 Wires and Cables Under 2000 V

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.

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. 96, Portable Power Cables, latest edition.
- 1.2.6. CSA C22.2 No. 123, Metal Sheathed Cables, latest edition.
- 1.2.7. CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- 1.2.8. CSA C22.2 No. 131, Type TECK 90 Cable, latest edition.
- 1.2.9. CSA C22.2 No. 174, Cables and Cable Glands for Use in Hazardous Locations, latest edition.
- 1.2.10. CAN/ULC S139 / UL 2196 (Binational Standard), Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables, latest edition.
- 1.2.11. ASTM B800 - Standard Specification for 8000 Series Aluminium Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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 #8 AWG. Contractor to provide copper conductors for sizes larger than #8 AWG 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 or RWU90 to CSA C22.2 No. 38 rated as follows:
  - .1 Insulation rated at 1000 V for 600 V systems that are ungrounded or have a neutral grounding resistor to limit ground fault current.
  - .2 Insulation rated at 600 V for the other 600 V and 347/600 V distribution systems not covered under item #1 above.

- .3 Insulation rated at 600 V for all systems rated at 480 V 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. Provide an anti-oxidant compound, Ideal NOALOX, on all aluminum conductor terminations.
- 2.1.5. RWU90 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 Bonding 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.
- 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 or No. 131, and to CSA C22.2 No. 174.
  - 2.3.3. Conductors:
    - .1 Three (3) bare copper bonding conductor sized to Table 16 of the electrical code.
    - .2 Circuit conductors: copper, size as indicated on Drawings.
    - .3 Profile of VFD Cable cross section shall be entirely symmetrical.
  - 2.3.4. Shield: Flat copper tape shield, or continuously corrugated and welded aluminum sheath, depending on cable construction.
  - 2.3.5. Insulation:
    - .1 Chemically cross-linked thermosetting polyethylene (XLPE) with high dielectric strength to withstand repetitive high voltage spikes of 3.1 times the nominal system voltage rating due to VFD IGBT output.
    - .2 Type RW90 or RWU90 CSA rated for 1000 V, and suitable for voltage spikes mentioned in .1 above.
  - 2.3.6. Where compliant with CSA C22.2 No. 123, Armour: continuously corrugated and welded aluminum.
  - 2.3.7. Where compliant with CSA C22.2 No. 131, Inner jacket: polyvinyl chloride material.
  - 2.3.8. Where complaint with CSA C22.2 No. 131, Armour: interlocking aluminum.
  - 2.3.9. Overall covering: thermoplastic polyvinyl chloride (PVC) material rated at a minimum of FT-4.

- 2.3.10. Cable to be complete with manufacturer's cable termination kits including terminating connectors for proper termination of shield to ground. Termination kits to ensure common mode stray currents are drawn away from the motor to extend motor life-span. Termination kits to include self-terminating connectors that provide 360 degree contact to the shield / sheath.
- 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, where installed in damp and wet locations.
- 2.4.5. Two (2) hour fire rating.
- 2.4.6. Conform to requirements of CSA C22.2 No. 124; and CAN/ULC S139.
- 2.4.7. All mineral-insulated cable larger than #6 AWG shall be single conductor. For conductors #6 AWG and smaller, multi-conductor mineral-insulated cable is acceptable.
- 2.4.8. Manufacturer / Product: nVent Pyrotenax System 1850.
- 2.5. FIRE RATED TYPE RC CABLE
- 2.5.1. Conductors: stranded annealed copper, size as indicated.
- 2.5.2. Insulation: low smoke silicon rubber.
- 2.5.3. Armour: continuously welded and corrugated copper sheath.
- 2.5.4. Outer Jacket: Provide black low smoke, zero halogen polyolefin, FT4 rated where installed in damp and wet locations.
- 2.5.5. Two (2) hour fire rating.
- 2.5.6. Conform to requirements of CSA C22.2 No. 123; and CAN/ULC S139 with hose stream.
- 2.5.7. Manufacturer / Product:
- .1 Prysmian Draka Lifeline Type RC90.
  - .2 Berkshire Hathaway Marmon RSCC VITALink Type RC90.
- 2.6. ARMOURED CABLES
- 2.6.1. Cables to: CSA C22.2 No. 51.
- 2.6.2. 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.
- 2.6.3. Type: AC90 (BX).
- 2.6.4. Armour: interlocking type fabricated from aluminium strip.
- 2.6.5. 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.
- 2.7. ALUMINUM SHEATHED CABLE
- 2.7.1. 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.
- 2.7.2. Insulation: type RA90 rated 1000 V.

- 2.7.3. Sheath: aluminium applied to form continuous corrugated seamless sheath.
- 2.7.4. Outer jacket of PVC applied over sheath for direct burial or wet locations.
  
- 2.8. DIESEL LOCOMOTIVE CABLES (DLO)
  - 2.8.1. Cable: to CSA C22.2 No. 96 Portable Power Cables, rated to 2000 V.
  - 2.8.2. Conductor: stranded tinned annealed copper, size and number as indicated
  - 2.8.3. Separator: paper or polyester tape separates the conductor from the rubber insulation to aid in stripping.
  - 2.8.4. Insulation: premium grade Ethylene Propylene Rubber (EPR), rated 90 deg. C.
  - 2.8.5. Jacket: black, heavy duty chlorinated polyethylene (CPE), sunlight resistant, rated at a minimum of FT-4.
  
- 2.9. WIRING TERMINATION
  - 2.9.1. Lugs, terminals, screws used for termination of wiring to be to be dual rated for Copper/Aluminum (Cu/Al).
  - 2.9.2. Lugs, terminals, and screws used for termination of multiple wires must be rated for their intended use.
  - 2.9.3. For lugs used in connecting power utility company equipment or services, provide lugs that have CSA Die Index stamped on lug to facilitate proper crimping.
  
- 3. Execution
  - 3.1. GENERAL
    - 3.1.1. Provide a minimum of one bonding conductor for each three ungrounded conductors on all conduit and cable runs. Provide separate bonding conductors for each ground fault circuit interrupter circuits. All bonding conductors to be copper and insulated with a green coloured insulation.
    - 3.1.2. Size bonding conductor to applicable tables of the:
      - .1 Ontario Electrical Safety Code.
    - 3.1.3. All equipment, junction boxes, pull boxes, liquid tight flex, etc. to be bonded to ground through bonding conductors.
    - 3.1.4. Provide separate neutral conductor for each 120 volt circuit for all circuits feeding receptacles and power outlets.
    - 3.1.5. Do not install cables or devices on the surface of, or within 100 mm of the underside of roof decks.
    - 3.1.6. Ensure slack is provided in wiring connections to equipment which contains moving parts.
    - 3.1.7. 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.
    - 3.1.8. All cable terminations to be compression type fittings for wire sizes greater than #8 AWG. All compression type fittings to be two-hole long barrel type with lug inspection / viewing window. Where mechanical screw type lugs are allowed by the Engineer's Representative, they will be suitable for quantity of parallel runs of wire that are to be terminated under.

- 3.1.9. Armoured Cable Type AC90 (BX) may only be used for individual drops from slab mounted junction box to 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 3 m. Contractor to receive written approval from the Engineer's Representative to run armoured cable further than 3 m from junction box. Daisy chaining of fixtures is only acceptable in dry wall ceilings. 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 or run in walls for receptacles.
- 3.1.10. Branch circuit wiring to be upsized as follows to address voltage drop when:
- .1 The entire length of the circuit wiring exceeds 25 m – branch wiring to be a minimum of No. 10 AWG.
  - .2 The entire length of the circuit wiring exceeds 40 m – branch wiring to be a minimum of No. 8 AWG.
  - .3 The entire length of the circuit wiring exceeds 60 m – branch wiring to be a minimum of No. 6 AWG.
- 3.1.11. Where feeders or branch circuits are run underground, upsize conductors to comply with the requirements of electrical code Rule 4-004, Ampacity of wires and cables, using Diagrams D8 to D11 and Tables D8A to D11B of the electrical code. Where conductors are upsized due to Tables D8A to D11B, upsize conduits to comply with the requirements of electrical code Rule 12-910, Conductors and cables in conduit and tubing.
- 3.1.12. Where one (1) hour or two (2) hour conductor fire rating is indicated on the Drawings, provide fire rated Mineral-Insulated cables or fire rated MC cables. Fire rated Mineral-Insulated and MC cables shall be installed in accordance with the manufacturer's installation instructions and the fire rated cable product listing in order to maintain their fire rating. Special attention shall be paid to cable supporting method and fire rating of the structure from which the cables are supported.
- 3.1.13. Where conductors supply power to emergency lighting and the emergency lights are located on a different floor level than the power source (i.e. panel), then the conductors shall be fire rated for at minimum one (1) hour using fire rated Mineral-Insulated cables. Conductors with two (2) hour fire rating shall be used where indicated on Drawings. Provide fire rated Mineral-Insulated cables or fire rated MC cables where conductors require fire ratings.
- 3.1.14. Where alternatives to fire rated cables are indicated on the Drawings, such as running conduits within concrete cast in place slabs, under concrete slabs on grade, or within fire rated shaft/riser, care must be taken to ensure that the required fire rating is maintained. Where drawings call for conduits to be run within concrete cast in place slabs, the slabs must be of sufficient thickness to achieve the required fire rating and be no less than 51 mm (2 in.) of concrete cover both above and below conduits where one (1) hour fire rating is required and 102 mm (4 in.) concrete cover both above and below conduits where two (2) hour fire rating is required. The contractor shall submit a letter confirming the concrete coverage or construction of fire rated assembly provides the sufficient fire rating of the enclosed conduits.
- 3.1.15. 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 TECK 90 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 installation instructions.
- 3.3.3. Fastenings:
- .1 One-hole steel straps to secure surface cables 53 mm and smaller. Two-hole steel straps for cables larger than 53 mm.
  - .2 Channel type supports for two or more cables.
  - .3 Galvanized threaded rods: 6 mm diameter minimum to support suspended channels.
  - .4 Pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."
- 3.3.4. Connectors:
- .1 Watertight, approved for respective cables.
- 3.3.5. For single conductor cables, ground the sheath at the upstream (source) panel and provide insulated fibre plate at the load end, so as to prevent circulating sheath currents.
- 3.3.6. Where TECK 90 cable is run through or passes through a plenum space, install TECK 90 cable in conduit and comply with electrical code conduit fill percentage rules.
- 3.4. INSTALLATION OF MINERAL-INSULATED CABLE SYSTEM AND FIRE RATED TYPE RC CABLE SYSTEM
- 3.4.1. General:
- .1 Comply with: the requirements of the manufacturer's UL listing for the fire rated cable system and the manufacturer's written installation instructions.
  - .2 Provide all Products required by the manufacturer's UL listing to provide a fully certified system.
- 3.4.2. Handling:
- .1 Cable shall be uncoiled by rolling or rotating supply reel. Do not pull from coil periphery or centre.
- 3.4.3. Splicing:
- .1 Make all fire rated splices in the factory. In the event that a field splice is necessary, have the manufacturer's field technician make it in the field.
- 3.4.4. Terminations:
- .1 Make field made terminations using the cable manufacturer's termination kits. Use stripping tools, crimping tools and compression tools, available from the manufacturer for proper cable termination.
  - .2 Connections to ferrous cabinets for single conductor cables shall incorporate brass plates. Install per manufacturer's drawing.
  - .3 At cable terminations, use thermoplastic sleeving over bare conductors.
- 3.4.5. Sheath induction reduction:
- .1 When multi-phase circuits have paralleled single conductors, run cables in groups having one of each phase in each group.

- .2 Separate each set of paralleled conductors by at least two single cable diameters.
- 3.4.6. Exposed or Surface Installations:
  - .1 Secure cable(s) to the fire rated building structure using:
    - .1 Supporting methods outlined in the manufacturer's UL listing for the fire rated system utilized.
    - .2 Support fire rated cables at the intervals required by the manufacturer's UL listing.
- 3.4.7. Wall or floor penetrations:
  - .1 Provide approved fire stopping of all penetrations.
  - .2 Neatly train and lace cable inside boxes, equipment, and panelboards.
  - .3 Where cables are buried in cast concrete or masonry, sleeve for entry of cables.
  - .4 When penetrating a fire rated wall or fire rated floor, the cable must extend a minimum of 305 mm beyond the fire rated wall or fire rated floor. The 305 mm dimension can be in any direction as 305 mm of cable length is required to allow for proper heat dissipation such that cable terminations do not overheat.
- 3.5. FIELD QUALITY CONTROL
  - 3.5.1. Prior to energizing wires/cables, measure insulation resistance of each wire/cable. Ensure readings are acceptable per installation recommendations. Tabulate and submit for approval as a submittal.
  - 3.5.2. All Wires and Cables to be tested on site as defined in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE and herein. Contractor to oversee all testing and correct any deficiencies noted.
- 3.6. INSTALLATION OF CONTROL CABLES
  - 3.6.1. Install control cables in conduit.
  - 3.6.2. Ground control cable shield.

END OF SECTION

26 05 26.00    Grounding + Bonding

1.        General

1.1.        WORK INCLUDED

1.1.1.      Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2.      Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2.        REFERENCES

1.2.1.      CSA C22.2 No. 41– Grounding and Bonding of Equipment, latest edition.

1.2.2.      Ontario Electrical Safety Code, latest edition.

1.2.3.      Ontario Building Code, latest edition.

1.2.4.      CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.2.5.      IEEE Standard 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System, latest edition.

1.3.        DESCRIPTION

1.3.1.      Provide system grounding to meet requirements of current applicable codes.

1.4.        SHOP DRAWINGS AND PRODUCT DATA

1.4.1.      Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.4.2.      Submit shop drawings for ground bars and ground rod inspection wells for engineer's review prior to manufacture.

1.4.3.      Submit main system ground test report as a shop drawing for engineer's review. Include final reviewed report in the project O&M manuals.

2.        Products

2.1.        GROUNDING & BONDING EQUIPMENT

2.1.1.      Meet standard of CSA C22.2 No. 41 – Grounding and Bonding of Equipment, latest edition.

2.2.        CONDUCTORS

2.2.1.      Bare or insulated, stranded, soft drawn annealed copper wire, for: ground bus, electrode interconnections, metal structures, ground connections, telephone ground.

2.3.        LUGS

2.3.1.      All grounding connections to be made with compression type fittings and lugs with lug inspection / viewing window.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install complete permanent, continuous, system and circuit, equipment, grounding and bonding systems including, conductors, connectors, and accessories, as indicated, to conform to requirements of local authority having jurisdiction over installation.
- 3.1.2. Provide main station ground grid as shown on drawing but the ground grid shall consist of a minimum of four (4) driven ground rods. Copper ground rods shall be not less than 3 m long and 19 mm in diameter and where practicable located adjacent to the equipment to be grounded (i.e. main electrical room). Interconnect all ground rods underground with a #2/0 AWG bare ground conductor.
- .1 If main ground grid cannot be installed directly below the main electrical room, then provide a remote ground grid by installing the ground rods at the lowest floor level of the building and provide two grounding conductors of a minimum of #4/0 AWG copper to connect the ground grid to the main electrical room equipment. Run the two conductors through separate routes separated by a minimum of 5 m.
- 3.1.3. Supply and install a new ground bus system consisting of a length of copper bus, 25 mm thick ebony pad with chamfered edges as shown on the drawings. A minimum of two 1200 mm ground bars are to be provided in transformer vault(s), main electrical room(s) and generator room(s). Where a perimeter ground bus is shown on the drawings, supply and install a 50 mm x 6 mm copper bus on all walls attached at 1.5 m intervals on 13 mm standoffs. The perimeter ground bus shall be continuous around the room and shall be continued above or below all openings such as doors and vents.
- 3.1.4. Interconnect the ground bars to the ground grid with a minimum #2/0 AWG bare copper ground conductor if the ground grid is adjacent to the main electrical room(s). Where the ground grid is remote, connect the ground bars to the remote ground grid as described in 3.1.2.(1) above.
- 3.1.5. Supply and install inspection box for each ground rod. Inspection box is to be suitable for installation in heavy traffic areas and is to come complete with a lockable lid and security key.
- 3.1.6. Connect to the ground bus all metal equipment enclosures, as well as all other metal parts such as mechanical pipes, ducts, waste lines, door frames, railings, grilles, fences, etc. with minimum #2/0 AWG bare copper conductors.
- 3.1.7. For solidly grounded systems, transformer neutrals, main service entrance switchboard neutrals and all similar bonding connections, the bonding conductors shall be sized in accordance with Table 16 of the Electrical Code.
- 3.1.8. Provide cable grips to receive all grounding conductors. Identify all grounding conductors at the ground pad using lamacoid nameplates. Ground bus system to be provided in rooms as shown.
- 3.1.9. Terminate the following conductors at the ground bus system:
- Service neutral -as indicated on drawings

- Telecommunications ground

-as per TIA Standard 607, latest edition

TBB/GE linear length m (ft)	TBB/GE size (AWG)
less than 4 (13)	6
4 – 6 (14 – 20)	4
6 – 8 (21 – 26)	3
8 – 10 (27 – 33)	2
10 – 13 (34 – 41)	1
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
20 – 26 (67 – 84)	3/0
26 – 32 (85 – 105)	4/0
32 – 38 (106 – 125)	250 kcmil
38 – 46 (126 – 150)	300 kcmil
46 – 53 (151 – 175)	350 kcmil
53 – 76 (176 – 250)	500 kcmil
76 – 91 (251 – 300)	600 kcmil
Greater than 91 (301)	750 kcmil

where,

TBB = Telecommunications Bonding Backbone

- Main system ground -#2/0 AWG or 2 x # 4/0 AWG for remote ground grids
- Bonding conductor -as per Table 16 of CSA C22.1

- 3.1.10. Ground all metallic water, gas, and waste systems with a minimum #6 AWG copper in accordance with code requirements.
  - 3.1.11. Install bonding connections to typical equipment included in, but not necessarily limited to, following list: frames of motors, starters, control panels, building steel work, elevators, distribution panels and outdoor lighting.
  - 3.1.12. Commission an approved certified testing Agency to perform a main system ground test. Submit the main system ground test report as a shop drawing for engineer's review. Provide a copy of the report in the maintenance manual. (Refer to Part 3.2).
  - 3.1.13. Install connectors in accordance with manufacturer's instructions.
  - 3.1.14. Ground rods to be interconnected by grounding grid conductors (sized as per sections above) and buried to a maximum depth of 600 mm below the rough station grade and a minimum depth of 150 mm below the finished station grade.
  - 3.1.15. Protect exposed grounding conductors from mechanical damage.
  - 3.1.16. Install bonding conductor for flexible conduit and connect at both ends to grounding bushing with solderless lug, clamp or cup washer and screw. Neatly cleat bonding conductor to exterior of flexible conduit.
  - 3.1.17. Provide separate, insulated bonding conductor within each feeder and branch circuit raceway.
  - 3.1.18. Interface with the lightning protection system, if one is installed for this building.
- 3.2. TESTING
- 3.2.1. The contractor shall pay for the testing and verification of the entire building ground system using a certified testing Agency. Tests shall include main ground grid and ground rods, and grounding connections between all electrical and communication rooms. The agency shall provide complete test reports indicating test methodology and results. All costs shall be included in contract bid.

3.2.2. Following are acceptable methods of testing the ground grid. Testing shall be in accordance with IEEE Standard 81 (latest edition).

- .1 Two-Point Method
- .2 Three-Point Method
- .3 Ratio Method
- .4 Staged Fault Tests
- .5 Fall-of-Potential Method

END OF SECTION

26 05 29.00 Hangers and Supports

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
  - 1.2. SHOP DRAWINGS AND PRODUCT DATA
    - 1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
    - 1.2.2. Conduit and equipment provided under the Electrical division shall be complete with all necessary supports and hangers required for a safe and workpersonlike installation.
2. Products
  - 2.1. MATERIALS
    - 2.1.1. Provide “U” type support Strut as manufactured by Unistrut or Hilti.
3. Execution
  - 3.1. INSTALLATION
    - 3.1.1. All drilling for hangers, rod inserts and work of similar nature shall be done by this Division.
    - 3.1.2. Auxiliary structural members shall be provided under the electrical section concerned where conduits or equipment must be suspended between the joists or beams of the structure, or where required to replace individual hanger to allow for installation on new services. Submit details for review as requested.
    - 3.1.3. Depending on type of structure, hangers shall be either clamped to steel beams or joists, or attached to approved concrete inserts.
    - 3.1.4. Approved type expansion shields and bolts may be used for conduit up to 103 mm diameter where the pre-setting of concrete inserts is not practical. Submit Shop Drawings.
    - 3.1.5. Suspension from metal deck shall not be allowed unless specifically accepted by the Engineer’s Representative. Drawings of the proposed method of suspension must be submitted for review.
    - 3.1.6. Hangers, hanger rods and inserts in all parking and ramp areas shall meet the requirements of CAN/CSA-S413 – Parking Structures (latest edition) and shall be of corrosion-resistant material or have an effective, durable corrosion resistant coating. Submit samples for approval.
    - 3.1.7. Suspending one hanger from another shall not be permitted.
    - 3.1.8. All hangers, supports, brackets and other devices used outside the building wall shall be galvanized. If galvanized components cannot be used submit samples of proposed substituted for review before installation.

3.2. HORIZONTAL RUNS ON THE ROOF

- 3.2.1. Where conduit or cables are run horizontally across a roof, conduit or cable shall be supported from pre-manufactured UV resistant sleepers with closed cell foam base.
- 3.2.2. Sleepers shall be "E-Z Sleeper" product from Pipe-Ease Inc. or approved equivalent.
- 3.2.3. Wood Blocks are not acceptable.

END OF SECTION

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26 05 31.00 Splitters, Junction, Pull Boxes and Cabinets

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 53.00 – IDENTIFICATION.
- 1.1.4. Section 26 05 63.00 – ACCESS DOORS AND ACCESSIBILITY.

1.2. REFERENCE

- 1.2.1. Ontario Electrical Safety Code, latest edition.
- 1.2.2. Ontario Building Code, latest edition.
- 1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit shop drawings and product data for cabinets in accordance with specification Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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. Lugs to be dual rated for Copper/Aluminum (Cu/Al).
- 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 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 plywood backboard for surface or flush mounting. The plywood backboard is to have a fire-resistant coating on the front. Do not paint over plywood fire rating certification stamp.

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 2000 mm 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 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 26 05 53.00 – IDENTIFICATION.
- 3.3.2. Install identification labels indicating system name, voltage, and phase.

END OF SECTION

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26 05 32.00 Outlet Boxes, Conduit Boxes and Fittings

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.2. REFERENCES

1.2.1. Ontario Electrical Safety Code, latest edition.

1.2.2. Ontario Building Code, latest edition.

1.2.3. CAN/ULC-S115, Fire Tests of Fire Stop Systems, latest edition.

2. Products

2.1. OUTLET AND CONDUIT BOXES GENERAL

2.1.1. Size boxes in accordance with the electrical code.

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. 347 V 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 or as indicated. 100 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.

2.2.2. Provide cast FS aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles connected to rigid conduit.

2.2.3. 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.

2.2.4. Square or octagonal outlet boxes for lighting fixture outlets.

2.2.5. 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 for receptacles; 73 mm for communication equipment.
- 2.5.2. Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 16 mm and 21 mm conduit. Minimum size: 73 mm 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 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 35 mm 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 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 vertical 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:
    - .1 160 cm<sup>2</sup> (0.016 m<sup>2</sup>) each in area, AND
    - .2 an aggregate area of 650 cm<sup>2</sup> (0.065 m<sup>2</sup>) in any 9.3 m<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. Opposing outlets on non-fire rated partition walls shall have a minimum 150 mm horizontal separation. Outlets shall not be mounted back to back.
- 3.1.8. Conform to the fire stopping requirements of the building code: unless provided with a fire stop in accordance with CAN/ULC-S115, "Fire Tests of Fire Stop 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, or be installed in adjacent stud cavities.

END OF SECTION

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26 05 34.00 Conduits, Conduit Fasteners and Fittings

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 31.00 – SPLITTERS, JUNCTION, PULL BOXES AND CABINETS
- 1.1.3. Section 26 05 32.00 – OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1.2. REFERENCES

- 1.2.1. CAN/CSA C22.2 No.18- Outlet Boxes, Conduit Boxes, and Fittings, latest edition.
- 1.2.2. CSA C22.2 No.45.1- Electrical Rigid Metal Conduit - Steel, latest edition.
- 1.2.3. CSA C22.2 No.56- Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, latest edition.
- 1.2.4. CSA C22.2 No.83- Electrical Metallic Tubing, latest edition.
- 1.2.5. CSA C22.2 No.211.2- Rigid PVC (Unplasticized) Conduit, latest edition.
- 1.2.6. CAN/CSA C22.2 No.227.3- Flexible Non-metallic Tubing, latest edition.
- 1.2.7. CSA C22.2 No.227.1 - Electrical Non-Metallic Tubing, latest edition.

2. Products

2.1. CONDUITS

- 2.1.1. Electrical rigid metal conduit: to CSA C22.2 No.45.1, 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 C22.2 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 on centre.
- 2.2.4. Hot dipped galvanized threaded rods, 6 mm dia. minimum, to support suspended channels.
- 2.2.5. For non-fire rated applications, pre-engineered support systems complying with CSA C22.2 No. 18.4 "Hardware for the support of conduit, tubing, and cable (Bi-national standard with UL 2239)."

### 2.3. CONDUIT FITTINGS

- 2.3.1. Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- 2.3.2. Factory 90 degree elbow where 90 bends are required for 1" and larger conduits when a hydraulic bender is not used.
- 2.3.3. Connectors, and couplings for EMT conduit are to be set-screw steel type. Below the level of suspended ceilings, in a sprinklered environment, provide watertight fittings and "O" rings on all conduit runs and when conduit is terminated at any piece of electrical equipment.
- 2.3.4. Provide plastic bushings for all connectors, rigid nipples and rigid conduit 35 mm 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 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. All conduits on project to be surface mounted. Conduits are not allowed in cast in-place concrete or concrete slabs unless written consent is received from the Engineer's Representative and Owner. Only once approved by the Engineer's Representative and Owner do the clauses contained within this section and the respective sections relating to conduits in cast in-place concrete or concrete slabs apply.
- 3.1.2. Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- 3.1.3. Do not install conduits, associated raceway system, or devices on the surface of, or within 100 mm of the underside of roof decks.
- 3.1.4. 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.
- 3.1.5. Where vertically run conduit passes through a slab, Contractor to provide a 100 mm high concrete pad with the pad extending 100 mm on all sides of the conduit.
- 3.1.6. Use electrical metallic tubing (EMT) conduit except where specified otherwise.
- 3.1.7. Use epoxy coated conduit in corrosive areas.
- 3.1.8. Use rigid galvanized steel threaded conduit where conduit is subject to mechanical damage.
- 3.1.9. Use rigid PVC conduit underground or in corrosive areas and where indicated.
- 3.1.10. Use flexible metal conduit for connection to motors or vibrating equipment in dry areas, connection to recessed luminaires without a prewired outlet box, connection to surface or recessed luminaires and work in movable metal partitions. Ensure slack is provided in wiring connections to equipment which contains moving parts.

- 3.1.11. 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. Ensure slack is provided in wiring connections to equipment which contains moving parts.
- 3.1.12. Use explosion proof flexible connection for connection to explosion proof motors.
- 3.1.13. Install conduit sealing fittings in hazardous areas. Fill with compound.
- 3.1.14. Minimum conduit size for lighting and power circuits: NPS 21 mm, unless otherwise noted on the Drawings.
- 3.1.15. Minimum conduit size for data / voice cabling: as indicated on drawings, otherwise 27 mm.
- 3.1.16. Install EMT conduit from a raised floor branch circuit panel to outlet boxes located in sub floor.
- 3.1.17. 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.
- 3.1.18. Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- 3.1.19. Mechanically bend steel conduit over 21 mm diameter.
- 3.1.20. Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- 3.1.21. Install fish cord in empty conduits.
- 3.1.22. Run two 27 mm spare conduits up to ceiling space and two 27 mm spare conduits down to sub-floor space from each flush panel. Terminate these conduits in 152 x 152 x 102 mm junction boxes or in case of an exposed concrete slab, terminate each conduit in flush concrete or surface type box.
- 3.1.23. Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- 3.1.24. Dry conduits out before installing wire.
- 3.1.25. 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 Engineer's Representative 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 rebar to minimize cutting of rebar when core drilling. Provide x-ray study before drilling or cutting where required by the Landlord and/or structural Engineer's Representative.
- 3.1.26. Provide sleeves for all new conduit passing through floor and roof slabs, beams, concrete walls and slab to slab partitions, etc.
- 3.1.27. 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.
- 3.1.28. 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 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.1.29. Prior to installation of any wire or cable in the ducts, pull through each duct a flexible mandrel not less than 300 mm long and size for the internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Provide photo and video evidence of compliance with this clause and send to Engineer's Representative for review within 24 hours of Work occurring.

3.2. SURFACE CONDUITS

- 3.2.1. Run parallel or perpendicular to building lines.
- 3.2.2. Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- 3.2.3. Run conduits in flanged portion of structural steel.
- 3.2.4. Group conduits wherever possible on suspended or surface mounted channels.
- 3.2.5. Do not pass conduits through structural members, except as indicated.
- 3.2.6. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- 3.2.7. 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 IN CAST-IN-PLACE CONCRETE

- 3.4.1. Locate to suit reinforcing steel. Install in centre one third of slab.
- 3.4.2. Protect conduits from damage where they stub out of concrete.
- 3.4.3. Install sleeves where conduits pass through slab or wall.
- 3.4.4. Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- 3.4.5. Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- 3.4.6. Encase conduits completely in concrete with minimum 25 mm concrete cover.
- 3.4.7. Organize conduits in slab to minimize cross-overs.

3.5. CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- 3.5.1. Run conduits 27 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.

3.6. CONDUITS UNDERGROUND

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

END OF SECTION

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26 05 39.00 Underfloor Distribution System

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. SHOP DRAWINGS AND PRODUCT DATA

1.2.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. GENERAL

2.1.1. The floor boxes are to be used in concrete floor and raised floor construction. The floor boxes shall be approved and tested by Underwriters Laboratories Inc. to their Standard UL514A and Canadian Standard C22.2. The floor boxes shall bear the cULus mark.

2.2. STAMPED STEEL BOXES

2.2.1. Boxes shall be manufactured from stamped steel and formed. Boxes shall be available in one-, two-, or three-gang configurations. Boxes shall also be available in deep and shallow versions. All stamped steel versions shall provide 44 mm of pre-pour adjustment and 12.7 mm of post-pour adjustment. Minimum depth of deep boxes shall be 88 mm. Minimum depth of shallow boxes shall be 63 mm. Overall box dimensions for both shallow and deep boxes shall be as follows:

One-gang:	122 mm W x 94 mm L
Two-gang:	122 mm W x 202 mm L
Three-gang:	122 mm W x 305 mm L

2.2.2. One-gang deep boxes shall provide at least 869 ml of Device Wiring Chamber volume. The deep version shall provide at least three 16 mm, five 21 mm and two 27 mm conduit knockout locations to feed cabling to the floor box.

2.2.3. Two-gang deep boxes shall provide at least a total of 1918 ml of Device Wiring Chamber volume. This total volume shall be divided between the two gangs with 951 ml of volume in the first gang and 967 ml of volume in the second gang. The deep version shall provide at least four 16 mm, eight 21 mm and four 27 mm conduit knockout locations to feed cabling to the floor box

2.2.4. Three-gang deep boxes shall provide at least a total of 2951 ml of Device Wiring Chamber volume. This total volume shall be divided among the three gangs with 918 ml of volume in each of the outside gangs and 1115 ml of volume in the center gang. The deep version shall provide at least five 16 mm, eleven 21 mm, and six 27 mm conduit knockout locations to feed cabling to the floor box.

### 2.3. COVERS AND FLANGES

- 2.3.1. All floor box options shall accept both brass and non-metallic cover plates and flanges. Flanges for both brass and non-metallic shall be available for one-, two-, or three-gang applications and install on the previous mentioned boxes. Each flange shall provide 12.7 mm of adjustment to accommodate various floor covering and concrete pour depths.

### 2.4. NONMETALLIC FLANGES AND COVER PLATES

- 2.4.1. Non-metallic flange dimensions shall be as follows:

One-gang:	146 mm W x 121 mm L
Two-gang:	146 mm W x 225 mm L
Three-gang:	146 mm W x 330 mm L

- 2.4.2. All non-metallic flanges shall be approved for use on carpet, tile, or raised floor applications. Non-metallic flanges shall be provided in a black or brown finish. All flanges shall also accommodate workstation connectivity outlets and modular inserts, and Connectivity Modular Insert System. Modular inserts shall snap directly into each flange through use of a mounting bezel.

- 2.4.3. Non-metallic cover plate options shall seat inside the non-metallic flanges and be flush with the finished floor. Non-metallic cover plate dimensions shall be 81 mm W x 105 mm L. Non-metallic cover plate options shall provide for both power and communication services. Communication covers shall accommodate workstation connectivity outlets and modular inserts, and Connectivity Modular Insert System.

### 2.5. COMMUNICATION DEVICES AND ACCESSORIES

- 2.5.1. The floor box manufacturer shall have available a complete line of workstation connectivity outlets and modular inserts, and Activate Connectivity Modular Inserts for UTP (including Cat 5), Fiber Optic, Coaxial, and other cabling types with faceplates and bezels to facilitate mounting.

## 3. Execution

### 3.1. INSTALLATION

- 3.1.1. The minimum concrete pour depth shall be 64 mm for the shallow versions and 89 mm for the deep versions. Each box shall contain four locations to accommodate leveling for pre-concrete pour adjustment. Each box shall provide four leveling screws for this pre-pour adjustment. The floor box shall be warranted for one year from the date of final acceptance.

END OF SECTION

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26 05 40.00 Poke-thru Devices

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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 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).

1.4. SHOP DRAWINGS AND PRODUCT DATA

1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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.

.1 Insert:

.1 The insert body shall have the necessary channels to provide complete separation of power and communication services. There shall be one 21 mm channel for power and two 16 mm 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 16 mm 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 21 mm conduit stub that is connected to the insert body and a 402 ml 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 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 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 NOCOM / Canadian Electrical Raceways (CER)
  - .4 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 cored-hole with a minimum diameter of 78 mm.
- 3.1.2. Use is defined by the UL Fire Resistance Directory as a minimum spacing of 610 mm on center and not more than one device per each 6 sq. m 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

26 05 53.00 Identification

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. Ontario Electrical Safety Code.

1.2.2. Ontario Building Code.

1.3. SHOP DRAWINGS AND PRODUCT DATA

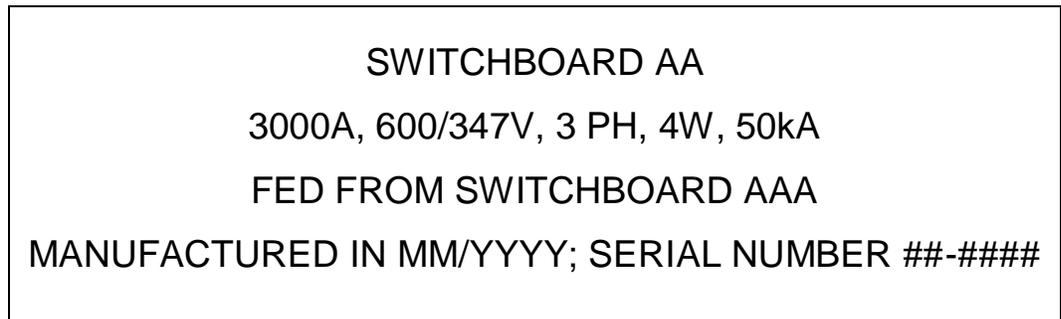
1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

2. Products

2.1. EQUIPMENT IDENTIFICATION

2.1.1. Identify electrical equipment with nameplates as follows:

- .1 Lamacoid 3 mm thick plastic engraved sheet, black or red face, white core, mechanically attached with self-tapping screws or rivets.
- .2 White letters 12 mm high for major switchboards, panelboards and power transformers.
- .3 White letters 12 mm high for terminal boxes, junction boxes, grid boxes, splitter boxes, disconnect switches starters and contactors.
- .4 Allow for an average of fifty (50) to one hundred (100) 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.
- .9 Sample:



- .10 Wording on nameplates to be approved by Engineer's Representative prior to manufacture.

- .11 Nameplates for splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes are to indicate the system and/or voltage characteristics.
- .12 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .13 Transformers: indicate capacity, primary and secondary voltages, and upstream source where Transformer is fed from.
- .14 Mechanical equipment: indicate equipment name and full circuit number including panel board identification.
- .15 Switchboards, Distribution Panels, and Panelboards: Name designation, rated ampacity, voltage, number of phases, and number of wires, if neutral is rated for 200%, interrupting capacity in units of kA, upstream source from which panelboard is fed, month and year manufactured, and serial number.
- .16 Automatic Transfer Switches (ATS): Name designation, rated ampacity, voltage, transfer switch arrangement (e.g. 3 pole with no neutral, 3 pole with solid neutral, 3 pole with overlapping neutral, 4 pole), withstand rating in units of kA, upstream normal power source from which ATS is fed, upstream emergency power source from which ATS is fed, month and year manufactured, and serial number.
- .17 Generators:
  - .1 Indicate kW rating, kVA rating, voltage, number of phases, number of wires, generator neutral grounding arrangement, year and month manufactured, and engine and alternator serial number.
  - .2 Indicate Maximum Site Design Load (as defined in CSA C282) in units of kW; engineering firm responsible for Maximum Site Design Load calculation; drawing number, issuance title (e.g. Issued for Construction, Electrical Contactor As-Built, Issued for CCN-E01, etc.), and issuance date which Maximum Site Design Load is based on. It is very important for future renovations and load additions that it is clear when the Maximum Site Design Load is from and what drawing it is based on.
  - .3 Sample nameplate:

Generator G1  
600 kW / 750 kVA  
600/347V, 3 PH, 4W, Wye solidly grounded  
Connected to ATS-PHXA  
MANUFACTURED IN MM/YYYY; SERIAL NUMBER ##-####  
Maximum Site Design Load 420 kW
- .18 Provide nameplates on all electrical equipment including:
  - .1 Splitters, terminal cabinets, grid boxes, pull boxes, and junction boxes
  - .2 Disconnects, starters and contactors, and Mechanical equipment
  - .3 Transformers
  - .4 Switchgear, Switchboards, Distribution Panels, and Panelboards
  - .5 Automatic Transfer Switches
  - .6 Generators

- .7 UPS equipment
- .8 Lighting control systems

2.1.2. Labels:

- .1 A printed label, similar to a Brady label 6 mm high letters unless specified otherwise, for internal components, such as relays, fuses, terminal blocks.

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: in conformance with the electrical code.
- 2.2.4. Use colour coded wires in communication cables and control wiring, matched throughout system.

2.3. CONDUIT AND CABLE IDENTIFICATION

- 2.3.1. Colour code conduits, boxes and metallic sheathed cables.
- 2.3.2. Code with plastic tape, paint, or coiled conduit markers at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- 2.3.3. Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour:
  - .1 up to 250 V Normal Power = Green
  - .2 up to 600 V Normal Power = Blue
  - .3 up to 250 V Emergency Power = Black
  - .4 up to 600 V Emergency Power = Orange
  - .5 High Voltage, greater than 750 V = Large independent label clearly identifying the voltage
  - .6 Telephone/Data = White
  - .7 Fire alarm = Red
  - .8 Other security systems = Yellow
  - .9 Controls = Purple

2.4. RECEPTACLE IDENTIFICATION

- 2.4.1. All receptacles including systems furniture receptacles and whip connections are to be labelled with the respective circuit numbers with a printed label, similar to a Brady label, with 12 mm characters. Circuit number to include full circuit number including panel board identification.
- 2.4.2. Label to be placed on wall above cover plate or on cover plate. Location of label to be consistent throughout project.

2.5. MANUFACTURERS AND CSA LABELS

- 2.5.1. Visible and legible after equipment is installed.

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 and class 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

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26 05 73.00 Electrical Power System Studies

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
    - 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
  - 1.2. REFERENCES
    - 1.2.1. CSA Z462 – Workplace Electrical Safety, latest edition.
    - 1.2.2. IEEE 1584 – IEEE Guide for Performing Arc Flash Hazard Calculations, latest edition.
    - 1.2.3. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition.
  - 1.3. SUMMARY
    - 1.3.1. The electrical power system studies for the project shall be performed by an approved electrical power systems contractor. The type and content of each study is specified in the following articles.
    - 1.3.2. The extent of the power systems studies shall include from the bus duct connection down to the branch circuit panels. All relays and fuse sizes to be included to ensure the best operation of the entire system. The studies shall also be performed to include the operation of the emergency power generation system.
    - 1.3.3. Contractor to label and re-label with the appropriate Client approved label all equipment that is new or the calculated values have changed from what is currently shown.
  - 1.4. SHOP DRAWINGS AND PRODUCT DATA
    - 1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
    - 1.4.2. Completed electrical power system studies shall be bound and submitted to the Engineer. Submit initial version(s) of the power system studies during the project shop drawing stage. Submit another “final” version of the power system studies at the end of the project utilizing the final/installed values. The study must be stamped and signed by a professional engineer in the applicable jurisdiction of the project for all submissions.
    - 1.4.3. Contractor providing electrical power systems study to allow for revisions/adjustments based on review comments and actual transformer impedances.
    - 1.4.4. Provide a minimum of three (3) bound coloured copies of all submissions to Owner and Engineer for review. Modify studies based on comments received and continue to re-issue until an accepted version is agreed upon.
    - 1.4.5. Provide a copy of the working electronic file in native program format along with each of the final copies of the studies. Identify what software was used to complete the studies. The information contained within the project file remains the property of the owner and can be used by the Owner for future system modifications.
    - 1.4.6. Provide samples of the proposed arc flash labels. All labels to match the Owners standard labels.

- 1.4.7. Contractor shall submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, contractor shall submit at a minimum a preliminary short circuit study for review.
2. Product
- 2.1. ELECTRICAL POWER SYSTEM STUDIES
- 2.1.1. Short-Circuit Analysis
- .1 Calculation of maximum RMS symmetrical three-phase short-circuit and single line to ground fault current at each significant location in the electrical system shall be made using a digital computer.
  - .2 Appropriate motor short-circuit contribution shall be included at the appropriate locations in the system so that the computer calculated values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
  - .3 A tabular computer printout shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interrupting or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
  - .4 The study shall include a computer printout of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
  - .5 Include a computer printout identifying the maximum available short-circuit current in RMS symmetrical amperes and the X/R ratio of the fault current for each bus/branch calculation.
  - .6 The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
  - .7 A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for the improvements to the system.
  - .8 The contractor shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
  - .9 Any inadequacies shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.
- 2.1.2. Protective Device Time-Current Coordination Analysis
- .1 The time-current coordination analysis shall be performed with the aid of a digital computer and will include the determination of settings, ratings, or types for the over-current protective devices supplied.
  - .2 A sufficient number of computer generated log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected over-current devices and other pertinent system parameters.

- .3 Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devices, the short-circuit current availability at the device location when known, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
- .4 The study shall include a separate, tabular computer printout containing the suggested device settings of all adjustable over-current protective devices, the equipment where the device is located, and the device number corresponding to the device on the system one-line diagram.
- .5 A computer generated system one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
- .6 A discussion section which evaluates the degree of system protection and service continuity with over-current devices, along with recommendations as required for increasing system protection or device coordination.
- .7 Significant deficiencies in protection and/or coordination shall be called to the attention of the engineer and recommendations made for improvements as soon as they are identified.

#### 2.1.3. Arc Flash/Incident Energy Study

- .1 An Arc Flash/Incident Energy Study shall be performed to determine the incident energy and arc flash protection boundary at each piece of electrical equipment and to identify the level of PPE required by people working on that respective equipment.
- .2 The study shall take into account all the information set forth in the short circuit study and the coordination study. Contractor to use the minimum and maximum fault currents provided by the utility to determine the worst incident energy levels. Provide two columns in your arc flash summary sheet identifying the current at both fault levels. Contractor to revisit the coordination study and revise coordination to provide the minimum incident energy levels as possible. Provide recommendations to reduce the incident energy levels even further at the risk of affecting the coordination to allow Owner and Engineer's Representative to review options and provide feedback.
- .3 Calculate the arc flash hazard, incident energy level and the flash protection boundary as per IEEE 1584. PPE level recommendations as per NFPA 70E / CSA Z462.
- .4 All electrical equipment to be identified with the incident energy, flash protection boundary and level of PPE required.
- .5 Purpose made labels to be provided on all electrical equipment. All equipment where levels were not calculated are to be provided with a standard warning label. Label samples to be submitted for review by Owner and Engineer's Representative.

#### 2.2. APPROVED ELECTRICAL POWER SYSTEMS CONTRACTORS

2.2.1. The power system studies shall be completed by qualified and experienced personnel.

2.2.2. The specified electrical power system studies shall be performed by:

- .1 Schneider-Electric Services.
- .2 Eaton - Cutler-Hammer Service Group.
- .3 ABB.
- .4 G.T. Wood.
- .5 K-Line – K-Tek.
- .6 Pelikan Inc.
- .7 General Electric (GE).

- .8 Eastenghouse.
- .9 AC Tesla.
- .10 Brosz Technical Services.
- .11 Enkompass Power and Energy Corp.

### 3. Execution

#### 3.1. GENERAL

- 3.1.1. Contractor to include for all on site surveys and investigations in order to obtain all the relevant information to complete all the studies.
- 3.1.2. The relays and equipment will be set up on site by the Technical Services Division Startup Service Contractor. Coordinate with this Contractor to ensure information is relayed accordingly.
- 3.1.3. Review work on site to ensure equipment has been set up as per the coordination study. Have the Technical Services Division Startup Service Contractor test systems at random to ensure the coordination study has been adhered to.
- 3.1.4. Submit a report and a letter reporting to the Engineer and Owner that the coordination study information has been followed.
- 3.1.5. Contractor to revise fuse sizes as identified in the report and modify the drawings to represent as-built conditions.

#### 3.2. LABELLING

- 3.2.1. Have power system study specialist install arc flash labels on all equipment. Coordinate with the Electrical Contractor.
- 3.2.2. Where manufacturer listed series ratings are permitted, install UL series rating label on all devices that are part of a series rating.

#### 3.3. TRAINING

- 3.3.1. Provide one day of in-depth training on arc-flash safety detailing the industry and code requirements including the details of the specific project for the Owner and the Owner's representatives.

END OF section

26 05 88.00 Cutting and Patching

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

2. Products

2.1. MATERIALS

2.1.1. All services and materials used for the cutting and patching shall meet all requirements specified in Div. 00, and Section 26 05 01.00, and shall be carried out by experienced workers.

2.1.2. Include for all cutting and patching for all Electrical services.

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 Engineer's Representative before cutting or core drilling any openings or-holes in slabs or structural elements.

3.1.3. Locate all openings in structure elements requiring cutting and patching, and x-ray the structure to obtain Structural Engineer's Representative's approval prior to cutting or core drilling of existing structure. Make adjustments to location of openings as required to minimize cutting of rebar, and completely avoiding electrical conduit.

.1 Cut-holes through slabs only.

.2 Do not cut-holes through beams.

.3 Holes to be cut are 200 mm (Diameter) or smaller only.

.4 Maintain at least 100 mm clear from all beam faces. Space at least 3-hole diameters on Centre.

.5 For-holes that are required closer than 25% of slab span from the supporting beam face, use cover meter above the slab to clear slab top bars.

.6 For-holes that are required within 50% of slab span, use cover meter underside of slab to clear slab bottom bars.

3.1.4. X-ray scanning:

.1 X-rays shall be performed by a qualified technician, in a safe manner and in accordance with all applicable regulations governing this activity. The company shall be licensed by the Canadian Nuclear Safety Commission (CNSC), and all radiography work shall be performed in accordance with the Nuclear Safety and Control Act.

.2 Follow any safety requirements stipulated by the property manager.

.3 Minimum requirements: All people must be evacuated within a radius of 10 m from each exposure location. Prior to conducting exposures verify this "safe zone". If the 10 m radius includes public areas such as a sidewalk, lobby, or elevator, these areas must be

controlled (e.g. elevators shut down or prevented from stopping on floors at which exposures are taking place). In addition, if exposure locations are near the walls of adjacent tenants, ensure the notification and evacuation of people within the 10 m radius. The 10 m radius applies to the camera floor and the floor directly below only. The qualified technician shall ensure adequate precautions for the additional floors above and below the camera floor.

- 3.1.5. Patch all openings after services have been installed to match the surrounding finishes.
- 3.1.6. In existing areas all cutting, and core drilling for individual services except where specifically noted, is part of this division work.
- 3.1.7. The cost of x-ray scanning, cutting, patching and finishing is included in this division contract.

END OF SECTION

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26 08 00.00 Commissioning

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 03.00 – AS-BUILT DRAWINGS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.4. Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.

1.2. SCOPE

- 1.2.1. The commissioning process for the Electrical Systems shall include:
  - .1 Verification that the installation meets the requirements of the contract documents.
  - .2 Verification that the systems performance meets the design intent.
  - .3 Provision of building operator training.
  - .4 Provision of As-Built documentation, operating and maintenance manuals, and systems operating manuals.
- 1.2.2. The Contractor, Engineer's Representative and Commissioning Agent shall provide the services to complete the process. The execution portion of this Section defines the areas of responsibility.
- 1.2.3. Provide labour, equipment and material to conduct the Contractor commissioning process as outlined in this Section.
- 1.2.4. The Owner will hire a Commissioning Agent who will provide services identified in the article within this section.

2. Products

2.1. MATERIALS

- 2.1.1. The Contractor and manufacturers shall provide all instrumentation and equipment necessary to conduct the tests as specified in the Electrical Sections. The Contractor shall advise the Engineer's Representative or Commissioning Agent of instrumentation to be used and the dates the instruments were calibrated.

3. Execution

3.1. INSTALLATION

- 3.1.1. This Section describes the commissioning process to be performed by the Contractor. The process shall provide a high level of quality control during the construction.
- 3.1.2. The commissioning process shall consist of:
  - .1 Shop Drawings/As-Built Drawings.
  - .2 Installation inspection and equipment verification.
  - .3 Power distribution system commissioning.

- .4 Emergency Power system commissioning.
  - .5 Fire alarm system verification and commissioning.
  - .6 Commissioning Agent performance testing.
  - .7 Commissioning meetings.
  - .8 Operating and maintenance manuals.
  - .9 Training.
  - .10 Systems acceptance.
- 3.2. INSTALLATION INSPECTION AND EQUIPMENT VERIFICATION
- 3.2.1. The Contractor shall complete the equipment verification forms for each piece of equipment. The completed forms shall be forwarded to the Engineer's Representative for review and be included in the operating and maintenance manual.
- 3.3. TEST FORMS AND VERIFICATION FORMS
- 3.3.1. The Commissioning Agent will prepare a test form manual, which will contain a form for every test identified in the Specification. A copy of this manual will be given to the Contractor, the General Contractor and the Engineer's Representative.
- 3.3.2. The Contractor shall prepare test forms for every test identified in this Specification. The Contractor shall complete each form as tests are completed and forward a copy to the Engineer's Representative for review on a monthly basis.
- 3.3.3. The forms shall be signed by either the authorities, the Engineer's Representative or the Commissioning Agent.
- 3.4. TESTING OF EQUIPMENT AND SYSTEMS
- 3.4.1. Conform to Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.4.2. The Contractor shall hire the services of the manufacturer's technicians to test the equipment and associated systems. The technician shall record the results of the tests on the testing forms. The tests shall be witnessed by the Engineer's Representative or the Commissioning Agent. When the tests have been completed satisfactorily the technician and witnessing authority shall sign the forms.
- 3.4.3. When equipment or systems fail a test, the test shall be repeated after repairs or adjustments have been made. The additional tests shall be witnessed by the Engineer's Representative or the Commissioning Agent.
- 3.4.4. Tests which have not been witnessed shall not be accepted and shall be repeated.
- 3.5. COMMISSIONING MEETINGS AND SCHEDULING
- 3.5.1. The Contractor shall include the schedule for all tests and equipment start-up tests in the construction schedule.
- 3.5.2. The commissioning meetings shall occur during the regular construction meetings. The testing schedules and results of all tests shall be reviewed.
- 3.6. OPERATING AND MAINTENANCE MANUALS
- 3.6.1. Conform to Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.6.2. Submit Operating and Maintenance Manuals to Commissioning Agent for review.

3.7. OPERATOR TRAINING

- 3.7.1. Conform to Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 3.7.2. Submit Operating and Maintenance manuals to Commissioning Agent for review.
- 3.7.3. The training shall be conducted in a classroom and at the equipment or system.
- 3.7.4. Training will begin when the operating and maintenance manuals have been delivered to the Owner and reviewed by the Engineer's Representative.
- 3.7.5. Submit a course outline to the Engineer's Representative before training commences. Provide course documentation for up to eight people.
- 3.7.6. Each training session will be structured to cover:
  - .1 The operating and maintenance manual.
  - .2 Operating procedures.
  - .3 Maintenance procedures.
  - .4 Trouble-shooting procedures.
  - .5 Spare parts required.
- 3.7.7. The training sessions will be scheduled and co-ordinated by the Commissioning Agent. The Commissioning Agent will video tape the session.
- 3.7.8. Training shall be provided for the following systems:

System	Minimum Training Times
Diesel Generator	4 hours
Automatic Transfer switches	4 hours
Fire alarm	4 hours
The electrical system	8 hours
UPS systems	4 hours
LV lighting control system	4 hours

3.8. COMMISSIONING AGENT

- 3.8.1. A Commissioning Agent will be hired by the Owner.
- 3.8.2. The commissioning agent responsibilities shall include:
  - .1 Preparing the commissioning plan.
  - .2 Co-ordinating with the contractor to schedule tests.
  - .3 Preparing a test form manual.
  - .4 Witnessing selected tests.
  - .5 Receiving all test forms.
  - .6 Conducting performance test.
  - .7 Co-ordinating the contractors training.
  - .8 Attend commissioning meetings.
  - .9 Preparing the systems operating manuals.
- 3.8.3. The Contractor shall co-ordinate and co-operate with the Commissioning Agent.

3.9. PERFORMANCE TESTING

- 3.9.1. The Commissioning Agent will conduct performance tests on each electrical system to verify that the design intent performance has been met. The performance tests will cover all seasonal modes.
- 3.9.2. The Contractor shall conduct performance tests on all electrical systems and document the results on the performance forms provided by the Commissioning Agent in accordance with this Specification.
- 3.9.3. The Contractor shall provide assistance to the Commissioning Agent and have personnel available during the performance testing procedures during construction and the warranty period.
- 3.9.4. Performance testing will begin when all electrical systems have been completed, tested by the Contractor reviewed by the Engineer's Representative and substantial completion has been achieved.

3.10. COMMISSIONING PROCESS ALLOCATION

- 3.10.1. The commissioning process shall be allocated a value equal to 5 % of the contract. This value shall be itemized in the Statement of Prices which form the basis for progress payment for the various portions of work. The Contractors may draw from this allocation as the commissioning process is completed.
  - .1 The Contractors shall submit all test and verification forms. The Engineer's Representative will use these forms to calculate a percentage complete.
  - .2 The Contractor may claim up to 3 % of the contract, as per Schedule of Breakdown, on a monthly basis, from this allocation leading up to performance testing. The remaining 2 % shall not be paid out until the performance testing, O&M manuals and training have been completed satisfactorily.

END OF SECTION

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26 09 24.00 Lighting Control Equipment – Addressable Low Voltage

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 51 13.00 – LIGHTING EQUIPMENT.
- 1.1.4. Lighting Control Sequence of Operations as attached to Specifications or as shown on drawings.

1.2. REFERENCES

- 1.2.1. CAN/CSA-C22.2 No. 141, Emergency Lighting Equipment, latest edition.
- 1.2.2. CAN/CSA-C22.2 No. 205, Signal Equipment, latest edition.
- 1.2.3. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
- 1.2.4. International Electrotechnical Commission (IEC)
- 1.2.5. National Electrical Manufacturers Association (NEMA)
- 1.2.6. Underwriters Laboratories, Inc. (UL)
- 1.2.7. UL 508 – Standard for Industrial Control Equipment
- 1.2.8. UL 916 – Standard for Energy Management Equipment
- 1.2.9. UL 924 – Standard for Emergency Lighting and Power Equipment

1.3. SUMMARY

- 1.3.1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.
- 1.3.2. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
  - .1 Energy Control Unit
  - .2 System Server
  - .3 0-10 V Dimming, Fixed Output Ballasts or 0-10 V LED Drivers
  - .4 System Field Devices (Input and Output Modules)
  - .5 Occupancy Sensors – Low Voltage
  - .6 Photo Sensors – Low Voltage
  - .7 Wallstations – Low Voltage
  - .8 Lighting Control System Software - Graphical User Interface based
  - .9 Communication Wire
  - .10 Area Lighting Controllers and/or Room Controllers (to dim/switch a group of luminaires)
  - .11 Interface to Audio Visual equipment (for integration with 3rd party LCD Touch Screen Panel)

- .12 Interface to BACnet
- .13 Interface to customizable Energy dashboard

#### 1.4. DESCRIPTION OF SYSTEM

- 1.4.1. The work covered in this section is subject to the requirements in the General Conditions of the Specifications. Contractor shall coordinate the work in this section with the trades covered in other sections of the specification to provide a complete and operable system.
- 1.4.2. Extent of the lighting control system work is indicated by drawings and by the requirements of this section. It is the intent of this section to provide an integrated, energy saving lighting control system as described herein from a single supplier. Contractor is responsible for confirming that all components and accessories of the lighting control system interoperate as a single system.
- 1.4.3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the System Provider, as required to ensure proper system operation and maintainability.
- 1.4.4. The lighting control system shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices that are not integral to luminaires, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN start-up shall be by the control system Manufacturer or Contractors certified by the Manufacturer.
- 1.4.5. The lighting control system shall utilize non-proprietary industry standard 0-10 V dimming or fixed output ballasts and/or 0-10 V LED drivers, occupancy sensors, daylight sensors, etc.
- 1.4.6. UL 924 listed devices shall have the ability to control 120 V / 277 V load.
- 1.4.7. System software interface shall have the ability to notify communication failures to system users via system & email messages. Email messages shall be available in html and text formats.
- 1.4.8. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
- 1.4.9. The electrical drawings may show a lighting control system designed with a specific manufacturer as a Basis of Design. There are pre-approved alternate manufacturers listed herein, which are acceptable lighting control systems to be used; however, by using pre-approved alternate manufacturers, the Contractor accepts responsibility and associated costs for all required modifications to circuitry, devices, and wiring, etc. as required to suit the alternate pre-approved manufacturer's lighting control system. The Contractor shall provide complete engineered shop drawings (including power and control wiring) with deviations from the original design highlighted for review and approval prior to rough-in. Where additional components or devices are required to meet the same design intent as indicated in the drawings and specifications, the Contractor shall include for all costs.

#### 1.5. LIGHTING CONTROL APPLICATIONS

- 1.5.1. Provide a minimum application of lighting controls as follows:
  - .1 Space Control Requirements – Provide occupancy/vacancy sensors as shown and noted on the electrical drawings. Occupancy/vacancy sensors to provide Manual- or

- Partial-ON functionality or Automatic-ON as described in the drawings and specifications.
- .2 Bi-Level Lighting – Provide multi-level controls in all spaces as indicated in the electrical drawings and specifications.
  - .3 Task Lighting / Plug Loads – Where indicated on the drawings, provide automatic shut off of plug loads and task lighting. For spaces with multiple occupants a single shut off consistent with the overhead lighting may be used for the area.
- 1.5.2. All enclosed rooms shall have controls that allow for independent control of each local control zone. Rooms larger than 300 square feet shall instead have at least four preset lighting scenes unless otherwise specified. Occupancy / vacancy sensors shall be provided to turn off all lighting in the space. Spaces with up to four moveable walls shall include controls that can be reconfigured when the room is partitioned.
- 1.6. SHOP DRAWINGS AND PRODUCT DATA
- 1.6.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.6.2. Submit manufacturer's data on lighting control system and components and the product data specified below at the same time as a package. Shop drawing submission shall include but not limited to the following:
- .1 Complete list of all parts needed to fully install selected system components.
  - .2 Composite wiring and/or schematic diagram of each control circuit as proposed to be installed. Submitted shop drawings shall detail control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
  - .3 Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
    - .1 Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
    - .2 For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
    - .3 Show exact location of all digital devices, including at minimum sensors, load controllers, and switches for each area on reflected ceiling plans. Contractor must provide AutoCAD and PDF format reflected ceiling plans. For sensors, prove sensor is suitable for the proposed application.
- 1.6.3. Provide room/area details including products and sequence of operation for each room or area. Illustrate typical acceptable room/area connection topologies.
- 1.6.4. Network riser diagram including floor and building level details. Include network cable specification and end-of-line termination details, if required. Illustrate points of connection to integrated systems. Coordinate integration with mechanical and/or other trades as required.
- 1.6.5. Software Operational Documentation:
- .1 Software operating and upgrade manuals
  - .2 Program Software Backup: On portable memory storage device, USB stick, complete with data files.
  - .3 Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.

- 1.6.6. Catalog sheets, specifications and installation instructions.
- 1.6.7. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
- 1.6.8. Copy of applicable warranty.
- 1.6.9. Additional information as required on a project specific basis.
  
- 1.7. PROJECT CONDITIONS
  - 1.7.1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
    - .1 Ambient temperature: 0° to 40° C (32° to 104° F).
    - .2 Relative humidity: Maximum 90 percent, non-condensing.
  
- 1.8. WARRANTY
  - 1.8.1. Provide a five year limited manufacturer's warranty on all equipment to be free of defects in materials and workpersonship.
  - 1.8.2. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
  
- 2. Products
  - 2.1. MATERIALS
    - 2.1.1. Control system: by one manufacturer and assembled from compatible components.
  
  - 2.2. CENTRAL LIGHTING CONTROL SOFTWARE
    - 2.2.1. The system shall offer central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
    - 2.2.2. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics is not acceptable.
    - 2.2.3. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
    - 2.2.4. The system shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
      - .1 Interactive;
      - .2 Vector based;
      - .3 Zoom;

- .4 Rotate;
  - .5 Pan;
  - .6 Tilt.
- 2.2.5. The system shall allow the building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
- 2.2.6. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
- 2.2.7. Shall display multiple floors in single view resulting in easier system performance visualization for the entire site as well as individual zones or spaces.
- 2.2.8. The system shall allow system performance visualization across a portfolio of buildings via a single interface.
- 2.2.9. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.
- 2.2.10. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
- 2.2.11. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual luminaire availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- 2.2.12. The system shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
- 2.2.13. Energy Analysis data shall be exportable in CSV or image file formats.
- 2.2.14. The system shall allow import of native AutoCAD files.
- 2.2.15. Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
- .1 Energy consumption broken down by energy management strategy.
  - .2 Energy demand broken down by energy management strategy.
  - .3 Occupancy data by zone.
  - .4 Building wide occupancy status
  - .5 Time Schedule configuration status
  - .6 Lighting energy consumption in a color gradient ("weather map" type) view
  - .7 Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications, etc.
- 2.2.16. The software shall offer user configurable fade times (up to 86400 seconds) for individual or group of luminaire during transition between scenes.
- 2.2.17. The system shall be programmable for Time Clock Scheduling of lights on or off via the Lighting Control Software interface.

- 2.2.18. There shall be an “Emergency Mode”, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building emergency monitoring system at a convenient point and not require multiple connections.
- 2.2.19. All ballasts and/or drivers shall be centrally addressable, on a per luminaire or multiple luminaire/zone basis, through the Central Control Software. The basis of design shall utilize 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of start-up or reconfiguration.
- 2.2.20. System shall be capable of operating independent of building’s existing network infrastructure if desired and shall not rely on Tenant supplied PCs for operation.
- 2.2.21. Firewall Technologies & VLAN Configuration methods shall be utilized to separate tenants from the lighting control network and ensure the integrity of lighting control network.
- 2.2.22. The assignment of individual or group of system components to zones shall be performed via the Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, ceiling tiles, etc. shall not be required.
- 2.2.23. Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
- 2.2.24. System shall auto-configure lighting controls for spaces that have been combined or divided temporarily by moving wall or similar systems.
- 2.2.25. System shall automatically lock wallstations and/or disable sensors based on one of the following system inputs: contact closure, a time schedule or the status of a monitored space.
- 2.2.26. The light management system shall be capable of interfacing digitally with a building automation system via BACnet/IP. The lighting control system shall be capable of communicating the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) to the BAS. Building Automation System shall utilize data from lighting control system input devices such as occupancy sensors to determine the status (occupied/unoccupied) of the mechanical control zones and perform climate adjustments accordingly.
- 2.3. DIGITAL WALLSTATIONS
- 2.3.1. The system shall connect with the wallstations via field bus that carry low voltage control signals.
- 2.3.2. Software configurable wallstations shall provide on/off switching and dimming control for up to six lighting zones/ five lighting scenes per wallstation or more with allowable multi-gang configurations.
- 2.3.3. Shall allow manual dimming of light levels and override of the time schedule.
- 2.3.4. Scenes/zones in the system control software shall be synchronized with the buttons on the wallstation.
- 2.3.5. All wallstations shall be individually addressable & reconfigurable via System Control Software.
- 2.3.6. All wall stations shall feature status LED’s
- 2.3.7. All wallstations shall be Class 2 Low Voltage devices.
- 2.3.8. All wallstations power source will be from the communication bus.
- 2.3.9. Communication shall be via NEC/CEC Class 2 communication wire.

- 2.3.10. Wallstation configuration shall be via GUI in a drag and drop format.
- 2.3.11. Custom button cap configuration shall allow combination of scene & zone in one wallstation.
- 2.3.12. Custom commands shall be applied to individual wallstation buttons.
- 2.3.13. Wall station shall display its current status (zone/scene under system control or OFF) when motion is detected in the close proximity of the wallstation
- 2.3.14. The following User Interface and custom labelling options shall be available:
  - .1 Up to five (5) scene switching & dimming
  - .2 Up to six (6) zone switching
  - .3 One (1) zone switching
- 2.3.15. Shall allow vacancy sensor configuration.
- 2.3.16. Dimensions shall meet NEMA WD-6 spec.
- 2.3.17. The following mounting options shall be supported:
  - .1 Mount in standard size wall box
  - .2 On mounting brackets for low voltage devices
- 2.3.18. Shall be used with “Decorator” style wall plate.
  
- 2.4. SYSTEM FIELD DEVICES
- 2.4.1. Shall provide a common interface to low voltage occupancy sensors and photo sensors via Input Modules. These modules shall automatically detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor). Addresses to the field devices shall be assigned during system start-up. Upon establishing two way communication with the Energy Control Unit (ECU), these individually addressable modules shall enable each lighting component to be independently controlled and configured to best meet the needs of the facility. These modules shall connect directly to the NEC/CEC Class 2 communication bus.
- 2.4.2. System Field Devices shall be individually addressable via System Control Software.
- 2.4.3. System shall automatically address individual nodes during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- 2.4.4. Electrically rated for up to 24 VDC.
- 2.4.5. Shall connect to NEC/CEC Class 2 communication wire.
- 2.4.6. Shall retain all system settings in non-volatile memory.
- 2.4.7. Suitable for fixture or junction box mounting in standard 1/2" knockout (7/8" dia.)
  
- 2.5. AREA LIGHTING CONTROLLER/ROOM CONTROLLER
- 2.5.1. Shall provide a common interface (DIM/SWITCH) to a group of 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers via field bus that carry low voltage control signals.
- 2.5.2. Area Lighting Controllers shall be addressable via Control Software.
- 2.5.3. System shall automatically address individual area lighting controllers during system start-up thus eliminating the need to pre-address devices or record serial numbers during installation.
- 2.5.4. Electrical Maximum Load Ratings:
  - .1 20A 120-347 Vac Ballast
  - .2 20A 120-347 Vac Resistive
  - .3 20A 120-347 Vac Tungsten

- .4 20A 120-347 Vac General Purpose
- .5 1.5 HP 120-277 Vac Motor
- 2.5.5. Communication shall be via NEC/CEC Class 2 communication wire.
- 2.5.6. Control Options for:
  - .1 ON/OFF Switching
  - .2 Continuous 0-10V dimming
  - .3 Shall be able to communicate with 0-10V ballasts/drivers
- 2.5.7. Shall be used for general purpose plug load control.
- 2.5.8. Shall control up to 30 ballast/LED Drivers.
- 2.5.9. Shall retain all system settings in non-volatile memory.
- 2.5.10. Mechanically has mounting for standard 1/2" electrical box knockout.
- 2.5.11. Colour to be selected by Architect/Engineer's Representative.
- 2.5.12. UL916, UL924 & UL2043 listed.
- 2.6. DIGITAL DAYLIGHTING SENSORS
  - 2.6.1. Digital daylighting sensors shall work to provide automatic switching, bi-level, or tri-level or dimming daylight harvesting capabilities for any load type.
  - 2.6.2. Daylighting sensors shall be interchangeable without the need for rewiring.
  - 2.6.3. The indoor sensor range shall be between 0 and 750 FC.
  - 2.6.4. The outdoor sensor range shall be between 0 and 750 FC.
  - 2.6.5. Atrium sensor range shall be from 2 to 2,500 FC.
  - 2.6.6. Skylight sensor range shall be between 10 and 7,500 FC.
  - 2.6.7. The capability of ON/OFF, bi-level or tri-level switching, or dimming, for each controlled zone, depending on the selection of load controller(s) and load binding to controller(s).
  - 2.6.8. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a field-selectable minimum level.
  - 2.6.9. Photosensors shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.
  - 2.6.10. Photosensors shall provide adjustable cut-off time. Cut-off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
  - 2.6.11. Optional wall switch override shall allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise lighting levels for a selectable period of time or cycle of occupancy.
- 2.7. DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR
  - 2.7.1. Wall or ceiling mounted (refer to drawings) passive infrared (PIR), ultrasonic or dual technology digital (passive infrared and ultrasonic) occupancy sensor.
  - 2.7.2. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
    - .1 Digital calibration and pushbutton configuration for the following variables:

- .1 Sensitivity – 0-100% in 10% increments
- .2 Time delay – 1-30 minutes in 1 minute increments
- .3 Test mode – Five second time delay
- .4 Detection technology – PIR, Ultrasonic or Dual Technology activation and/or re-activation.
- .5 Walk-through mode
- .2 Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the DLM local network.
- .3 Programmable control functionality including:
  - .1 Each sensor may be programmed to control specific loads within a local network.
  - .2 Sensor shall be capable of activating one of 16 user-definable lighting scenes.
  - .3 Adjustable retrigger time period for manual-on loads. Load will retrigger (turn on) automatically within a configurable period of time (default 10 seconds) after turning off.
  - .4 On dual technology sensors, independently configurable trigger modes are available for both Normal (NH) and After Hours (AH) time periods. The retrigger mode can be programmed to use the following technologies:
    - .5 Ultrasonic and Passive Infrared
    - .6 Ultrasonic or Passive Infrared
    - .7 Ultrasonic only
    - .8 Passive Infrared only
    - .9 Independently configurable sensitivity settings for passive infrared and ultrasonic technologies (on dual technology sensors) for both Normal (NH) and After Hour (AH) time periods.
  - .4 Communication shall be via Class 2 communication bus.
  - .5 Manual override of controlled loads.
  - .6 All digital parameter data programmed into an individual occupancy sensor shall be retained in non-volatile FLASH memory within the sensor itself. Memory shall have an expected life of no less than 10 years.
  - .7 Units shall not have any dip switches or potentiometers for field settings.
- 2.7.3. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local network. No additional configuration will be required.
- 2.8. COMMUNICATION WIRE
  - 2.8.1. The system shall have the capability to use both NEC/CEC Class 1 and Class 2 wiring to integrate peripheral devices such as ballasts/LED drivers, occupancy sensors, photo sensors, relay-based controls, area lighting controllers, and wallstations into a complete, networked programmable lighting control system.
  - 2.8.2. Electrically uses NEC/CEC Class 2 Communication bus.
  - 2.8.3. Multi-conductor cable with stranded-copper conductors.
  - 2.8.4. Shall power photo sensors, PIR and dual-technology occupancy sensors.
  - 2.8.5. Shall allow random devices connection without the need for special network channel termination.
  - 2.8.6. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).

2.9. ENERGY CONTROL UNIT (ECU)

2.9.1. The Energy Control Unit (ECU) shall collect, process and distribute lighting control information to the system field devices and wall stations over NEC/CEC Class 2 communication bus. Each CU shall feature multiple NEC/CEC Class 2 communication channels that can control a large quantity of nodes (sensors, wall stations, 0-10V Dimming, Fixed Output Ballasts, 0-10V LED Drivers, etc.) per channel, per the manufacturers recommended maximum.

2.9.2. The ECU shall be the central intelligence point for the area it controls collecting signal information from sensors, wallstations and personal control software and determining appropriate brightness levels or on/off status for each luminaire or zone. The CU shall connect with a facility's or tenant's Local Area Network (LAN) via Ethernet to enable desktop personal control.

2.9.3. Ethernet communication ports that employ TCP/IP protocol shall be provided to simultaneously enable the following connections:

- .1 Lighting Control Network
- .2 Tenant LAN Access Point

2.9.4. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting NEC/CEC Class 2 communication bus.

2.9.5. Each CU channel shall support up to 100 nodes or 800 nodes in total.

2.9.6. Shall have status LEDs for the following:

- .1 Network activity on CU's Ethernet port/s
- .2 CU channel status
- .3 CU status

2.9.7. Shall enable the following functionalities:

- .1 Backup to and Restore from USB flash drives
- .2 Cycle lights through 100%, 25% & 0% steps
- .3 Disable/enable all controller functionalities
- .4 IP Address Reset
- .5 Electronically deactivate individual channels

2.9.8. Shall have configuration stored in non-volatile flash memory.

2.9.9. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

2.9.10. UL916 and UL924 listed.

2.10. SYSTEM SERVER (SSU)

2.10.1. The System Server shall host the lighting control system database for all the lighting control devices. In addition, it shall provide remote accessing capability to change system settings and/or parameters.

2.10.2. Server shall have the ability to:

- .1 Analyze system performance or energy data or generate system report;
- .2 Record energy consumption with average sampling every 5 minutes for unlimited duration;
- .3 Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
- .4 Reside on a client server (virtual server);

- .5 Interconnect with Control Units over standard Ethernet connection that employs TCP/IP protocol;
- 2.10.3. Each System Server shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employ TCP/IP protocol.
- 2.10.4. Shall mount in a standard 19" rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
- 2.11. EMERGENCY LIGHTING CONTROL DEVICES
  - 2.11.1. Emergency Lighting Control Unit – A UL 924 listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
    - .1 120/277 volts, 50/60 Hz, 20 amp ballast rating
    - .2 Push to test button
    - .3 Auxiliary contact for remote test or fire alarm system interface
- 2.12. MANUFACTURERS
  - 2.12.1. The following are acceptable manufacturers:
    - .1 Legrand– Encelium
    - .2 Cooper Lighting Solutions
    - .3 Lutron – Athena
    - .4 Acuity – nLight
    - .5 Crestron – Commercial Lighting Controls
- 3. Execution
  - 3.1. PRE-INSTALLATION MEETING
    - 3.1.1. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation site visit after receipt of approved submittals to review the following:
      - .1 Confirm the location and mounting of all digital devices, with special attention to placement of occupancy and daylighting sensors.
      - .2 Review the specifications for low voltage control wiring and termination.
      - .3 Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.
      - .4 Discuss requirements for integration with other trades.
  - 3.2. INSTALLATION AND SERVICES
    - 3.2.1. Locate and install equipment in accordance with manufacturer's recommendations and as indicated.
    - 3.2.2. Install all devices and wiring in a professional manner. All line voltage connections to be tagged to indicate circuit and switched legs.

- 3.2.3. Install all room/area devices using manufacturer's factory-tested cable with pre-terminated connectors. If pre-terminated cable is not used for room/area wiring, test each field-terminated cable following installation and supply the lighting controls manufacturer with test results. Contractor to install any room to room network devices using manufacturer-supplied network wire. Low voltage wiring topology must comply with manufacturer's specifications. Contractor shall route network wiring as shown in submittal drawings as closely as possible, and shall document final wiring location, routing and topology on as built drawings.
- 3.2.4. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated. Before start up, contractor shall test all devices to ensure proper communication.
- 3.2.5. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
- .1 Adjust time delay so that controlled area remains lighted while occupied.
- 3.2.6. Provide written or computer-generated documentation on the configuration of the system including room by room description including:
- .1 Sensor parameters, time delays, sensitivities, and daylighting setpoints.  
.2 Sequence of operation, (e.g. manual ON, Auto OFF. etc.)  
.3 Load Parameters (e.g. blink warning, etc.)
- 3.2.7. Post start-up tuning – After 30 days from occupancy contractor shall adjust sensor time delays and sensitivities to meet the Owner's requirements. Provide a detailed report to the Consultant/Owner of post start-up activity.
- 3.3. FACTORY SERVICES
- 3.3.1. Upon completion of the installation, the manufacturer's factory authorized representative shall start up and verify a complete fully functional system.
- 3.3.2. The Electrical Contractor shall provide both the manufacturer and the Consultant with three weeks written notice of the system start up and adjustment date.
- 3.3.3. Upon completion of the system start up, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- 3.4. SYSTEM START UP AND COMMISSIONING
- 3.4.1. If applicable, a commissioning agent will verify the installation and programming of all building systems, which includes the lighting control system. Manufacturer should include an extra day of technician's time to review the functionality and settings of the lighting control hardware with the commissioning agent, including reviewing submittal drawings and ensuring that instructions on how to configure each device are readily available. Manufacturer is NOT responsible for helping the commissioning agent inspect the individual devices. It will be the commissioning agent's responsibility to create and complete any forms required for the commissioning process, although the manufacturer or contractor may offer spreadsheets and/or printouts to assist the agent with this task.
- 3.4.2. The commissioning agent shall work with the electrical contractor during installation of the lighting control hardware to become familiar with the specific products. The agent may also accompany the manufacturer's technicians during their start-up work to better understand the process of testing, calibration and configuration of the products. However, the contractor and manufacturer shall ensure that interfacing with the agent does not prevent them from completing the requirements outlined in the contract documents.

3.5. TESTING

- 3.5.1. Upon completion of all line, load and interconnection wiring, and after all luminaire are installed and lamped, a qualified factory representative shall completely configure and test the system.
- 3.5.2. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

3.6. TRAINING

- 3.6.1. Provide four half days of training for the Owner and the Owner's maintenance staff on the operation and maintenance of the system.
- 3.6.2. Training to be recorded for use by Owner in the future.

END OF SECTION

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26 12 16.00 Dry Type Power Transformers

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.4. Section 26 05 53.00 – IDENTIFICATION.
- 1.1.5. Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.

1.2. REFERENCES

- 1.2.1. CSA C9, Dry-Type Transformers, latest edition.
- 1.2.2. CSA-C22.2 No. 47, Air-Cooled Transformers (Dry-Type), latest edition.
- 1.2.3. CSA C802.2, Minimum Efficiency Values for Dry Type Transformers, latest edition.
- 1.2.4. U.S. Department of Energy (DOE) “DOE 2016 Efficiency”, latest edition.
- 1.2.5. Natural Resource Canada Regulation SOR/2018-2001 (NRCAN 2019), latest edition.
  - .1 Electricity Act, 1998 Regulation 509/18 Energy and Water Efficiency – Appliances and Products, latest edition.
- 1.2.6. ANSI/IEEE-C57.12.01, General Requirements for Dry-Type Distribution and Power Transformers, latest edition.
- 1.2.7. ANSI/IEEE-C57.12.51, Requirements for Ventilated Dry-Type Transformers, latest edition.
- 1.2.8. ANSI/IEEE-C57.12.70, Standard Terminal Markings and Connections for Distribution and Power Transformers, latest edition.
- 1.2.9. ANSI/IEEE C57.12.91, Test Code for Dry-Type Distribution and Power Transformers, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. Include:
  - .1 Dimensioned drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.
  - .2 Technical data:
    - .1 kVA rating.
    - .2 Primary and secondary voltages.
    - .3 Frequency.
    - .4 Single or three phase.
    - .5 Polarity or angular displacement.
    - .6 Full load efficiency.
    - .7 No load losses.

- .8 Load losses.
  - .9 Full load losses.
  - .10 Regulation at unity power factor.
  - .11 BIL.
  - .12 Insulation type.
  - .13 Sound rating.
  - .14 Design impedance.
- 1.3.3. Where RC Snubber is required by the clauses below, provide Shop Drawings for RC Snubber, including cutsheets and details of all accessories.
- 1.4. OPERATION AND MAINTENANCE DATA
- 1.4.1. Provide operation and maintenance data for dry type transformers in accordance with section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS for incorporation into manual.
- 1.4.2. Operation and maintenance instructions to include:
- .1 Tap changing.
  - .2 Recommended environmental conditions.
  - .3 Recommended periodic inspection and maintenance.
- 1.5. DELIVERY AND STORAGE
- 1.5.1. The manufacturer is responsible for delivery of the transformers to site; off-loading shall be by the Electrical Contractor. Transformer manufacturer to include for separate shipping for each transformer and for any additional shipping costs for weekend or after hours delivery. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from potential damage from weather and construction operations. Store so condensation will not form on or in the transformer housing, and provide temporary heat where required to obtain suitable storage conditions.
- 1.5.3. Handle transformer using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets provided for that purpose.
- 1.6. WARRANTY
- 1.6.1. The transformer shall carry a 1 year warranty from the time of substantial completion.
2. Products
- 2.1. TRANSFORMER CHARACTERISTICS
- 2.1.1. Dry-Type transformer to be ANN – convection air cooled unless fan cooling is identified with the dual sizing on drawings.
- 2.1.2. If transformer requires fan cooling then provide one (1) stage of fan cooling. All current carrying parts shall be rated to carry the full current at the fan cooling rating.
- 2.1.3. Size and Rating: as per drawings, 60 Hz.
- 2.1.4. Insulation: Class 220 degree C. insulation system (former designation: Class H), 150 degree C. temperature rise.
- 2.1.5. Impedance: minimum per CSA C9, unless stated otherwise on Drawings.

2.1.6. Basic impulse level as per CSA and built to a minimum of:

<u>Insulation voltage class (kV)</u>	<u>BIL (kV)</u>
5	60
15	95
18	110
25	125
34.5	150
46	200

2.1.7. Secondary winding: wye, four wire with neutral brought out and grounded unless high resistance grounded system has been identified.

2.1.8. Unless shown otherwise on drawings, transformer to meet the energy efficiency requirements of the energy efficiency standards referenced in this specification, whichever is more stringent, at **50%** of rated load.

## 2.2. ENCLOSURE

2.2.1. Fabricated from sheet steel.

2.2.2. Bolted removable panels for access to tap connections, enclosed terminals of fans and other accessories. Enclosure to be able to be broken down and re-built for installation.

2.2.3. Cable/Bus entry and exit:

- .1 See details on drawings for location and cable/bus arrangement for the transformer. Coordinate bus connections with suppliers of the adjacent equipment. Provide transition sections in order to provide adequate clearances for the high and low voltage buses.

2.2.4. Indoor, sprinkler proof, ventilated.

## 2.3. MOUNTING

2.3.1. Transformers suitable for floor mounting in electrical room and connected as per the drawings. See drawings for exact arrangement of equipment.

2.3.2. Provide vibration isolation pads under transformer.

## 2.4. VOLTAGE TAPS

2.4.1. Provide a no load tap changer with  $2 \pm 2 \frac{1}{2}\%$  FCAN (full capacity above normal) & FCBN (full capacity below normal) located in the primary windings.

2.4.2. Off circuit tap selection shall be by tap links. Tap change to be bolted-link type.

## 2.5. WINDINGS

2.5.1. Transformer core shall be manufactured from quality non-aging, cold rolled, fully processed silicon steel laminations. Cores are to be precisely cut to close tolerances to eliminate burrs and improve performance.

2.5.2. If the windings of the transformer are a Y-Y configuration, the transformer core to be a five leg type.

2.5.3. Cores to be step-lap, fully mitred construction for optimum energy efficiency and low noise level. Cores are to be carefully assembled and rigidly held secure with structural steel clamps to minimize gaps.

- 2.5.4. Glass resin I beams that can withstand 2000 lbs per square inch shall be used as blocking coil supports for superior resistance to axial short circuit forces.
- 2.5.5. Primary and secondary coils:
  - .1 Copper unless noted otherwise on the contract documents.
- 2.5.6. Windings to be vacuum impregnated with resin for two complete impregnation cycles.
- 2.5.7. Coil and core assembly:
  - .1 Taps located at front of coils for accessibility.
- 2.5.8. Sound level:
  - .1 For transformers less than 5000 kVA, the average sound level shall comply with the latest edition of CSA C9.
  - .2 Where transformer size shown on drawings exceeds range addressed by CSA C9, average sound levels at no load and measured to IEEE C57.12.91 shall comply with the following:
    - .1 7,500 kVA – 1.2 kV to 15 kV -> 73 dBA;
    - .2 7,500 kVA – 15 kV to 44 kV -> 74 dBA;
    - .3 10,000 kVA – 1.2 kV to 15 kV -> 75 dBA;
    - .4 10,000 kVA – 15 kV to 44 kV -> 76 dBA;
    - .5 15,000 kVA – 1.2 kV to 15 kV -> 76 dBA;
    - .6 15,000 kVA – 15 kV to 44 kV -> 77 dBA.
  - .3 Where transformer size shown on drawings falls within the range covered by CSA C9, but exceeds the voltage range given in CSA C9, comply with the CSA C9 average sound level for the closest lower voltage range.
- 2.6. ACCESSORIES
- 2.6.1. Wiring and terminal box for protective devices.
- 2.6.2. Digital type winding temperature indicator with 3 sequence contacts. Provide sensors in each winding to monitor their respective temperatures.
- 2.6.3. Fans for forced air cooling, with temperature indicator sequence contacts control. Fans are to be provided with one redundant fan. Fans to be powered directly from the transformer.
- 2.6.4. Grounding terminal: inside enclosure.
- 2.6.5. All transformer lugs to be dual rated for Copper/Aluminum (Cu/Al).
- 2.6.6. Provide vibration isolation pads under transformer.
- 2.6.7. Nameplate shall be stainless steel.
- 2.6.8. Provide flexible bus connectors fully rated for the transformer for both the high and low voltage when the transformer is bus connected.
- 2.6.9. Where single line diagram shows circuit breakers upstream of transformer, provide an RC Snubber connected to the primary of the transformer to limit switching transients seen by the transformer.
  - .1 RC Snubber details:
    - .1 Voltage class: based on transformer primary voltage shown on Drawings.
    - .2 BIL: to match that of primary of transformer.
    - .3 Phases: to match number of wires feeding transformer primary.

- .4 Inclusive of resistor (R) and capacitor (C). Provide resistor and capacitor that are able to withstand high peak power and high energy pulses.
- .5 Enclosure type to match that of transformer, if not contained within transformer enclosure.
- .2 RC Snubber to include:
  - .1 Visual and electronic indicator of snubber continuity and proper functioning. Wire electronic indicator to terminal blocks for external monitoring by Building Automation System, Fire Alarm System, or similar.
  - .2 Current sensors for monitoring of resistor and fuse, with alarming on loss of continuity.
  - .3 Disconnect switch for RC Snubber.
  - .4 Current limiting fuses for protection of RC Snubber, with blown fuse detection. Wire detection to terminal blocks for external monitoring by Building Automation System, Fire Alarm System, or similar.
  - .5 Discharge resistors for capacitor safety.
- 2.7. FINISH
  - 2.7.1. Finish enclosure exterior in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
  - 2.7.2. Transformer to be painted ANSI-61 grey.
- 2.8. EQUIPMENT IDENTIFICATION
  - 2.8.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.9. FACTORY TESTING
  - 2.9.1. The transformer shall be tested in accordance with CSA C9 and ANSI C57.12.91.
  - 2.9.2. All standard factory testing is to be witnessed by the Technical Services Division Startup Service Contractor, the Owner and the Engineer's Representative. In addition, perform all other tests identified in this section and Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE that are not included in the standard testing procedure.
  - 2.9.3. Include in your bid for the complete cost of two people, either two representatives from the Owner or one representative from the Owner and one from the Engineer's Representative to attend the factory witness testing for the equipment. Cost to include, but not limited to, all travel, food and lodging costs.
  - 2.9.4. As a minimum perform the following tests:
    - .1 Resistance measurements.
    - .2 Turns ratio test is performed between windings for all tap positions.
    - .3 Polarity and phase rotation.
    - .4 Excitation current and no load losses on rated voltage and 110% of rated voltage.
    - .5 Impedance and load loss.
    - .6 Applied potential.
    - .7 Induced potential.
    - .8 Core insulation test.
    - .9 Sound level.

- 2.9.5. Carry out the following insulation tests using a 10,000 V megger with 20,000 mega-ohm scale and resulting insulation resistance corrected to base of 20 deg. C.
- .1 High voltage to ground with secondary grounded for duration of test.
  - .2 Low voltage to ground with primary grounded for duration of test.
  - .3 High to low voltage.
- 2.9.6. Perform heat run test for 24 consecutive hours at 100% load. The recorded information to include:
- .1 Primary and secondary voltage at no load.
  - .2 Primary and secondary voltages at normal load once per hour.
  - .3 Primary and secondary current in each phase once per hour.
  - .4 kW and kVA (ampere measurement) once per hour.
  - .5 Transformer cores and ambient temperature once per hour.
  - .6 Transformer cores and ambient temperature at the end of the heat run test.
- 2.9.7. Perform BIL testing on transformer.
- 2.9.8. Inspect primary and secondary connections for tightness and for signs of overheating.
- 2.9.9. Inspect and clean bushings and insulators.
- 2.9.10. A certified test report is to be supplied and reviewed by the Engineer's Representative without requesting a resubmit, prior to shipping of the transformer.
- 2.10. MANUFACTURERS
- 2.10.1. The following are acceptable manufacturers:
- .1 Hammond Power Solutions
  - .2 Delta Transformers
  - .3 Schneider-Electric
  - .4 Eaton Cutler-Hammer
  - .5 Rex Power Magnetics
  - .6 STI Power
  - .7 Hitachi Energy (Formerly ABB)
  - .8 Bemag

### 3. Execution

#### 3.1. INSTALLATION

- 3.1.1. Install transformers only after other work in area is completed and in accordance with manufacturer's instructions.
- 3.1.2. Lifting and moving of transformer;
- .1 Use qualified millwright contractor with relative experience to lift and move the transformer into place.
  - .2 Use spreader bars on slings when lifting transformers into place.
  - .3 Set and secure transformer in place rigid, plumb, level and square.
- 3.1.3. Ensure internal connections are mechanically tight.

- 3.1.4. Make connections at high voltage and low voltage terminals. Use flexible connectors to make bus connections to transformer.
- 3.1.5. Connect transformer ground terminal to system ground. Ground transformer at two locations to the substation grounding grid.
- 3.1.6. Set taps to produce rated secondary voltage at no-load.
- 3.1.7. Wire one set of contacts on temperature measuring device to sound alarm to the building automation system when unsafe condition reached and wire second set of contacts to trip transformer circuit interrupter.
- 3.1.8. Energize transformer and confirm correct phase rotation on the secondary side of the transformer. For transformer replacements, measure phase rotation before existing transformer removal and after the installation of the new transformer. Measurements should be done using the same rotation meter.
- 3.1.9. Use torque wrench to adjust internal connections in accordance with manufacturer's recommended values.
- 3.1.10. Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.
- 3.1.11. Where RC Snubber is required by the clauses above, provide connection of RC Snubber monitoring accessories to the Building Automation System, Fire Alarm System, or similar.
  
- 3.2. FIELD QUALITY CONTROL
  - 3.2.1. All tests to be performed by Technical Services Division Startup Service Contractor as listed in Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
  - 3.2.2. Transformer to be tested on site before being removed from the delivery truck, and again tested once installed in its final location.

END OF SECTION

26 24 17.00 Panelboards – Breaker Type

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.1.3. Section 26 05 05.00 – MOUNTING HEIGHTS.

1.1.4. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 29 – Panelboards and Enclosed Panelboards, latest edition.

1.2.2. CSA C22.2 No. 5 – Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.3.2. Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.3.3. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

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.

.1 120/208 V panelboards – 10 kA

.2 347/600 V panelboards – 22 kA

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, for all panelboards other than those used in residential suites.
- 2.1.12. Trim and door finish: baked grey enamel.
- 2.1.13. Enclosure to be CSA Type 1 with drip hood with the exception of recessed panel enclosures which are to be CSA Type 1.
- 2.1.14. Provide Surge Protection Device where shown on Drawings.
- 2.1.15. Series ratings may be acceptable. Panels to be labeled as such. Manufacturer to supply supporting data.
- 2.1.16. All lugs to be dual rated for Copper/Aluminum (Cu/Al).
  
- 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. 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.
  - 2.2.8. Breaker terminals to be dual rated for Copper/Aluminum (Cu/Al).
  
- 2.3. EQUIPMENT IDENTIFICATION
  - 2.3.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
  - 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 strut channel stand-offs or on fire rated plywood backboards. The plywood backboards are to be as per Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 3.1.3. Mount panelboards at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS.
- 3.1.4. Connect loads to circuits.
- 3.1.5. Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

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26 27 13.00 Electronic Metering

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.2. STANDARDS

- 1.2.1. Except as noted by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations of the Canadian Electrical Manufacturer's Association, CSA and Measurement Canada.
- 1.2.2. The system shall be bench certified/approved by Measurement Canada for legal trade under the "Electricity and Gas Act" of Canada.
- 1.2.3. At the completion of installation, the system shall be field reviewed to verify compliance with Measurement Canada Specifications.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. Submit shop drawings and manufacturers data for the component items shown and specified under this section of the specification. This shall include, but not limited to:
  - .1 System riser, one line and installation diagrams.
  - .2 Manufacturer's system and communications connection diagram.
  - .3 Information on selected reporting software.
  - .4 All electrical and mechanical meters.
  - .5 All final verification and acceptance forms/letters.
- 1.3.3. Do not supply any equipment to this project prior to shop drawing review by the Engineer's Representative.
- 1.3.4. Shop drawings will be stamped and signed by the Electrical Contractor prior to submittal, allow a minimum of one week for review of the shop drawings submitted.
- 1.3.5. At the completion of the Project, As-Built Drawings will be submitted by the Submetering Supplier/Manufacturer and Electrical Contractor, who will prepare a complete manufacturer's manual including but not limited to all as-built wiring diagrams and all required Measurement Canada certifications and test results.

1.4. DESCRIPTION OF SYSTEM

- 1.4.1. Work under this section is subject to the requirements of Section 26 05 01.00 - GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

- 1.4.2. Provide a fully digital utility (i.e. electricity, water, gas, heating and cooling energy) measurement system for multi-tenant buildings incorporating complete metering. The mechanical meters and electrical metering panel(s) must have its own local display for reading the meters connected to it.
- 1.4.3. All utility consumption metering on site shall be supplied and coordinated through the Submetering Supplier and Electrical Contractor. Consumption metering for all utilities on site must be coordinated through the Submetering Supplier and Electrical Contractor to:
- .1 Ensure metering infrastructure meets all applicable regulatory requirements.
  - .2 Is capable of seamlessly integrating to the chosen end user platform.
  - .3 Allow for necessary tenant billing data criteria.
  - .4 Ensure non-proprietary data protocols.
  - .5 Allow for one point of contact for all stakeholders.
- 1.4.4. Submetering System to collect data on Electricity energy consumption. Meters to communicate data to central point(s) and be remotely accessible by operations team, accounting, etc., using a web-based data collection and reporting software.
- 1.4.5. System to include:
- .1 Meter Hardware - Electrical
  - .2 Communications Infrastructure
  - .3 Data Collection and Reporting
  - .4 Execution and Verification
- 1.4.6. The submetering system shall be scalable to include other utility metering, including the power metering system on the Main 416 V Switchboard. System shall be used for tenant billing, and/or energy management.
- 1.4.7. Provide computerized metering in accordance with the Contract Documents. The system to come complete with all parts necessary to operate this system.
- 1.4.8. Remote sub-metering panels shall be used for electricity consumption and display in a digital format and in real numbers.
- 1.4.9. All electricity submetering units to be mounted in a CSA Type 1 with drip hood, sprinkler proof enclosure either located next to the electrical panel(s) and require no tools to open.
- 1.4.10. Metering panels communicate over their own network, which can report to remote computers using telephone or Ethernet/WAN/Internet communications.
- 1.5. WARRANTY
- 1.5.1. All meters shall have a manufacturer's warranty of 3 years.
- 1.5.2. All other equipment shall be free from defect in materials and workpersonship under normal use and service for the period of twenty four (24) months from the date of acceptance.
2. Products
- 2.1. ELECTRICAL METERS/METERING AND SUBMETERING EQUIPMENT
- 2.1.1. The electricity meter system will be used to monitor key house electrical loads and riser disconnects on each tenant floor and optional metering for select tenant 120/208 plug loads fed within the building.

- 2.1.2. All meters to be Measurement Canada approved and their installation to be verified and commissioned as per Measurement Canada S-E-04 standards.
- 2.1.3. Meters to have Ethernet interface for direct connection to building's central fibre communications network.
- 2.1.4. Each multi-meter includes current transformers, potential transformers (if applicable), cable connections and Ethernet and BACNet IP capabilities. Meters must have BTL listing (BACNet Testing Laboratories).
- 2.1.5. All electrical meters must be tested, sealed and verified to Measurement Canada standards (no exceptions). Verification of meter installation on-site to comply with Measurement Canada S-E-04 inspection procedures.
- 2.1.6. Meters must be capable of directly metering North American 120/208 V, 120/240 V, 240/416 V, and 277/480 V and 347/600 V wye services. Meters may use manufacturer specified and supplied Potential Transformers for the higher voltages, if required.
  - .1 The Potential transformers, if required, shall be mounted in a separate enclosure rated for the size and capacity necessary to feed the number of meters shown as per the drawings and rated by the manufacturer. Potential transformers must be Measurement Canada approved for revenue metering (independently or as part of system approval).
  - .2 Potential transformers shall be factory assembled and come complete with electrical disconnects and fuses mounted in a separate enclosure.
- 2.1.7. Metering Units must have the capability of a single incoming cable with associated current transformers (CT's).
- 2.1.8. All CTs to be solid core with 5A secondary ratio.
- 2.1.9. Must meet all ISO 9001 standards for quality control where all meters test to a minimum of +/- 0.2% accuracy.
- 2.1.10. Operating Frequency: 50/60 Hz.
- 2.1.11. Power Factor Range: 0.5 to 1.0 lead/lag.
- 2.1.12. Operating Temperature Range: -40 degrees to +55 degrees C.
- 2.1.13. Current Ranges: 100/200/400 Amps or 5/10 Amp interface (services over 400 A or critical loads)
- 2.1.14. Metering unit(s) must be able to meter a minimum of 24 single-pole circuits, 12 single phase/Network meters and 8 three phase type meters.
- 2.1.15. All meters shall be bi-directional.
- 2.1.16. All meter front panel instantaneous-value update intervals shall be no greater than once every 60- seconds.
- 2.1.17. All RMS values shall be True RMS, not Average RMS.
- 2.1.18.
- 2.1.19. Meter communications options: Ethernet, Modbus TCP, BACNet or modem:
  - .1 Ethernet interface at each metering device
  - .2 Meters must be a push IP based communication
  - .3 There cannot be any modifications to customer's existing firewall
  - .4 Modbus TCP or BACnet communications for interface to client systems
- 2.1.20. Meters and their elements must conform to the Measurement Canada "Standard Drawings for Electrical Metering Installations" to ensure accurate metering. All configurations shall come with current transformers/transducers required in the "Standard Drawings".

- 2.1.21. Approved Electrical Submeter Manufacturers:
- .1 Schneider METSEPM556
- 2.2. DATA COLLECTION, REPORTING, BILLING AND SYSTEM SOFTWARE
- 2.2.1. All meter data must be collected via the communication infrastructure and reported through one or more of the following software options. At a minimum, 15 minute interval KWh data must be available for download into a CSV, Excel file.
- 2.2.2. The following capabilities and services must be provided:
- .1 Web-hosted Energy Reporting Software:
    - .1 Provide QMC MeterConnex web-based reporting software or approved equal. Graphing and exportation of meter data shall be available on-line. Tenant interface shall also be available, provided as a Software as a Service with no upfront costs
    - .2 BAS and Power Quality Meter Integration:
      - .1 Seamlessly integrate meter register data for meters pertaining to building operations and/or maintenance. This shall include communicating and fully integrating the Submetering System with information from the Power Quality Meters installed on the Main 600V Switchboard of the building. Electrical Contractor to coordinate communications protocol with Power Quality Meters supplied as specified in section 26 09 13.01 - Power Quality Metering System.
    - .3 The Submetering Supplier must have the following capabilities as an option for their system:
      - .1 Tenant Billing Services:
        - .1 Read all meter data on a monthly basis and produce tenant invoices for electricity, heating and cooling energy and domestic water use. Billing summary shall be capable of being sent to property or tenant directly.
        - .2 Shall provide menu driven generation of energy bills in a format similar to the format provided by the local Utility Supplier. Shall permit energy cost calculations that utilizes information from account bill received from the local Utility Supplier, allowing for the incorporation of co-incident demand charges and time of use rates allocated to each tenant.
        - .3 Shall permit multiple metering points to be allocated to a single tenant file in order to totalize a number of metering points and energy costs to a single tenant account.
        - .4 Shall permit reconfiguration of tenant accounts through menu selection.
        - .5 Shall list all tenant accounts including the tenant history file.
        - .6 Shall access the actual metering measurements used in deriving each Tenant's invoice.
        - .7 Provide billing data within a format compatible with standard accounting packages.
      - .2 This service shall be provided on an ongoing basis and negotiated with the Owner/Property Manager at completion of system installation.
    - .4 The Submetering System Software shall meet the following requirements:
      - .1 Must be accessible by any user via standard web-browser, such as IE, Chrome, etc.
      - .2 Also provide a Windows™ based simplified user interface for system operation.

- .3 Tiered access so users can only access meter data and reports selected by system owner.
- .4 Up to 100 user accounts available.
- .5 Multiple utilities must be presented, including electricity, water, gas and thermal energy.
- .6 Environment Canada weather data must be collected (Heating and Cooling Degree Days, Average Temperature).
- .7 Metering data must be available to other software parties via API (Application Program Interface).
- .8 All data must be exportable in CSV or Excel format.
- .9 Mandatory Functionality:
  - .1 Bill Generation, including utility consumption and rates.
  - .2 Visual Reports, including 15 minute energy profiles, load comparisons.
  - .3 Heat Mapping Tool.
  - .4 Weather Regression modelling based on HDD/CDD or average temperature.
  - .5 Alarming tools: demand or consumption min and max thresholds and automated email or text alarm to selected users.
  - .6 Automated reporting tool: automated PDF report sent to selected users showing energy-related KPIs (Key Performance Indicators) of property.
  - .7 Revenue legal metering measurements shall be received from all sub-metering sensors and stored in a central Data Collection Unit (DCU).
  - .8 To monitor, acknowledge and control communications with the remote metering points and to log any disruption of the communication link or unauthorized system access or tampering.
  - .9 To permit the user to view instantaneous readings of voltage, current, power, phase angle, present and peak demand for any electricity meter.
  - .10 To permit the user to view instantaneous readings present usage (totalized) or demand (last 15 minute interval) for any mechanical meter.
  - .11 Provide the ability to export data into Reporting Applications (e.g. Web and Excel VBA).
  - .12 To include service menus for diagnostic monitoring of the metering equipment and through either a modem and telephone link or Internet access to permit remote diagnostics by the manufacturer's service technicians. Security access control shall permit remote diagnosis to be locked out.

## 2.3. WIRING

- 2.3.1. Provide all wiring in conduit as required to operate the entire system. Wiring to be provided as per manufacturer's instructions. All power wiring to be in conformance with the electrical code.

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3. Execution
- 3.1. DRAWING REVIEW
- 3.1.1. Submetering Supplier and Electrical Contractor to review tenant electrical using construction contract drawings to coordinate and budget all meters and M-Bus communications system according to site-specific distribution and property needs. This includes the Electrical Contract Drawings.
- 3.2. ELECTRICAL METER INSTALLATION
- 3.2.1. All metering equipment shall be installed in electrical or mechanical rooms, as indicated on the drawings.
- 3.2.2. Remove electrical panel cover.
- 3.2.3. Wire bending space should be in compliance with Canadian Electrical Code Section 12. Verify that Current Transformers, Power Taps, and wiring can be installed without crowding the electrical panel.
- 3.2.4. Verify that the Current Transformers can be installed with a minimum 1/2 inch clearance to uninsulated live parts in panel, and without bearing against dead metal parts.
- 3.2.5. Verify that power is 120V, 120/280V, 120/240V, 240/416V or 416V, 277/480V, 480V, 347/600V or 600V. Verify that neutral is available if applicable.
- 3.2.6. Provide a dedicated 15A, 120VAC circuit for each panel and equipment from the nearest available panel. Provide a new breaker in the respective panel.
- 3.2.7. Verify that the meter is the right size and voltage for the installation.
- 3.2.8. Secure metal conduit to panel. Use insulating bushing. Reliable grounding is required. Locknuts must be tightened enough to pierce paint in cabinet.
- 3.2.9. Secure meter enclosure in or on wall, according to location, and connect conduit using locknut. Attach the enclosure to a wall stud using screws to provide equivalent support.
- 3.2.10. Install CT's and PT's per manufacturer's recommendations.
- 3.2.11. Interconnect all metering panels with wiring in conduit as per manufacturer's instructions. Provide connection of Metering Panels to remote accesses connection: telephone, Ethernet connection, etc.
- 3.2.12. Replace electrical panel covers.
- 3.2.13. Contact Electrical Safety representatives for verification of compliance to governing electrical codes.
- 3.2.14. All electrical multi-meters must be verified according to Measurement Canada S-E-04 inspection procedures.
- 3.2.15. Contact Measurement Canada or accredited service provider for installation verification. Installation verification shall include a tenant-to-breaker check. Electrical Contractor must be available for verification support.
- 3.2.16. Top of meter display to be no higher than 1.9m (75") and bottom of the meter display to be no lower than 1.2m (47") above finished floor.
- 3.3. CALIBRATION AND MAINTENANCE SERVICE
- 3.3.1. All meters shall be Measurement Canada bench verified, and Submetering Supplier will provide all Inspection/Verification Certificates within as-built documentation in order to provide a complete operational system.

- 3.3.2. Submetering Supplier will include all required Measurement Canada installation inspections in pricing. All appropriate equipment is to be labelled with the respective certification labels.
- 3.3.3. Electrical Contractor to provide "AS BUILT" – marked up by Submetering Supplier; "Record of Metering Installation" sheet(s) indicating each meter, serial no., address, cross reference, metered tenant(s) and other applicable information. Information to be forwarded to software or reporting vender.
- 3.3.4. The Submetering Supplier shall verify, adjust and test the system. Verification to be carried out with the assistance of the Electrical and Mechanical Contractor. Upon completion, Submetering Supplier to issue a "CERTIFICATE OF ACCEPTANCE" to the Engineer's Representative/Owner, and Electrical Contractor. This shall be submitted as a Shop Drawing to the Consultants and incorporated into the final O&M Manuals.
- 3.3.5. Submetering Supplier shall demonstrate operation of the system as follows:
- .1 Meter readings at the meter
  - .2 Diagnostics
  - .3 Provide manual of installed system.
- 3.3.6. The Submetering Supplier shall provide pricing for billing services, on a per meter price, for collection of tenant sub-metered energy for return to building management or local distribution company (LCD) to apply against facility energy costs.
- 3.3.7. The Submetering Supplier shall detail remote connectivity requirements (telephone, High-Speed Internet, etc.). Building owner/property manager shall provide necessary remote connectivity to allow for remote billing services, if required.
- 3.3.8. Submetering Supplier to register the system with Measurement Canada and work with the Owner to obtain all required information to do so.
- 3.3.9. After the specified Measurement Canada approval period (seal period typically 6 years), the Submetering Supplier shall provide options for maintaining Measurement Canada Approval. This may include, but not limited to: Onsite Re-verification or removal of existing equipment and replacement with Measurement Canada verified equipment.
- 3.3.10. The Submetering Supplier shall provide pricing to the Owner for system maintenance, repair and/or replacement service to the extent that is covered by the warranty.
- 3.4. COMMUNICATIONS
- 3.4.1. Provide a dedicated IP connection at point of central data collection for remote meter reading and diagnostics of the system.
- 3.5. TRAINING
- 3.5.1. Submetering Supplier to provide 4 hour training and software manual for Owner's staff of selected reporting system.

END OF SECTION

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26 27 19.00 Multi-Outlet Assemblies

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 27 26.00 – WIRING DEVICES.
- 1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

1.2. REFERENCE

- 1.2.1. CSA C22.2 No. 62 – Surface Metal Raceways, latest edition.
- 1.2.2. ANSI/TIA 569-C – Commercial Building Standard for Telecommunications Pathways and Spaces, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. If variations from the reviewed shop drawings occur during the installation of the system, final as built drawings shall be submitted for each floor that has been altered.

2. Products

2.1. SURFACE RACEWAY FOR WIRING DEVICES

- 2.1.1. The raceway and all system components must be CSA listed.
- 2.1.2. Raceway to be constructed of galvanized steel unless stainless steel is identified on the drawings. Raceway base shall have a minimum thickness of 1.3 mm (0.050 in.) and the cover shall have a minimum thickness of 1 mm (0.040 in.).
- 2.1.3. Raceways shall be painted with the colour to be determined by the architect at the time of shop drawing stage. Submit available colour selections with the shop drawing submittal.
- 2.1.4. The raceway shall have a minimum of two compartments unless additional compartments are identified on the drawings. Assembled base and cover shall be a 120 mm (4¾ in.) wide for two section raceway and additional 60 mm (2-3/8 in.) for every additional compartment with a minimum depth of 45 mm (1¾ in.) unless specified otherwise on the drawing.
- 2.1.5. The raceway shall be a modular design with separate covers for each compartment divided with fixed barriers. The compartment covers to be snap on design, which snap side by side on a common base. Raceway covers shall be enhanced tamper resistant form, where screws are only necessary on access plates and the covers of certain fittings, but not on standard cover lengths. A tool shall be provided to form the shape in the cover flange necessary to maintain enhanced tamper resistance when the cover is field cut. Another tool shall be provided for cutting covers to ensure square field cuts.

- 2.1.6. Provide all required fittings including, but not limited to flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, entrance fittings, and a full complement of device mounting brackets and plates. All fittings shall be an enhanced tamper resistant form and shall be divided with barriers and made to match the size of the accompanying raceway base.
- 2.1.7. Provide full capacity corner elbows and tee fittings to maintain a controlled 50 mm (2 in.) cable bend radius, which meets the specifications for Fiber Optic cabling and exceeds the TIA 569 requirements for communications pathways.
- 2.1.8. Device brackets shall be provided in sizes to match the width of the raceway and with mounting-holes appropriately located to ensure proper mounting of devices in all compartments.
- 2.1.9. Device plates shall be made in any length from 152.4 mm (6 in.) to 1.5 m (60 in.) with cut outs to accommodate various combinations of power and/or communication devices in all compartments. Device plates shall be 152.4 mm (6 in.) and 304.8 mm (12 in.) long with a flange to overlap the joint of the adjacent cover. Provide 5% additional device plates for future additions or modifications for all types of devices installed.

## 2.2. MANUFACTURERS

- 2.2.1. The following are approved manufacturers:
  - .1 CER - Canadian Electric Raceways.
  - .2 Legrand – Wiremold.
  - .3 Hubbell.

## 3. Execution

### 3.1. INSTALLATION

- 3.1.1. Prior to and during installation, refer to system layout or approval drawings containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets, which accompany system components, as well as complete system instruction sheets, whichever is applicable.
- 3.1.2. All raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, also in accordance with manufacturer's installation sheets.
- 3.1.3. All metal raceway shall be electrically continuous and bonded in accordance with the respective electrical code for proper grounding.
- 3.1.4. Provide a separate insulated bonding conductor in the entire length of the raceway.
- 3.1.5. Raceway shall be securely supported at intervals not exceeding 1500 mm (5 ft.) or in accordance with manufacturer's installation sheets.
- 3.1.6. All raceway systems shall be installed complete, including insulating bushings and inserts where required by manufacturer's installation sheets. All unused raceway openings shall be closed.
- 3.1.7. Locate wireway and wiring devices as shown.
- 3.1.8. Install supports, elbows, tees, connectors and fittings. Keep the number of elbows, offsets and connections to a minimum.
- 3.1.9. Install wiring and wiring devices as indicated.

3.1.10. Install barriers to separate different wiring systems.

END OF SECTION

26 27 26.00 Wiring Devices

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 05.00 – MOUNTING HEIGHTS.
- 1.1.4. Section 26 05 53.00 – IDENTIFICATION.
- 1.1.5. Section 26 51 13.00 – LIGHTING EQUIPMENT.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No. 42, General use receptacles, attachment plugs, and similar wiring devices, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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 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 Decora 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 receptacles, Decora 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. Duplex receptacles with USB charging outlets, Decora 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 Six back wired entrances, four side wiring screws.
  - .4 Triple wipe contacts and riveted grounding contacts.
  - .5 One USB A charging outlet and one USB C charging outlet, 5 V DC, 6 A shared between the two ports.
- 2.2.4. 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.
- 2.2.5. Other receptacles with ampacity and voltage as indicated.
- 2.2.6. All millwork surface mounted receptacles to be Legrand 1-gang+ adorne wall plate + 2A T-Slot duplex receptacle c/w USB-A & USB-C.
- 2.2.7. Receptacles to be coloured as follows:
  - .1 Normal Power – Colour to be selected by Architect/Engineer's Representative.
  - .2 Emergency/Essential Power – Red.
  - .3 Isolated Ground – Orange.
  - .4 Switched – Gray.
  - .5 UPS – Blue.
- 2.2.8. All dwelling receptacles of CSA configuration 5-15R and 5-20R shall be tamper resistant receptacles and shall be so marked; receptacles dedicated for microwaves, refrigerators, freezers or those receptacles located in an attic or crawl space shall not be required to be tamper-resistant.
- 2.2.9. All dwelling receptacles rated 125 V, 20 A or less shall be provided with arc-fault protection, except for the following:
  - .1 Bathroom and washroom basin receptacles.
  - .2 Kitchen counter receptacles
  - .3 Refrigerator receptacles
- 2.2.10. Arc-fault protection for dwelling unit receptacles shall be provided by:
  - .1 A combination-type arc-fault circuit interrupter
  - .2 An outlet branch-circuit interrupter installed at the first outlet on the branch circuit, where the wiring method for the portion of branch circuit between the branch circuit overcurrent device and the first outlet consists of metal raceway, armoured cable, or non-metallic conduit or tubing.
- 2.2.11. Electrical Contractor shall coordinate with furniture supplier to identify switched circuits prior to installation.
- 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 600 W, 1500 W, 2000 W.

- .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, fluorescent, and LED.

### 2.4.2. 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 W of Electronic Low Voltage load.
- .3 Reset-able overload protection when capacity is exceeded.

### 2.4.3. LED dimmers.

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

### 2.4.4. Manufacturers

- .1 Lutron Maestro Series.
- .2 Leviton True Touch Series.

## 2.5. SPECIAL WIRING DEVICES

### 2.5.1. Pilot lights as indicated, with neon type 0.04 W, 125 V lamp and red plastic lens flush type.

## 2.6. COVER PLATES

### 2.6.1. Cover plates for wiring devices.

### 2.6.2. Cover plates from one manufacturer throughout project.

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

### 2.6.4. Provide stainless steel cover plates, suitable for the respective device, for all devices mounted in flush-mounted outlet boxes located in finished areas.

### 2.6.5. Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

### 2.6.6. Weatherproof rain tight while-in-use metal cover, complete with gaskets for duplex receptacles located outside or as indicated.

### 2.6.7. Weatherproof rain tight while-in-use metal cover, 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 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.
- .4 Mount toggle switches at height specified in Section 26 05 05.00 – MOUNTING HEIGHTS 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 26 05 05.00 – MOUNTING HEIGHTS or as indicated.
- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

3.1.3. Dimmers:

- .1 Install dimmers as indicated. Provide suitable clearances in multi-gang boxes as recommended by the manufacturer to maintain the dimmer rating.
- .2 Coordinate the dimmer selection with the ballast/driver to be controlled, to ensure compatibility.
- .3 Where line voltage controls are used, install an identified conductor at each location of a manual or automatic control device in accordance with electrical code requirements.

3.1.4. Cover plates:

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.1.5. Labelling

- .1 Provide labels with panel name and circuit number on all receptacles in conformance with Section 26 05 53.00 – IDENTIFICATION.

END OF SECTION

26 28 14.00 Fuses Low Voltage

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 248, Low Voltage Fuses, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit shop drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

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 Fuses: product of one manufacturer.

2.1.2. 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 R fuses. For UL Class RK1 fuses, peak let-through current and I<sup>2</sup>t values not to exceed limits of CSA C22.2 No. 248.

- .1 Type R1, (UL Class RK1), time delay, capable of carrying 500 % of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
  - .2 Type R2, time delay, capable of carrying 500 % of its rated current for 10 s minimum.
  - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- 2.2.4. Class C fuses.
- 2.2.5. Fuses for Motors:
- .1 All fuses for motor loads are to be time-delay type.
- 2.3. FUSE STORAGE CABINET
- 2.3.1. Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door, B-LINE model 243012 + 2 shelves FCS2412, finished in accordance with Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 2.4. FUSE PULLER
- 2.4.1. Provide a fuse puller for each size of fuse to be located in the fuse storage cabinet. Fuse puller to be clearly labelled for the appropriate building and fuse cabinet. Fuse puller to be equal to the Ideal Safe-T-Grip Fuse Puller.
- 2.5. MANUFACTURERS
- 2.5.1. The following are acceptable manufacturers:
- .1 Mersen
  - .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 physically match mounting devices.
- .1 Install Class R rejection clips for Class R fuses.
- 3.1.3. Ensure correct fuses fitted to assigned electrical circuit.
- 3.1.4. Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

END OF SECTION

26 28 21.00 Moulded Case and Insulated Case Circuit Breakers

1. General

1.1. WORK INCLUDED

1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.

1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.

1.2. REFERENCES

1.2.1. CSA C22.2 No. 5 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS

1.3.2. Include time-current characteristic curves for breakers with ampacity of 400 A and over or with interrupting capacity of 22,000 A symmetrical (RMS) and over at system voltage.

1.3.3. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

2. Products

2.1. BREAKERS GENERAL

2.1.1. Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg. C. ambient.

2.1.2. Common-trip breakers: with single handle for multi-pole applications.

2.1.3. Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3-8 times current rating.

2.1.4. Circuit breakers with interchangeable trips as indicated.

2.2. THERMAL MAGNETIC BREAKERS

2.2.1. 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.

2.3. MAGNETIC BREAKERS

2.3.1. Moulded case circuit breakers to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

## 2.4. FUSED THERMAL MAGNETIC BREAKERS

2.4.1. Fused thermal magnetic breakers with current limiting fuses internally mounted. Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker. Coordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker. Fuses individually removable and interlocked with breaker. The removal of fuse cover, blowing of a fuse or removal of a fuse, shall trip the breaker.

## 2.5. SOLID STATE TRIP BREAKERS

2.5.1. Circuit breaker to operate by means of an adjustable solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition.

2.5.2. Electronic trip with true RMS sensing.

2.5.3. Use current transformers to ensure accurate measurement from low current up to high currents.

2.5.4. Electronic trip with thermal memory/imaging.

2.5.5. Adjustable solid state trip unit complete with:

- .1 Adjustable long time pick-up
- .2 Adjustable long time delay
- .3 Adjustable short time pick-up (where S indicated on Drawings)
- .4 Adjustable short time delay (where S indicated on Drawings)
- .5 Adjustable instantaneous pick-up (where I indicated on Drawings)
- .6 Adjustable ground fault pick-up (where G indicated on Drawings)
- .7 Adjustable ground fault delay (where G indicated on Drawings)
- .8 Long time, short time, instantaneous tripping for phase and ground fault short circuit protection as noted above.

2.5.6. Trip unit consisting of adjustable protection settings set by rotating switch or digital keypad, and rating plug.

2.5.7. Provide features listed below:

- .1 Provide instantaneous maintenance mode (arc flash reduction maintenance system) including settings as low as 2.5 times breaker rating plug with switch built into respective switchboard. Provide LED light that confirms that maintenance mode is engaged.
- .2 Provide instantaneous maintenance mode (arc flash reduction maintenance system) including settings as low as 2.5 times breaker rating plug, enabled remotely through 24 V DC circuit and remote switch. Provide LED light that confirms that maintenance mode is engaged.
- .3 Provide trip unit with local trip indication and ability to locally and remotely indicate reason for trip (e.g. overload, short circuit, or ground fault).

## 2.6. INSULATED CASE CIRCUIT BREAKERS GENERAL

2.6.1. Use insulated case circuit breakers where shown on the Drawings.

2.6.2. Provide draw out type electrically operated circuit breaker with remote open/close key switch.

- 2.6.3. Provide circuit breaker operating mechanisms that are two-step, fully-stored energy devices for quick-make, quick-break operation with a maximum of a five-cycle closing time. Open-close-open (O-C-O) cycle possible without recharging. Provide motor operator that automatically charges when circuit breaker is closed. Charge the closing springs (step one) upon actuation of the operating handle or an operation cycle of the circuit breaker motor and close the circuit breaker contact (step two) upon operation of a local "close" button. Automatically charge the opening springs when closing the circuit breaker contacts.
- 2.6.4. Provide breaker that is 100 % continuous current rated in its enclosure.
- 2.6.5. Provide kirk keys where indicated on the Drawings.
- 2.6.6. Completely isolate current-carrying components from the accessory mounting area and double insulate current-carrying components from the operator with accessory cover in place.
- 2.6.7. Provide padlocking provisions furnished to receive up to three padlocks when circuit breaker is in the open position, positively preventing unauthorized closing of the circuit breaker contacts.
- 2.6.8. Provide provisions for up to two key locks allowing locking in the disconnected position. Provide provisions for locking in the connected, test and disconnected positions by padlock or key lock.
- 2.6.9. Provide buttons, with lockable clear cover, located on the face of the circuit breaker, to open and close the circuit breaker and indicators to show the position of the circuit breaker contacts, status of the closing springs, and circuit breaker position in the cell. Provide an indicator that shows "charged-not OK to close" if closing springs are charged but circuit breaker is not ready to close. Provide circuit breaker racking system that has positive stops at the connected, test, disconnected and withdrawn positions.
- 2.6.10. Equip circuit breaker with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Provide circuit breaker that provides a positive ground contact check between the circuit breaker and cell when the accessory cover is removed while the circuit breaker is in the connected, test or disconnected positions.
- 2.6.11. Provide interlocks to prevent circuit breaker draw out when in closed position and to prevent closing unless fully engaged or in test position. Provide breaker that is trip free during racking operation.
- 2.6.12. Provide as an option, primary connectors that can be rotated to provide flexible vertical or horizontal connections. Ensure front connections are available as an option for shallow depth equipment designs.
- 2.6.13. Provide ready-to-close contact that indicates remotely that the circuit breaker is "ready to close." The circuit breaker is ready to close when it is open, spring mechanism is charged, a maintained closing order is not present, a maintained opening order is not present, and the circuit breaker is in an operational position.
- 2.6.14. Provide secondary control wiring that is front accessible and available in cage clamp or ring terminal connections. Provide secondary wiring that is inaccessible when switchboard door is closed.
- 2.6.15. Provide long service life circuit breaker. Provide circuit breakers certified to perform a minimum of 10,000 operations without maintenance where circuit breaker frames are 3000 A and below.
- 2.6.16. Equip circuit breaker with a visual contact wear indicator.
- 2.6.17. Provide circuit breaker arc chutes that don't contain asbestos.
- 2.6.18. Trip Unit
  - .1 Comply with the requirements noted above in the Solid State Trip Breakers section.
  - .2 Provide trip units that are removable to allow for field upgrades.

- .3 Provide trip units that are capable of the following types of ground-fault protection: residual, zero sequence, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
- .4 Ensure neutral current transformers are available for four-wire systems.
- .5 Provide trip units that have real time metering and metering functions that include current, voltage, power and frequency. Provide metering accuracy of 1.5 % current, 0.5 % voltage, and 2 % power. Accuracies listed are total system including CT and meter and are of reading, not full scale, in a range of 5 – 500 %.
- .6 Provide trip unit with provisions for communications on a network.

## 2.7. ACCESSORIES

### 2.7.1. Include:

- .1 shunt trip, when electrically operated or when indicated.
- .2 auxiliary switches, when electrically operated or when indicated.
- .3 motor-operated mechanism, when electrical operation indicated.
- .4 on-off locking device.
- .5 handle mechanism.
- .6 Where a breaker serves a fire pump, the breaker is to come complete with auxiliary contacts that are to be monitored by the fire alarm system.

## 2.8. MANUFACTURERS

### 2.8.1. The following are acceptable manufacturers:

- .1 Schneider Electric
- .2 Eaton Cutler-Hammer
- .3 Siemens

## 3. Execution

### 3.1. INSTALLATION

- 3.1.1. Install circuit breakers as indicated.
- 3.1.2. Contractor to wire any neutral CT's to the breaker trip unit where required by the breaker ground fault detection system or as otherwise required by the manufacturers instructions.

END OF SECTION

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26 28 23.00 Disconnect Switches – Fused and Non-Fused

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 53.00 – IDENTIFICATION.

1.2. REFERENCE

- 1.2.1. CSA C22.2 No. 4 – Enclosed Switches, latest edition.
- 1.2.2. CSA C22.2 No. 39 – Fuse-holder Assemblies, latest edition.

1.3. SHOP DRAWINGS AND PRODUCT DATA

- 1.3.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.3.2. Submit initial power system study at the same time as shop drawings for electrical distribution equipment, such that the Engineer can review the adequacy of equipment interrupting capacity or withstand ratings, prior to equipment being released for manufacture. In situations where the entire study cannot be submitted with the electrical distribution shop drawings, submit at a minimum a preliminary short circuit study for review.

2. Products

2.1. DISCONNECT SWITCHES

- 2.1.1. Fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, size as indicated.
- 2.1.2. Non-fusible, horsepower rated disconnect switch in CSA Type 3R enclosure, with minimum 10 kA Short Circuit Current Rating (SCCR), with manufacturer listed series rating with upstream breaker / fuse where available fault current exceeds 10 kA and with UL series rating label on disconnect switch, size as indicated.
- 2.1.3. Provision for padlocking in on-off switch position by three locks.
- 2.1.4. Mechanically interlocked door to prevent opening when handle in ON position.
- 2.1.5. Fuses: size as indicated, class J, current limiting, in accordance with Section 26 28 14.00 – FUSES LOW VOLTAGE.
- 2.1.6. Fuse-holders: suitable without adaptors, for type and size of fuse indicated.
- 2.1.7. Quick-make, quick-break action.
- 2.1.8. ON-OFF switch position indication on switch enclosure cover.

2.2. EQUIPMENT IDENTIFICATION

- 2.2.1. Provide equipment identification in accordance with Section 26 05 53.00 – IDENTIFICATION.
- 2.2.2. Indicate name of load controlled on nameplate.

2.2.3. Provide a Lamacoid nameplate 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

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26 51 13.00 Lighting Equipment

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS.
- 1.1.2. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.3. Section 26 05 04.00 – SUBMITTALS – SHOP DRAWINGS.
- 1.1.4. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.
- 1.1.5. Section 26 06 05.16 – LUMINAIRE SCHEDULE.

1.2. REFERENCES

- 1.2.1. CSA C22.2 No. 74 – Equipment for Use with Electric Discharge Lamps, latest edition.
- 1.2.2. The Consortium of Energy Efficiency (CEE) guidelines, latest edition.
- 1.2.3. IESNA LM-79 – Approved Method: Electric and Photometric Measurements of Solid-State Lighting Products, latest edition.
- 1.2.4. IESNA LM-80 – Approved Method: Measuring Lumen Maintenance of LED Light Sources, latest edition.
- 1.2.5. The Certified Ballast Manufacturers Association (CBM) standards, latest edition.
- 1.2.6. NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts, latest edition.
- 1.2.7. CSA C22.2 No. 141 – Emergency Lighting Equipment, latest edition.

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 in accordance with the requirements of the Luminaire Schedule. If alternates or substitutions are entertained, then it is the responsibility of the Contractor/Supplier to provide: a comparison table showing the specified and the proposed luminaire performance information, IES files for the proposed luminaires, the 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. An extra review fee, per luminaire submitted, will be charged to the Contractor (with no additional costs to the Project Owner). Reviewed alternates may be rejected, regardless of the payment fee received, when alternates do not meet the project requirements. Invoices must be paid prior to Consultant's review starting or changes in the design documents to incorporate the proposed alternates after their review. The Contractor/Supplier is responsible to ensure the light levels provided in the alternate submittal package will achieve the design light levels. Where the light levels are not achieved, the Contractor is responsible to replace the luminaire with a luminaire that will meet the required levels with no increase in energy use at no cost to the Owner. Rather than replacing the luminaires, the Engineer's Representative may accept the installation of additional luminaires by the Contractor at no cost to the Owner in order to achieve the required light levels.

- 1.3.2. Accompanying the request for a luminaire or lamp substitution, the contractor shall submit a complete lighting calculation report with photometric modeling of the space showing light levels including average, maximum, minimum and max to min values.
- 1.4. SHOP DRAWING AND PRODUCT DATA
- 1.4.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/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.
- 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, and voltage.
- 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.
- 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.
- 1.4.8. Where luminaires consist of multiple field assembled components, include manufacturer supplied installation manual detailing the assembly procedure.
- 1.5. OPERATION AND MAINTENANCE DATA
- 1.5.1. Provide operation and maintenance data for lighting equipment in accordance with Section 26 01 00.00 – OPERATING AND MAINTENANCE INSTRUCTIONS for incorporation into the manual.
- 1.5.2. Operation and maintenance instructions shall include documentation related to warranty claim process.
- 1.6. FIXED PER UNIT COST LUMINAIRES
- 1.6.1. Listed in the luminaire schedule are a fixed per unit cost for certain luminaire types. Electrical Contractor is responsible for completing a take-off of the drawings to determine quantity of each luminaire type and use the listed fixed unit price to calculate the total cost per luminaire type. The total cost for all luminaires shall be carried in the bid for the electrical contract. Provide a breakdown of the total cost, per luminaire type, that is carried under the electrical contract. All luminaires are to be included in the electrical contract including all luminaires identified with fixed unit costs. The Electrical Contractor is to include fixed per unit cost luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.6.2. The fixed per unit cost excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost luminaires. Show the applicable taxes as a separate line item.

1.7. CASH ALLOWANCE LUMINAIRES

- 1.7.1. Listed in the luminaire schedule are 'cash allowance' fixtures for certain luminaire types. A complete take-off of the drawings has been done to determine the quantity of each 'cash allowance' luminaire type and the total cost has been carried in the Div-0/1 cash allowance value. The total cost for all 'cash allowance' luminaires are NOT to be carried in the bid for the electrical contract.
- 1.7.2. After tender award to the successful Electrical Contractor, the Consultant shall provide the Electrical Contractor the exact manufacturer/model number(s) of all 'cash allowance' luminaires and the Electrical Contractor shall be responsible for purchasing the fixtures through the monies from the cash allowance.
- 1.7.3. Provide a breakdown of the total cost, per luminaire type, that is carried under the base electrical contract. All luminaires are to be included in the base electrical contract excluding all luminaires identified as 'cash allowance' luminaires. However the Electrical Contractor is to include 'cash allowance' luminaires in Light Fixtures – Materials in the standard progress draw breakdown defined in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS once the Consultant provides the Electrical Contractor with the exact manufacturer/model number(s).
- 1.7.4. The cash allowance value carried excludes applicable taxes and includes lamps and distributor markups. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all 'cash allowance' luminaires. Show the applicable taxes as a separate line item.

1.8. WARRANTY

- 1.8.1. The manufacturer shall provide a warranty against defects in material and workmanship, starting at substantial completion. Parts warranty shall be 5 years and labour warranty shall be 1 year.
- 1.8.2. LED's, Drivers, Lamps and ballasts showing signs of premature failure shall be replaced at no cost to the owner.
- 1.8.3. LED Drivers must have a 5 year warranty.

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. Refer to luminaire schedule for project specific details, and lamps required.
- 2.2.3. 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 manufacturing batch to avoid colour differences. Replace all lamps that exhibit colour shift, or exhibit premature lumen intensity decline, at no cost to the owner.
- 2.2.5. Light Emitting Diodes (LED)

- .1 LEDs shall meet the standards of IESNA LM-79 and LM-80.
- .2 All LED drivers shall be tested and comply with the maximum in-rush current limits as stated in NEMA 410.
- .3 LED's shall be manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, or Samsung. Colour temperature shall be as indicated on the luminaire schedule. Lamps are to be binned with no visible colour variance (+/- 100K from specified colour temperature). 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.
- .4 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 luminaire 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.
- .5 In case of failure of an LED luminaire, complete or part thereof, an 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.
- .6 Any additional time involved by Smith + Andersen will be billed at our hourly rates to the manufacturer or vendor.

### 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 3 V through 55 V.
  - .2 Adjustment of LED current from 200 mA to 1.05 A at the 100 percent control input point in increments of 1 mA.
  - .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 120 V through 277 VAC at 60 Hz.
- 2.3.9. Driver must 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 0.5 V and 0.65 V 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 10 V Analog Control Protocol, Class 2, capable of sinking 0.6 mA per driver at a low end of 0.3 V. Limit the number of drivers on each 0-10 V control output based on voltage drop and control capacity.
- 2.3.16. Must meet ESTA E1.3 for RGBW LED drivers
- 2.3.17. Provide drivers manufactured by Cree, Osram, Nichia, Toshiba, Lumileds, Bridgelux, Samsung, or Edoleds.
- 2.4. BALLASTS
- 2.4.1. All Ballasts shall 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. All ballasts shall be tested and comply with maximum in-rush current limits as stated in NEMA 410.
- 2.4.3. Not all ballasts could be used, refer to luminaire schedule for project specific details.

- 2.4.4. 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.
- 2.4.5. Ballasts shall contain no PCB's and audible rating will be class A or better.
- 2.4.6. Racks are to be provided for remote ballasts.
- 2.4.7. 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. Luminaires shall be suitable for the environment where installed, include seals and gaskets, and corrosion resistant baked-on finish as required and as specified.
- 2.5.3. Louvers, lenses and diffusers must be of suitable thickness to prevent sagging.
- 2.5.4. Where drawings show luminaires mounted end-to-end, luminaires shall be suitable for continuous, seamless and tandem mounting.
- 2.5.5. All poles are to come complete with internal vibration dampeners to accommodate wind conditions to avoid damage due to wind-induced vibrations.
- 2.5.6. All concrete bases for poles and bollards shall be designed to accommodate the height, weight, etc. of the pole/bollard and its accessories for the soil conditions for which it is installed. Engineered shop drawings shall be provided that is signed by a structural engineer registered in the local jurisdiction.
- 2.5.7. Where cameras are shown to be installed on poles, the poles shall be stiffened to reduce vibration and sway, and shall be rated for video recording cameras.
- 2.5.8. The supply and installation of fixed per unit cost and 'cash allowance' luminaires shall comply with all standards set forth in Electrical Specifications. Electrical Contractor is responsible to include in the base bid for delivery, scheduling, receiving, storage, partial assembly, installation, wiring, aiming, cleaning and warranties for all fixed per unit cost and 'cash allowance' luminaires.
- 2.5.9. Provide exit signs that comply with building code requirements, including CSA C22.2 No. 141.
- 2.5.10. 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 'L' denote LED type.
  - .2 Designations beginning with the letter 'X' denote exit sign.

## 3. Execution

### 3.1. INSTALLATION

- 3.1.1. It is the responsibility of the contractor to obtain the information related to the luminaire and luminaire trim finishes/colours from the Interior Designer or Architects prior to the fabrication of luminaires. The Contractor shall provide adequate time for the design team to review and comment on luminaire and luminaire trim finishes.

- 3.1.2. 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.
- 3.1.3. The Electrical Contractor shall be responsible for the supply and installation of all concrete bases for poles and bollards. Unless otherwise shown on the drawings, concrete bases to be ArtForm style or Approved Equal and shall extend a minimum 900 mm above grade in parking lots and a minimum 150 mm above grade in pedestrian walkways.
- 3.1.4. 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.
- 3.1.5. Install remote ballasts in racks and wire luminaires to ballasts in conduit. Provide wiring as per manufacturer's recommendations.
- 3.1.6. Locate luminaires in accordance with the Architect's Drawings. Coordinate exact locations on site. Refer to Architect's drawings for dimensions of coves and valences.
- 3.1.7. Install in accordance with Manufacturer's Instructions, Local Codes, Electrical Division Drawings and Specifications.
- 3.1.8. All suspended luminaires shall have cables and support stems vertically aligned.
- 3.1.9. 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.
- 3.1.10. All luminaires shall be installed underneath other services located within ceiling space. Contractor is responsible for interference drawings to ensure all services in ceiling are coordinated.
- 3.1.11. Any dimensions provided in the drawings or schedules are intended as general guidelines. For exact dimensioning refer to the Architectural drawings. The detailed information shall be cross referenced with the electrical specifications and the Luminaire Schedule applying the most stringent requirement.
- 3.1.12. It is the responsibility of the Electrical Contractor to coordinate luminaire trims and mounting system with ceiling finishes. Luminaires delivered on site with the wrong ceiling mounting system shall be replaced without additional costs for the owner. Restocking fees will not be accepted.
- 3.1.13. For suspended ceiling installations support luminaires from structural slab in accordance with local inspection requirements.
- 3.1.14. Where luminaires are mounted in tandem, align luminaires mounted in continuous rows to form straight uninterrupted line.
- 3.1.15. Align luminaires mounted individually parallel or perpendicular to building grid lines.
- 3.1.16. 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.
- 3.1.17. Connect luminaires to lighting circuits.
- 3.1.18. 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 in length unless approved otherwise in writing from the Engineer's Representative.
- 3.1.19. Modular wiring systems shall be employed only where indicated or with approval of the Engineer's Representative.

- 3.1.20. 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.
- 3.1.21. Lamps are to be installed after luminaire is cleaned.
- 3.1.22. 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.
- 3.1.23. 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

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28 31 02.00 Multiplex Fire Alarm System

1. General

1.1. WORK INCLUDED

- 1.1.1. Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS.
- 1.1.2. Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.1.3. Section 26 05 34.00 – CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 1.1.4. Section 26 08 01.00 – TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 1.1.5. Section 26 05 21.00 – WIRES AND CABLES UNDER 2000 V.

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. CAN/ULC-S1001, Integrated Systems Testing of Fire Protection and Life Safety Systems, latest edition.
- 1.2.5. CAN/ULC-S553, Standard For Installation of Smoke Alarms, latest edition.
- 1.2.6. CSA C22.2 No. 124, Mineral-Insulated Cable, latest edition.
- 1.2.7. CAN/ULC-S559, Standard for Equipment for Fire Signal Receiving Centres and Systems, latest edition.
- 1.2.8. CAN/ULC-S561, Standard for Installation and Services for Fire Signal Receiving Centres and Systems, latest edition.

1.3. SYSTEM DESCRIPTION

- 1.3.1. All equipment and components shall be new, and the manufacturer's current model.
- 1.3.2. Spare modules will be provided for future tenant tie ins. Panels will be tied into emergency standby generators, fire pumps, security panels, and auxiliary and ancillary devices.
- 1.3.3. Elevator shafts will have a weather proof heat detector located in the pit along with a smoke detector located at the top of the shaft.
- 1.3.4. Emergency power feed from generator(s) shall have two supervisory zones each, monitoring Generator Running and Generator General Trouble.
- 1.3.5. Emergency power feed from inverter(s) shall have three supervisory zones each, monitoring Inverter Running, Inverter on Bypass and Inverter General Trouble.
- 1.3.6. Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- 1.3.7. System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general and two-stage alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- 1.3.8. Zoned, non-coded single stage or two stage, as indicated.
- 1.3.9. Modular in design to allow for future expansion.

- 1.3.10. Operation of system shall not require personnel with special computer skills.
- 1.3.11. System to include:
- .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
  - .2 Data Gathering Panels/Transponders with stand-alone capabilities.
  - .3 Power supplies.
  - .4 Initiating/input circuits.
  - .5 Indication/output circuits.
  - .6 Auxiliary circuits.
  - .7 Wiring.
  - .8 Manual and automatic initiating devices.
  - .9 Audible and visual signalling devices.
  - .10 End-of-line resistors.
  - .11 Local and remote annunciators.
  - .12 Printer and event log memory chip.
  - .13 Historic event recorder.
  - .14 Isolation modules.
  - .15 Central alarm monitoring.
  - .16 Programmed features.
- 1.4. REQUIREMENTS OF REGULATORY AGENCIES
- 1.4.1. System components shall be listed by ULC/CSA and comply with applicable provisions of the building code, and meet requirements of local authority having jurisdiction.
- 1.5. SHOP DRAWINGS AND PRODUCT DATA
- 1.5.1. Submit Shop Drawings and product data in accordance with Section 26 05 04.00 – SUBMITTALS/SHOP DRAWINGS.
- 1.5.2. Include:
- .1 Detail assembly and internal wiring diagrams for control units and auxiliary cabinets.
  - .2 Overall system riser wiring diagram identifying control equipment, initiating zones, signaling circuits; and identifying terminations, terminal numbers, conductors and raceways.
  - .3 Details for devices.
  - .4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.
  - .5 Step-by-step operating sequence, cross referenced to logic flow diagram.
  - .6 Submit battery sizing calculations and battery selection.
- 1.6. OPERATION AND MAINTENANCE DATA
- 1.6.1. Provide operation and maintenance data for fire alarm system for incorporation into the O&M manual.

1.6.2. Include:

- .1 Instructions for complete fire alarm system to permit effective operation and maintenance.
- .2 Technical data - illustrated parts lists with parts catalogue numbers.
- .3 Copy of approved Shop Drawings with corrections completed and marks removed except review stamps.
- .4 List of recommended spare parts for system.
- .5 Detailed sequence of operation or operational matrix.
- .6 Full fire alarm verification inspection report.
- .7 USB stick, containing electronic version of fire alarm passive graphic both in PDF and CAD, as part of O&M manual.

1.7. MAINTENANCE MATERIALS

1.7.1. Include:

- .1 Spare glass rods for manual pull stations, if applicable.
- .2 Key for fire alarm panel, remote annunciator, and pull stations.
- .3 Specialty tool for resetting sprinkler supervisory, if applicable.
- .4 Spare fuses for control circuits.
- .5 Beam detector calibrated test filters (if applicable).

1.8. WARRANTY

- 1.8.1. Provide a one year warranty including all materials, parts, and labour. Be responsible for correcting any deficiencies that are discovered during the one year warranty period, including any that are discovered by the Owner's first annual inspection and test to CAN/ULC-S536.

1.9. TRAINING

- 1.9.1. Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

2. Product

2.1. MATERIALS

- 2.1.1. Equipment and devices: ULC listed, labelled and supplied by single manufacturer.
- 2.1.2. Power supply: to CAN/ULC-S524.
- 2.1.3. Audible signal devices: to ULC-S525.
- 2.1.4. Visual signal devices: to CAN/ULC-S526.
- 2.1.5. Control unit: to CAN/ULC-S527.
- 2.1.6. Manual pull stations: to CAN/ULC-S528.
- 2.1.7. Thermal detectors: to CAN/ULC-S530.
- 2.1.8. Smoke detectors: to CAN/ULC-S529.
- 2.1.9. Smoke alarms: to CAN/ULC-S531.
- 2.1.10. Signal Transmitting Units and Monitoring: to CAN/ULC-S559 and CAN/ULC-S561.

2.2. SYSTEM OPERATION: SINGLE STAGE SIGNALS ONLY

2.2.1. Actuation of any alarm initiating device to:

- .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
- .2 Indicate zone of alarm at central control unit and at the remote annunciator.
- .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
- .4 Transmit signal to fire department via central station.
- .5 Except for air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings, cause air conditioning and ventilation fans serving more than 1 storey or 1 suite in a storey to shut down.
  - .1 Air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings shall only shutdown upon activation of the duct smoke detector(s) associated with that specific mechanical unit. On general alarms activated by other initiating devices (i.e. sprinkler, pull station, smoke/heat detector, etc.), the air handling unit shall continue to operate in order to maintain corridor pressurization.
- .6 For high rise buildings, provide manual 'OFF' switches at the main fire alarm panel in the CACF to manually stop air moving fan units that serves more than 2 storeys.
- .7 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix.
- .8 Cause fire doors and smoke control doors, if normally held open, to close automatically.
- .9 Cause the release of all mag-lock devices on doors that are secured closed.

2.2.2. Emergency elevator recall:

- .1 Actuation of any alarm initiating devices in elevator lobbies, elevator machine room, elevator pit, or top of hoistway to cause elevators to return to primary recall floor, or to alternate recall floor, as required. Elevator recall shall not be activated upon alarms from manual pull stations or on general fire alarm condition.

2.2.3. Acknowledging alarm: indicated at central control unit.

2.2.4. Actuation of supervisory devices to:

- .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
- .2 Indicate respective supervisory zone at central control unit and at remote annunciator.
- .3 Cause audible signal at central control unit to sound.
- .4 Activate common supervisory sequence.

2.2.5. Resetting of alarm or supervisory device shall not return system indications/functions back to normal until control unit has been reset.

2.2.6. Trouble on system to:

- .1 Indicate circuit in trouble at central control unit.
- .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.

2.2.7. Trouble on system: suppressed during course of alarm.

2.2.8. Trouble condition on any circuit in system not to initiate alarm conditions.

- 2.3. SYSTEM OPERATION: TWO STAGE SIGNALS ONLY
- 2.3.1. Actuation of any alarm initiating device on first stage to:
- .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
  - .2 Indicate zone of alarm at central control unit and at the remote annunciator.
  - .3 For low rise buildings:
    - .1 Cause audible devices throughout building to sound at 20 strokes per minute.
  - .4 For high rise buildings:
    - .1 Cause audible signaling devices to sound continuously in ALARM tone on floor of alarm, floor above, and floor below, at 20 strokes per minute in ALERT tone on other floors of building.
  - .5 Transmit signal to fire department via central station.
  - .6 Except for air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings, cause air conditioning and ventilation fans serving more than 1 storey or 1 suite in a storey to shut down.
    - .1 Air handling systems providing make-up air to public corridors serving suites in Group C major occupancy High Buildings shall only shutdown upon activation of the duct smoke detector(s) associated with that specific mechanical unit. On general alarms activated by other initiating devices (i.e. sprinkler, pull station, smoke/heat detector, etc.), the air handling unit shall continue to operate in order to maintain corridor pressurization.
  - .7 For high rise buildings, provide manual 'OFF' switches at the main fire alarm panel in the CACF to manually stop air moving fan units that serves more than 2 storeys.
  - .8 Cause supply and/or exhaust fans to function automatically to provide required control of smoke movement per the mechanical smoke control matrix.
  - .9 Cause fire doors and smoke control doors, if normally held open, to close automatically.
  - .10 Cause the release of all mag-lock devices on doors that are secured closed.
- 2.3.2. Emergency elevator recall:
- .1 Actuation of any alarm initiating devices in elevator lobbies, elevator machine room, elevator pit, or top of hoistway to cause elevators to return to primary recall floor, or to alternate recall floor, as required. Elevator recall shall not be activated upon alarms from manual pull stations or on general fire alarm condition.
- 2.3.3. Actuation of any alarm initiating device on second stage to:
- .1 Cause audible signalling devices to sound in alarm tone throughout building.
- 2.3.4. If first stage alarm is not acknowledged within 5 min, system to automatically go into second stage.
- 2.3.5. Acknowledging alarm: indicated at central control unit.
- 2.3.6. Possible to silence signals by "alarm silence" switch at central control unit, after minimum 20 minutes period of operation.
- 2.3.7. Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- 2.3.8. Actuation of any supervisory device to:
- .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
  - .2 Indicate respective supervisory zone at central control unit and remote annunciator

- .3 Cause audible signal at central control unit to sound.
- .4 Activate common supervisory sequence.
- 2.3.9. Resetting alarm or supervisory device not to return system indications/functions back to normal until control unit is reset.
- 2.3.10. Trouble on system to:
  - .1 Indicate circuit in trouble at central control unit.
  - .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
- 2.3.11. Troubles on system: suppressed during course of alarm.
- 2.3.12. Trouble condition on any circuit in system not to initiate alarm conditions.
- 2.4. CONTROL PANEL
- 2.4.1. Central control unit (CCU):
  - .1 Suitable for Data Communication Link style C (DCL-C) unless otherwise noted on the drawings: to CAN/ULC-S524.
  - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
  - .3 Minimum capacity of 1000 addressable monitoring and 500 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
  - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
  - .5 Integral power supply, battery charger and standby batteries.
  - .6 Basic life safety software: retained in non-volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (e.g. zone labels, priorities) and changing of system operation software.
  - .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
  - .8 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Should communications fail between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
    - .1 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
  - .9 Support up to 4 RS-232-C I/O ports. CCU output: parallel ASCII with adjustable baud rates to allow interface of any commercially available printer, terminal or PC.
  - .10 Equipped with software routines to provide Event-Initiated-Programs (EIP); change in status of one or more monitor points, may be programmed to operate any or all of system's control points.

- .11 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .12 On-board, 20-column, DC strip printer, thermal head with automatic paper take-up, and silent operation; operational while system is operating on standby power. Expanded font available for selected printing conditions.
- .13 Printer to record activities on system controlled by EIA RS-232-C link from within CCU.
- .14 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.

## 2.5. DATA GATHERING PANELS (DGP'S) /TRANSPONDERS

- 2.5.1. Fire control modules: distributed throughout building complex in separately enclosed units (DGP'S) and interconnected to central control unit utilizing multiplex data transmission techniques.
- 2.5.2. Fire alarm integrated DGP's: microprocessor based, provide interface between standard alarm input/output devices and central control unit.
- 2.5.3. Each DGP: circuitry with ability to detect failure in communication with CCU resulting from faults in communication wiring. In event of loss of communication with CCU, DGP capable of operating in stand-alone mode. In this mode, DGP capable of reacting to connected input devices, and apply stand-alone programming to determine state of connected outputs. Stand-alone programming instructions: independent of, but capable of executing same type of algorithms as that of CCU.
- 2.5.4. Each DGP: self-contained unit, with integral power supply, battery charger and standby batteries. Short circuit, over voltage, and brown-out monitoring to protect powered components by automatically switching to standby batteries whenever trouble condition exists in power supply.
- 2.5.5. Addressable DGP's:
  - .1 DGP's are to be of the addressable type which provide two-way data communication with up to 128 addressable devices/interface modules, utilizing digital poll/response protocol communication format. Each addressable device: uniquely identified by own address, set at time of installation.
  - .2 Addressable DGP's must have stand-alone operating capability.
  - .3 Interface modules: facilitate connection of non-addressable devices (e.g. flow switch) to addressable DGP; provided in different types for connection to monitoring devices (e.g. flow/tamper switch), signalling devices (e.g. bells, horns), and control functions (e.g. fan shutdown, door release); communicate with addressable DGP over minimum number of wires (specified by manufacturer).
  - .4 Possible to connect all 3 types of addressable interface modules (monitoring, signal and control) to same addressable communication loop.
  - .5 Possible to connect variable-sensitivity addressable smoke detectors together with other addressable devices to same addressable communication loop.

## 2.6. POWER SUPPLIES

- 2.6.1. 120V, 60 Hz as primary source of power for system. The circuit shall be labelled at the main power distribution panel as FIRE ALARM. The fire alarm disconnect must be locked, a locked electrical room or panel door does not constitute the lock for the disconnect.
- 2.6.2. Voltage regulated, current limited distributed system power.
- 2.6.3. Primary power failure or power loss (less than 102 V) will activate common trouble sequence.

- 2.6.4. Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- 2.6.5. Abnormal operating conditions such as a fault in battery charging circuit, short or open in the battery leads, shall activate a common trouble sequence and standby power trouble indicator.
- 2.6.6. Standby batteries: 5 year NiCad sealed, maintenance free.
- 2.6.7. Continuous supervision of wiring for external initiating and alarm circuits are to be maintained for 24 hrs with capability of maintaining alarm activation for a minimum of 2 hrs, immediately following 24 hrs of supervision.
  
- 2.7. INITIATING/INPUT CIRCUITS
  - 2.7.1. Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCL-C, as per CAN/ULC-S524, configuration to central control unit or DGP's/transponders.
  - 2.7.2. Alarm receiving circuits (active and spare) are to be compatible with smoke detectors and open contact devices.
  - 2.7.3. Actuation of alarm initiating device is to cause system to operate as specified in "System Operation".
  - 2.7.4. Receiving circuits for supervisory devices are to be wired in DCL-A configuration to central control unit or DGP's/transponders.
  - 2.7.5. Actuation of supervisory initiating device is to cause the system to operate as specified in "System Operation".
  - 2.7.6. Sprinkler devices such as pressure switches and flow switches are to have the tamper switch wired after the switch and before the EOL, to create a trouble condition while still allowing the device to electrically initiate its respective zone.
  - 2.7.7. Low room temperature devices are to be provided in sprinkler rooms whenever a dry sprinkler system is provided.
  
- 2.8. ALARM OUTPUT CIRCUITS
  - 2.8.1. Alarm output circuits are to be connected to signals, wired in class B configuration to the central control unit or DGP's/transponders.
  - 2.8.2. The signal circuits' operation is to be capable of sounding bells, horns as required. Each signal circuit: rated at 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
  - 2.8.3. Manual alarm silence, automatic alarm silence and alarm silence inhibit is to be provided by system's common control.
  - 2.8.4. Separate circuits shall be provided for audible signal devices on each floor area.
  - 2.8.5. Audible signal devices within dwelling units or suites of residential occupancy shall be wired on separate signal circuits from those not within suites of residential occupancy or dwelling units.
  - 2.8.6. Provide 25% spare capacity in visual signal device circuits to allow for site adjustments of visual signal device candela ratings.
  
- 2.9. AUXILIARY CIRCUITS
  - 2.9.1. Auxiliary contacts for control functions.
  - 2.9.2. Actual status indication (positive feedback) from controlled device.

- 2.9.3. Alarm or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
- 2.9.4. Five sets of separate contacts for elevator fire alarm recall, for each elevator or bank of elevators sharing a common shaft and common fire detectors:
- .1 Elevator recall to primary floor, from elevator lobby smoke detectors on all floors except primary recall floor.
  - .2 Elevator top of shaft detection signal to elevator controller.
  - .3 Elevator pit detection signal to elevator controller.
  - .4 Elevator machine room detector signal to elevator controller.
  - .5 Elevator recall to alternate floor, from elevator lobby smoke detector(s) at primary recall floor.
- 2.9.5. Upon resetting system, auxiliary contacts are to return to normal or to operate as pre-programmed.
- 2.9.6. Fans: stagger-started upon system reset; timing circuit to separate starting of each fan or set of fans connected to auxiliary contact on system. Timing circuit: controlled by CCU.
- 2.9.7. Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.
- 2.10. WIRING
- 2.10.1. All fire alarm system wiring must be new.
- 2.10.2. Twisted copper conductors: 300 V CSA FAS minimum 105°C with FT4 rating and in mechanical protection i.e. EMT or flex as specified under Section 26 05 34.00 - CONDUITS, CONDUIT FASTENERS AND FITTINGS.
- 2.10.3. To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
- 2.10.4. To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
- 2.10.5. To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
- 2.10.6. All initiating circuits are to be wired in a DCL-C (i.e. Class A) configuration.
- 2.10.7. All output circuits are to be wired in a Class B configuration, unless otherwise shown on drawings.
- 2.10.8. All wiring between junction boxes and water flow switch, pressure switch, or supervisory switches will be in liquid tight flexible conduit.
- 2.10.9. Where a fire alarm transponder or annunciator located in one fire compartment is connected to a central processing unit or another transponder or annunciator located in a different fire compartment, the data communication link conductors connecting them shall be fire rated for at minimum one (1) hour. Where fire alarm system branch circuits connect transponders and individual fire alarm devices located on another storey, the branch circuits shall be fire rated for at minimum one (1) hour between the transponder and the first fire alarm device located on another storey than the transponder. Provide twisted, shielded pair Mineral-Insulated fire rated cables configured to eliminate interference and cross-talk, except where fire alarm riser diagram clearly illustrates another fire rating approach for particular conductors.
- 2.11. MANUAL ALARM STATIONS
- 2.11.1. Addressable manual pull station.
- .1 Pull lever, break glass rod, semi-flush wall mounted type, single stage, or 2 stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

- .2 Provide two pole for direct disconnect of magnetic locking devices local to the devices.

## 2.12. AUTOMATIC ALARM INITIATING DEVICES

- 2.12.1. Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 deg. C., rate of rise 8.3 deg. C. per minute:

- .1 Electronics to communicate detector's status to addressable module/transponder.
- .2 Detector address to be programmed on site.

- 2.12.2. Addressable Smoke detector: photo electric:

- .1 Twistlock plug-in type with fixed base.
- .2 Wire-in base assembly with integral red alarm LED.
- .3 Auxiliary output contact.

- 2.12.3. Addressable Duct type smoke detectors: photo-electric with sampling tubes:

- .1 Twistlock plug-in type with fixed base.
- .2 Wire-in base assembly with integral red alarm LED.
- .3 Auxiliary output contact.
- .4 Properly sized air sampling tubes.

- 2.12.4. Addressable Beam type detectors: long range and short range:

- .1 Complete with transmitter and receiver.
- .2 Short range operating distance of 9-30 meters.
- .3 Long range operating distance of 30-100 meters.
- .4 Operating temperatures shall be of -5 to 55 deg. C.
- .5 The beam detector shall feature alignment LEDs on both the receiver and the transmitter and automatic gain control.
- .6 Beam detector calibrated test filters, if applicable.

- 2.12.5. Addressable variable-sensitivity smoke detectors:

- .1 Photo-electric type.
- .2 Electronics to communicate detector's status to addressable module/transponder.
- .3 Detector address to be set on detector head in field.
- .4 Sensitivity settings: 3 settings determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
- .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.
- .6 Auxiliary output contact.

- 2.12.6. Water flow switches: lever and pressure type:

- .1 Shall have a mechanical alarm transmitted delay adjustable from 0-60 seconds. Initial settings shall be 30-45 seconds. Times will be recorded and submitted to Engineer's Representative.
- .2 The tamper switch located within the water flow switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.

- 2.12.7. Sprinkler and standpipe valve supervisory switches:

- .1 The tamper switch located within the supervisory switch shall be wired as per manufacturer's recommendations such that if the housing is open a latching trouble will be initiated.
- 2.12.8. Smoke alarms: ionization and photo electric.
- .1 Twistlock plug-in type with fixed base.
  - .2 Wire-in base assembly with integral red and green LEDs for alarm/normal status.
  - .3 Silence button to silence nuisance alarms.
  - .4 Test button to verify circuitry and alarm operation.
  - .5 Electrical Rating: 120VAC, 60Hz and Battery Backup
    - .1 Battery capacity to provide power for minimum 7 days in normal condition, followed by 4 minutes of alarm.
  - .6 Visual signal device light with the following performance requirements:
    - .1 The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.
    - .2 Maximum pulse duration in accordance with NFPA 72 "National Fire Alarm and Signaling Code."
    - .3 Shall be clear or nominal white and shall be minimum 175 cd but not exceed 1000 cd (effective intensity).
    - .4 The visual signal device light shall be synchronized where multiple smoke alarm visual signal devices are installed within the same area and/or viewpoint.
- 2.12.9. Combination Smoke/Carbon Monoxide alarms:
- .1 Smoke Detection: ionization.
  - .2 Twistlock plug-in type with fixed base.
  - .3 Wire-in base assembly with integral red and green LEDs for alarm/normal status.
  - .4 Silence button to silence nuisance alarms.
  - .5 Test button to verify circuitry and alarm operation.
  - .6 Electrical Rating: 120 VAC, 60 Hz and Battery Backup
    - .1 Battery capacity to provide power for minimum 7 days in normal condition, followed by 4 minutes of alarm.
  - .7 Visual signal device with the following performance requirements:
    - .1 The flash rate shall not exceed two flashes per second (2 Hz) nor be less than one flash every second (1 Hz) throughout the listed voltage range of the appliance.
    - .2 Maximum pulse duration in accordance with NFPA 72 "National Fire Alarm and Signaling Code."
    - .3 Shall be clear or nominal white and shall be minimum 175 cd but not exceed 1000 cd (effective intensity).
    - .4 The visual signal device shall be synchronized where multiple smoke alarm visual signal devices are installed within the same area and/or viewpoint.
- 2.13. AUDIBLE SIGNAL DEVICES
- 2.13.1. Bells: flush or surface mounted, as indicated, single stroke, polarized, 24 V dc, 150 mm or 250 mm, as indicated.

- .1 Vibrating type, gongs of special alloy steel, 24 V dc, 150 mm or 250 mm, as indicated.
- 2.13.2. Signal chimes: heavy duty, single stroke, 24 V dc, with solid striking plunger and resonating chamber.
- 2.13.3. Horns: 24 V dc, indoor horn type with compression driver, surface mounted.
  - .1 Corrosion, vibration and vermin resistant.
  - .2 Taps: multiple, adjustable with maximum tap output sound level of 100 db at 3 m.
  - .3 Frequency response: 400 to 4000 Hz.
- 2.13.4. Weatherproof Horns: 24 V dc, for use primarily in mechanical equipment areas, both indoor and outdoor. Horn type with compression driver, surface mounted.
  - .1 Corrosion, vibration and vermin resistant.
  - .2 Frequency response: 400 to 4000 Hz.
  - .3 Complete with weatherproof box as recommended by manufacturer.
  - .4 High output 40 mA @ 24 Vdc, Low output 20 mA @ 24 Vdc.
- 2.13.5. Residential, In-Suite, Mini-Horns: 24 V dc, horn type.
  - .1 Complete with signal silence feature, including integral push button or touch to silence, and LED that indicates active signal circuit when lit. Provide signal silence feature that silences mini-horn for a period of not more than 10 minutes.
  - .2 Mountable within a single-gang backbox.
  - .3 Capable of continuous and temporal tones.
- 2.14. VISUAL ALARM SIGNAL DEVICES
- 2.14.1. Visual signal device type: white flashing light, wall mount or ceiling mounted as per drawings.
  - .1 Synchronized at one flash per second.
  - .2 Flash tube enclosure in clear LEXAN.
  - .3 "FIRE" installed red letters.
  - .4 Operating on 20-24 V dc.
  - .5 Field adjustable for 15 cd, 30 cd, 75 cd, 95 cd, 110 cd, and 115 cd, unless specified otherwise.
- 2.14.2. Fire do not enter signs and their accessories:
  - .1 Compliant with CAN/ULC-S527 "Standard for Control Units for Fire Alarm Systems" and/or CAN/ULC S526 "Standard for Visual Signal Devices for Fire Alarm and Signaling Systems, Including Accessories."
  - .2 Powered by fire alarm system; operating on 24 V dc.
  - .3 Fire alarm signaling device.
- 2.15. COMBINATION AUDIBLE AND VISUAL SIGNAL DEVICES
- 2.15.1. Combination Horn Strobes, complying with the requirements noted above for: Audible Signal Devices and Visual Alarm Signal Devices.

2.16. END-OF-LINE DEVICES

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

2.17. REMOTE ANNUNCIATORS

2.17.1. LED type, with designation cards to indicate zones.

2.17.2. Display:

- .1 Alarms for alarm initiating circuits.
- .2 Common supervisory alarm for supervisory initiating circuits.
- .3 Common system trouble.

2.17.3. Trouble buzzer:

- .1 Acknowledging trouble at main panel to silence trouble buzzers in system.

2.17.4. Supervised, with LED test button.

2.17.5. Interconnected with main fire alarm panel at minimum.

2.18. REMOTE PRINTER

2.18.1. System printer: to give a hard copy record of system events c/w following features:

- .1 120V ac, 60 Hz.
- .2 80 columns.
- .3 160 cps.
- .4 Utilizes fan fold paper.
- .5 Connected to RS-232 output at central control panel.

2.19. ISOLATION MODULE

2.19.1. Provide isolation modules in accordance with CAN-ULC-S524.

- .1 Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an DCL-C branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL segment branch.
- .2 If a wire-to-wire short occurs, the isolator module shall automatically disconnect the DCL-C segment. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- .3 The isolation module will provide a single LED that flashes to indicate the isolation module is operating and illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.20. CENTRAL ALARM MONITORING

2.20.1. Provide Signal Transmitting Unit that utilizes internet connection as primary communications method and cellular network as secondary (back-up) communications method.

- .1 Provide remote antenna for cellular network reception for Signal Transmitting Unit, if location of Signal Transmitting Unit in the building does not facilitate adequate cellular network strength.

2.20.2. Provide a demarcation point; refer to CAN-ULC-S524 Annex E.

- 2.20.3. Provide monitoring of the system including alarm zones, supervisory zones, and trouble signals.
- 2.21. PROGRAMMED FEATURES:
- 2.21.1. By-pass feature for signalling devices:
- .1 Bypassing of audible devices shall be provided through the programmable keys. The use of the feature is intended for personnel with programming access.
- 2.21.2. Evacuation feature.
- .1 Evacuation key will be programmed and accessible for any personnel working on the fire alarm panel.
- 2.22. REMOTE TERMINAL
- 2.22.1. CRT screen: 120 V, 60 Hz, to incorporate 100% solid state circuitry, with 30 cm screen and front mounted controls for brightness, contrast, vertical and horizontal hold and power ON/OFF switch.
- 2.23. FIRE ALARM ZONE PASSIVE GRAPHIC DISPLAY:
- 2.23.1. Layout
- .1 The fire alarm zone passive graphic display shall be completed in the latest version of AutoCAD. The drawing shall indicate all the building floor plans and respective fire alarm zones with the description corresponding to the zone indication at the fire alarm control panel and annunciator.
  - .2 The fire alarm zones indicated for each floor shall be clearly defined with borders to indicate zone separation.
  - .3 The general font style shall be Helvetica upper case. Text size:
    - .1 6 mm in height for building name and 4.5 mm for municipal address and floor plans all coloured green.
    - .2 Main entrance arrow and text shall be Romans forward slant style 3 mm in height coloured cyan.
    - .3 Fire alarm zones and equipment notes shall be 3 mm in height coloured red.
    - .4 Fire hose cabinets shall be Romans forward slant style 3 mm in height coloured cyan.
  - .4 Graphic display colours.
    - .1 Outline of building plan to be black line on white background.
    - .2 All egress corridors shall be clearly defined with Red colour #13 solid hatch pattern.
    - .3 All stairs and elevators shall be indicated using yellow solid hatch pattern.
  - .5 Include the following information on the graphic display:
    - .1 A north arrow on the upper left corner of the zone graphic.
    - .2 "You are here" location in Red and properly orientated to the viewer when standing in front of the graphic.
    - .3 A drawing scale graph and drawing file number located in the lower right of the zone graphic.
    - .4 Building name and number at the bottom centre of the graphic display with municipal address indicated on the next line below.

- .5 The main building entrance and street reference.
- .6 Location of fire alarm control panel and annunciators, fire department connections, fire pumps, fire hose cabinets and associated standpipe and sprinkler valves.
- .7 Location of main gas valve, suppression systems, chemical storage vaults, major mechanical equipment and duct smoke detectors indicating zone number.
- .8 Substation and transformer locations indicating primary and secondary voltages.

2.23.2. Construction

- .1 The graphic display shall be:
  - .1 Printed on white heavy weight 40lb. coated bond with colour UV inks, laminated on 1.5 mm styrene board and covered with clear Lexan.
  - .2 Standard passive graphic display size ranges from 8.5"x11" to 23"x35". The final size of the graphic may vary depending on the layout requirements and site conditions.
- .2 Trim to be No. 4 stainless steel finish.

2.23.3. Location

- .1 Install graphic display adjacent to each fire alarm annunciator panel and the fire alarm control panel.
- .2 Graphic display to be fixed to the building structure or fire alarm control panel enclosure using tamper proof screws at each corner and at the midpoint on all four sides.

2.23.4. Approval Drawings

- .1 Submit three full colour print copies of the passive display graphic for review by the Owner, the Engineer's Representative and the local fire department.
- .2 Include the final approved zone graphic drawing in electronic format with the as-built drawings.

2.24. ANCILLARY DEVICES

- 2.24.1. Remote relay unit to initiate fan shutdown, magnetic door locks and door hold open devices.

2.25. STI STEEL WEB STOPPERS, DETECTOR COVERS.

- 2.25.1. Provide STI 9600 series detector cover for areas where sporting events or similar activities avail. STI STOPPER 2 & WEATHER PROOF STOPPER 2, COVERS FOR MANUAL STATIONS.

- 2.26.1. Provide STI Stopper 2 1100 series manual station covers for all vandal resistant locations identified on the electrical and architectural drawings.

- 2.26.2. Provide Weather Proof Stopper 2 1200 (flush mount) or 3100 (surface mount) series manual station covers for all weather proof locations and outdoor applications identified on the electrical and architectural drawings.

2.27. RELAY BASE, FOR FIRE DETECTORS.

- 2.27.1. Provide power along with the relay base detector such that the device that is being controlled with the normally open or normally closed relay base may operate or function. Power requirements and relay condition to be determined on site.

## 2.28. MANUFACTURERS

2.28.1. The following are acceptable manufacturers:

- .1 Chubb Edwards.
- .2 Simplex.
- .3 Mircom.
- .4 Siemens.
- .5 Notifier.

## 3. Execution

### 3.1. INSTALLATION

3.1.1. Install systems in accordance with CAN/ULC-S524.

3.1.2. Install central control unit and connect to ac power supply.

3.1.3. Install manual alarm stations and connect to alarm circuit wiring.

3.1.4. Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts. Install duct type detectors complete with sampling tubes. Ensure duct type smoke detectors are installed far enough away from humidifiers to avoid false alarms; coordinate location of duct type smoke detector with Mechanical Contractor. If false alarms occur, relocate duct type smoke detector at no cost to the Owner.

3.1.5. Connect alarm circuits to main control panel.

3.1.6. Install bells, horns and visual signal devices and connect to signalling circuits.

3.1.7. Connect signalling circuits to main control panel.

3.1.8. Adjust visual signal device candela ratings upward, where required to meet coverage. Utilize spare visual signal device circuit capacity required in Part 2.

3.1.9. Install end-of-line devices.

3.1.10. Install remote annunciator panels and connect to annunciator circuit wiring.

3.1.11. Install door releasing devices.

3.1.12. Install remote relay units to control fan shut down.

3.1.13. Where smoke dampers or combination smoke and fire dampers are shown, terminate damper position monitoring wiring for both fire alarm system and building automation system on damper actuator position end switches. Building automation system wiring to damper location will be provided by Mechanical Division.

3.1.14. Sprinkler system: wire alarm and supervisory switches and connect to control panel.

- .1 Sprinkler devices should be wired such that opening of a device will cause a trouble on an alarming device or a supervisory on a supervising device.
- .2 Where mechanical/sprinkler contractor makes revisions to the base design, electrical contractor shall coordinate any revisions to fire protection system directly with the mechanical/sprinkler contractor at no cost to the owner and update as-built drawings accordingly.

3.1.15. Room detection system (where applicable):

- .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
  - .2 Locate and install audible signals and visual alarms.
  - .3 Locate and install detectors under raised floor. Fasten to steel brackets approximately 300 mm above sub-floor level to clear cables and conduits.
- 3.1.16. Connect fire suppression systems to control panel.
- 3.1.17. 'T-Tapping' is not permitted.
- 3.1.18. For audible and visual signal devices in spaces subject to future tenant renovations, install devices in surface mounted boxes and leave 3 m of extra wiring coiled up in the box to allow the devices to be lowered / relocated to suit the tenant fit up ceiling and wall locations.
- 3.1.19. Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- 3.1.20. Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- 3.1.21. Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.
- 3.1.22. Install smoke and smoke/CO alarm in accordance with CAN/ULC-S553.
- .1 Where more than one smoke (or smoke/CO) alarm is installed within a dwelling unit, interconnect the wiring such that actuation of one smoke (or smoke/CO) alarm will cause all the smoke (or smoke/CO) alarms within the dwelling unit to sound.
- 3.1.23. Where devices are to be installed in environments where the temperature can drop below 0°C (or below the addressable device temperature rating), an appropriately rated conventional device is to be installed.
- .1 Provide and install an addressable input module remotely located in a conditioned environment suitable for the device temperature rating.
  - .2 Connect the conventional device(s) to addressable input module(s) as necessary to monitor the status of the conventional device.
  - .3
- 3.1.24. Where shown on Drawings, install "Fire do not enter signs" in accordance with the requirements of CAN/ULC-S524.
- 3.2. FIELD QUALITY CONTROL AND COMMISSIONING
- 3.2.1. Perform tests and verification in accordance with Section 26 08 01.00 - TECHNICAL SERVICES DIVISION STARTUP SERVICE.
- 3.2.2. The installing contractor is responsible for hiring and coordinating with the manufacturer to perform the following:
- .1 Testing of system to CAN/ULC-S536 prior to performing verification.
  - .2 Partial verification inspection to CAN/ULC-S537 and reports as required for partial occupancy.
  - .3 Complete an entire building test to CAN/ULC-S536 and provide detailed report. Provide a full verification inspection and test report at the end of the project. Cumulative partial verification reports do not constitute a full verification.
- 3.2.3. All fire alarm test and verification reports are to be submitted with a covering letter from the manufacturer clearly stating that there are no deficiencies with the installation prior to releasing the respective area for occupancy.

### 3.3. LIFE SAFETY INTEGRATION TESTING

- 3.3.1. The fire alarm contractor and fire alarm manufacturer shall participate in the coordination and testing work associated with the Integrated Testing Plan (ITP), as described in more detail in Section 26 05 01.00 – GENERAL INSTRUCTIONS FOR ELECTRICAL SECTIONS. All work shall be coordinated with the Integrated Testing Coordinator (ITC). The work shall include but not be limited to:
- .1 Perform functional testing of the integration of all life safety and fire protection systems as a whole to ensure the proper operation and interconnection between the systems.
  - .2 Testing of the integrated life safety systems must be done as a complete installed assembly; individual component testing or partially installed assembly testing is not acceptable.
  - .3 Follow the testing methodology for verifying and documentation of operation as outlined in the ITP and in accordance with CAN/ULC-S1001.
  - .4 Provide fire alarm verification report along with all other documentation requested by the ITC as it relates to the electrical systems in conformance with CAN/ULC-S1001.

### 3.4. CENTRAL ALARM MONITORING

- 3.4.1. Locate Signal Transmitting Unit in same room as main fire alarm panel or in CACF room, unless shown otherwise on Drawings.
- 3.4.2. Provide a data connection from the Owner's network for internet access for central monitoring.
- 3.4.3. Coordinate with the Owner's Fire Alarm Monitoring Company and install power, conduit and wiring to the Signal Transmitting Unit in compliance with CAN/ULC-S559 and CAN/ULC S561.
- 3.4.4. Facilitate conversation between Owner and Owner's preferred fire alarm central alarm monitoring service to ensure that central monitoring service is provided in time for completion of fire alarm scope and Project occupancy.

END OF SECTION

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END OF SECTION

27 00 05.10 General Instructions for Telecommunications Sections

1. General

1.1. OVERVIEW

- 1.1.1. Conform to the requirements of Divisions 0 and 1, which apply to and form part of all sections of the work.
- 1.1.2. In the event of a conflict between Divisions 0 or Division 1 sections and information contained in Sections 27 00 05.10 - GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS, 27 00 05.60 – ADMINISTRATIVE REQUIREMENTS, and 27 00 05.70 – PROJECT SPECIFIC REQUIREMENTS of this document, the more stringent, onerous, and/or costly requirement shall apply.
- 1.1.3. Read and comply with all sections of this document.
- 1.1.4. Provide all labour, materials, tools, and equipment required for the complete scope of the Work specified in all sections of the Contract Documents.

1.2. SECTIONS AFFECTED

- 1.2.1. These instructions apply to and form a part of all Telecommunications Sections.

1.3. INTENT

- 1.3.1. The Specifications are an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.
- 1.3.2. Be completely responsible for the acceptable condition and operation of all systems, equipment, and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment, and repair related damages. The replacement of equipment and repair to damages shall be coordinated with other trades completed in a timely fashion so as not to affect the complete construction of the Telecommunications Systems and/or work by others.

1.4. WORK INCLUDED

- 1.4.1. Provide a new Telecommunications Structured Cabling system for the area included in the scope of this Contract. The Structured Cabling Systems shall be as follows:
  - .1 Reuse existing cabling and equipment where indicated on the Drawings.
  - .2 Horizontal Structured Cabling System consisting of 4-pair Copper Cabling for data applications.
- 1.4.2. All horizontal cabling shall be serviced from the nearest logical Telecommunications Room, either existing or new as shown on floor plans.
- 1.4.3. The Telecommunications Structured Cabling system is based on a physical star wiring topology (unless otherwise specified) that is designed in accordance with and supported by a manufacturer backed certification and warranty as specified herein. This cabling infrastructure solution shall encompass, and not be limited to, all telecommunication outlets, cable, cable terminating hardware, equipment cabinets/racks, and selected connectivity devices.

- 1.4.4. Provide CMP (FT6) rated components of the Telecommunications Cabling System that is to be located within spaces deemed a Return Air Plenum. CMR (FT4) rated components may be used in spaces upon approval by all Authorities Having Jurisdiction (AHJ) and/or the Telecommunications Engineer's Representative. For this project, all components shall have a CMP (FT6) rating unless otherwise specified in this document. All CMP (FT6) rated products must be CSA/ULC.
- 1.4.5. While every attempt has been made to ensure all information is correct at the time of publication, the products specified are available and that any part numbers identified are correct, it is the responsibility of the Telecommunications Contractor to verify all part numbers and to report any errors and/or omissions in the Drawings and/or Specification during the procurement process.
- 1.4.6. Dimensions shown on Drawings are approximate. Verify dimensions by reference to Shop Drawings and field measurements.
- 1.4.7. Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- 1.4.8. Include all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, bonding, taxes, and all necessary and related items required to provide complete and operational systems shown and described.
- 1.5. BIDDER INQUIRIES
- 1.5.1. Bidders who find discrepancies or omissions in this RFQ, or who have any doubt as to the technical meaning or intent of any part of this RFQ, shall direct their questions or other inquiries in writing to the Telecommunication's Engineer's Representative as defined in Section 27 00 05.20 – DEFINITIONS AND ABBREVIATIONS
- 1.5.2. In fairness to all bidders, all questions will be answered and distributed to all. Oral questions will not be answered. No questions will be answered within 48 hours of the closing date / hour of the bid. Refer to Division 0 for question period close time and date.
- 1.6. TENDER FORMS AND SUBMISSION OF TENDERS
- 1.6.1. Submit all information called for on the Telecommunications Tender and Supplementary Tender Forms. Tenders not completed in full may, at the discretion of the Owner, be rejected.
- 1.6.2. Show separate, identified, alternate and unit prices for optional components or items called for as additions to or deductions from the Tender amount.
- 1.6.3. The Owner reserves the right to accept or reject any substitution without question.
- 1.6.4. Include incidental fees and other fees for items required to successfully install the Structured Cabling Solution that may or may not be indicated in this document. Meet all requirements of this document and all telecommunications (and related) standards, municipal, local, Provincial and Federal building, safety, fire and electrical codes.
- 1.7. HOLDBACK
- 1.7.1. The value for testing and documentation (cable test results and as-builts), for payment purposes, shall be set at 10% of the base contract or \$5,000; whichever is greater. This amount will be withheld from the Telecommunications Contractor until testing and correction of deficiencies is 100% complete.

1.8. SCHEDULE

- 1.8.1. By submitting a response to this document and associated Drawings, the Telecommunications Contractor agrees to meet and adhere to all project milestones as indicated in the project schedule(s).
- 1.8.2. Acknowledge that project schedule(s) are subject to change. Verify all project milestones with the Telecommunications Engineer's Representative and/or General Contractor.

1.9. LABOUR

- 1.9.1. Comply with all job-site requirements for the duration of the project.
- 1.9.2. Do not assign or sub-contract any Work without the prior written consent of the Telecommunications Engineer's Representative. In the event of sub-contractor approval, submit a complete list of sub-contractors during the procurement process.
- 1.9.3. Use only workers who are fully trained, qualified, and experienced on the installation, termination, and testing of the Structured Cabling Solution.
- 1.9.4. Third party certification will not be permitted unless the certifying contractor performs the termination and testing for all cabling. If third party certification is necessary, the Telecommunications Contractor shall obtain the consent of the Telecommunications Engineer's Representative prior to submitting a bid response.
- 1.9.5. Make any changes or alterations required by an authorized inspector of the authority having jurisdiction.
- 1.9.6. Obtain consent from the Telecommunications Engineer's Representative before changing the Project Manager and/or Site Supervisor during the Project.

1.10. ACCESS AND PROTECTION

- 1.10.1. Access to the Site shall be limited to location and time of day. Refer to Section 27 00 05.70 – PROJECT SPECIFIC REQUIREMENTS and conform to requirements.
- 1.10.2. Refer to the security and protection requirements in the General Conditions and conform to all requirements.

1.11. DRAWINGS, CHANGES AND INSTALLATION

- 1.11.1. The Drawings are intended to show the general character and scope of the Work and not the exact details of the Work. Complete the Work with all accessories required for a complete and operative installation.
- 1.11.2. The location, arrangement, and connection of equipment and material as shown on the Drawings represent a close approximation to the intent and requirements of the contract. The Telecommunications Engineer's Representative reserves the right to make reasonable changes required to accommodate conditions arising during the progress of the Work, at no extra cost to the Owner.
- 1.11.3. Certain details indicated on the Drawings are general in nature and specific labelled detail references to each occurrence of use is not indicated, however, such details shall be applicable to every occurrence on the Drawings.
- 1.11.4. The location and size of existing services shown on the Drawings are based on the best available information. Verify the actual location of existing services in the field before Work is commenced.
- 1.11.5. Make changes and modifications necessary to ensure co-ordination and to avoid interference and/or conflicts with other trades, or to accommodate existing conditions, at no extra cost to the Owner.

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- 1.11.6. Leave areas clear where space is indicated as reserved for future equipment, and equipment for other trades. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.11.7. Where equipment is shown to be 'roughed in only', obtain accurate information from the Telecommunications Engineer's Representative before proceeding with the Work.
- 1.11.8. Location of outlets, luminaires, diffusers, grilles, registers, thermostats, sprinklers, and all other equipment shown on Drawings (if shown) is diagrammatic.
- 1.11.9. Remedy any Work not installed in correct location (at the sole discretion of the Telecommunications Engineer's Representative). The Telecommunications Contractor is responsible to mark-out their Work and fully co-ordinate with all other trades. Review the Work with Telecommunications Engineer's Representative prior to rough in.
- 1.12. APPROVED EQUAL
- 1.12.1. Wherever the term "approved equal", "approved equivalent", or another variation is used herein, it is to be understood that reference to the specified trade name, brand name, manufacturer's name, model number, and catalog number has been made solely to indicate the minimum standard of quality required in material, workmanship, and service. Any proposed alternate shall be submitted for review and acceptance before procurement and installation. The review and acceptance shall be at the sole discretion of the Owner and the Telecommunications Engineer's Representatives.
- 1.13. CONFLICTING REQUIREMENTS
- 1.13.1. In the case of conflict or discrepancy in the requirements indicated in the contract documents the more stringent, onerous, and/or costly requirement shall apply.
- 1.14. EQUIPMENT AND MATERIALS MINIMUM REQUIREMENTS
- 1.14.1. Materials and equipment provided under this Division shall be new and free from defects.
- 1.14.2. All equipment and material for which there is a listing service shall bear a ULC and/or CSA label.
- 1.14.3. Equipment shall meet all applicable FCC/CRTC Regulations.
- 1.14.4. Materials shall have a flame spread in accordance with local Authorities Having Jurisdiction, and in accordance with the Specifications of this project.
- 1.15. DOCUMENT FORMAT
- 1.15.1. This document has been constructed based on a 3-part specification for Division 27. The first part 'General' describes general information pertaining to the section. The second part 'Product' describes the products that shall be provided for the project. The third part 'Execution' details the requirements for the installation of the specified products. Reference sections 1 and 3 for the relevant General information and Execution requirements of products that are listed in section 2.
- 1.16. STATEMENT OF PRICES
- 1.16.1. Submit a statement of their estimated prices for the various portions of the Work including both labour and materials to form a basis of progress payments. The total price of all portions of the Work shall equal the total price of the Work covered under the Telecommunications Division.

1.17. VALUATION OF CHANGES

- 1.17.1. 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 Telecommunications Engineer's Representative otherwise determines that the method shall be unit prices set out in the Contract.
- 1.17.2. Provide the Telecommunications 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.
- 1.17.3. 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.
- 1.17.4. The following shall not be included in the cost of the Work but are covered by the hourly rate:
- .1 The Contractor's payroll, administrative, head office and site office expenses, including stationary, postage and other office supplies.
  - .2 The costs of the Telecommunications Contractor's Project Manager, clerical and administrative personnel, and executive personnel.
  - .3 Use of temporary offices, sheds, small / hand tools, storage, site office consumables, etc., including but not limited to 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, all government payroll burdens, variable labour factors and union or association funds.
  - .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 the Contractor's and Subcontractors use in the Work. Telecommunications Engineer's Representative will provide one PDF copy of change notice documentation.
  - .8 The cost of preparing As-Built drawings, layout drawings, working drawings and Shop Drawings. This includes any and all AutoCAD / BIM (or other method) costs related to interference drawings or other associated drawings that may be required as part of the changes.
  - .9 The cost of cleanup and disposal of waste material.
  - .10 Parking, travel, coffee breaks, rest periods, warranties, safety training, WHMIS and health and safety committee, and non-productive time.
  - .11 Rentals, additional bonding, project financing.
- 1.17.5. 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 CCDC 2-[latest version] GC 6.2.

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- 1.17.6. 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.
- 1.17.7. Charge special equipment rental rates at cost. Submit the invoice for special equipment rental with the cost of the Work.
- 1.17.8. The maximum percentage fee for mark-ups shall be as stated in the Division 0/1 specifications or the Contract Supplementary Conditions.
- 1.17.9. 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.
- 1.17.10. Labour Rate:
- .1 For the duration of the contract, extra Work hourly labour units are to be based on the latest edition of the National Electrical Contractors Association (NECA) labour unit's column 1 (one). No additional factors will be accepted.
  - .2 The hourly labour rate for all changes will be based on a Journeyperson rate as listed on the Supplementary Bid Form. The Owner and/or Telecommunications Engineer's Representative reserve the right to renegotiate the labour rate. The hourly labour rate will be inclusive of overhead, mark-up, and profit. The labour rate will be inclusive of all labour burden charges as stated in this 'Valuation of Changes' section above.
  - .3 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: safety measures and regulations, drawings and specifications study, layout, measuring and marking the installation locations, material unloading jobsite storage and delivery to the installation area, inspection, uncrating and shipping support removal, tool-acquisition and return to storage, clean-up of excess material.
  - .4 Submit a detailed labour cost breakdown showing a breakdown of all adders to the base wage rate comprising the proposed hourly rate. The Owner and the Telecommunications Engineer's Representative reserve the right to negotiate the hourly labour rate with the Contractor.
- 1.17.11. When pricing additional work for Proposed Changes, the Telecommunications Contractor shall only price new materials that are required for the Proposed Change. Where existing materials and / or infrastructure (i.e. roughed-in cables) can be re-used for the Proposed Change, the Telecommunications Contractor shall utilize these items in the valuation of the Change at no extra cost.
- 1.17.12. Where a Proposed Change includes both credits and extras, overhead and permitted mark-ups apply to the net extra or credits, if any, of the entire change.
- 1.17.13. When pricing Proposed Changes containing both additions and credits, and where no work and / or materials have been installed on site, the Electrical Contractor shall only price the net new materials and net new labour that are required for the Proposed Change. Per unit labour and material costs shall be equal for credits and additions.

## PROPOSED CHANGE ORDER

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

### 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>
4-Pair Category Cable		\$X.XX C		\$X.XX C	
Termination Module		\$X.XX C		\$X.XX C	
Patch Cord		\$X.XX C		\$X.XX C	
Modular Patch Panel		\$X.XX C		\$X.XX C	
Labelling		\$X.XX C		\$X.XX C	
Testing		\$X.XX C		\$X.XX C	
<b>TOTALS</b>					

### Summary

<u>Description</u>	<u>Total Hours</u>
General Materials	\$Y.YY
<hr/>	
<b>Material Total</b>	
JOURNEYPERSON (xx Hrs. @ \$xx.00)	
<hr/>	
Subtotal	
<b>MARK-UP</b>	
Overhead/Mark-up (@ 5.000 %)	
<hr/>	
Profit (@ 5.000%)	
<hr/>	
Total Mark-up	
<hr/>	
<b>Final Amount (TNIP)</b>	

2. Products

2.1. NOT USED.

3. Execution

3.1. CYBER SECURITY

3.1.1. Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.

3.2. DEFINITIONS

3.2.1. Cyber Assets: Systems (including hardware, software, and data) and Telecommunication networks (including hardware, software, and data).

3.2.2. Critical Cyber Assets: Those cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.

3.2.3. Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.

3.2.4. Cybercrime: to be any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.

3.2.5. Cyber Hygiene: is a reference to the practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.

3.2.6. Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.

3.2.7. Cyber Security: refers to the body of technologies, processes and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.

3.2.8. Cyber Threat or Cyber Security Threat: is a malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS/DoS) attacks and other attack vectors.

3.2.9. Cyber Threat Actors: is a broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.

3.2.10. IP Multicast: is a technique for one-to-many and many-to-many real-time communication over an IP Infrastructure network.

3.2.11. Endpoint: is a remote computing device that communicates back and forth with a network to which it is connected. Such as a server, desktop, or laptop.

3.2.12. Network Certificates: are also known as a Digital Certificates, which are an electronic "password" that allows a person, organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:

- .1 Secure Socket Layer Certificate (SSL) Digi-SSL
- .2 Software Signing (Code Signing Certificate) Digi-Code

- .3 Client Certificate (Digital ID) Digi-ID
- 3.2.13. Social Engineering: are exploitation methods that target human vulnerabilities, such as carelessness and trust.
- 3.2.14. Technical Vulnerabilities: are weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- 3.3. CYBER SECURITY MEASURES
- 3.3.1. The following multi-layered Cyber Security measures shall be implemented at minimum to limit and or reduce the Owner's potential risk from a cyber threat event; such as a Cyber Security data breach or Cyber Security attack.
- 3.3.2. Password Management
  - .1 Employ password management best practices such as:
    - .1 Do not use default passwords.
    - .2 Use strong and unique passwords for all applications. Where there is no password policy inherent in the software use a minimum of 8 characters; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ? ]).
    - .3 Reset passwords at regular intervals.
    - .4 Configure two-factor authentication for all accounts where possible in the system software.
    - .5 Do not use System Admin logins for simple tasks. Create separate user accounts with rights levels appropriate for the job function. These user accounts can be defined and created in many ways such as role based, individual logins or assigned roles.
    - .6 Use different passwords for every account.
    - .7 Enforce secure password policies within the business environment.
    - .8 Have interface lock after a predefined # of failed login attempts for a pre-determined time interval.
- 3.3.3. Port and Interface Management
  - .1 Employ Port Management techniques such as:
    - .1 Restrict access on network switch ports to assigned devices addresses.
    - .2 Be sure to lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
    - .3 Shut off all unused communication services and hardware interfaces.
    - .4 The use of 3rd party port security monitoring such as Solarwinds should be investigated and is highly recommended.
- 3.3.4. Physical and Virtual Networks
  - .1 Where a dedicated LAN has not been provided a dedicated VLAN for the Security System including Video Surveillance, Access Control, Intrusion Detection, Duress Alarm, etc. is required.
- 3.3.5. Encryption
  - .1 Minimum TLS 1.2 should be used and where available use of TLS 1.3 for all network attached equipment.
- 3.3.6. Network Certificates

- .1 Make sure Network Certificates are up to date and not expired for all equipment and systems.
- 3.3.7. Firmware & Software Update Management
  - .1 Be sure to have the latest stable Firmware / Software version on all devices/ equipment/ as well as implement a Firmware/Software Update management process and procedure.
- 3.3.8. Manufacturer's System Hardening Guides
  - .1 Be sure to have the Manufacturers System hardening guides provided for the equipment being installed and implement as many recommendations/features as practical to do so.
- 3.3.9. External Memory
  - .1 Restrict the use of external memory. The use of devices such as external USB Thumb drives should be restricted or not used at all unless expressly allowed by the Owner's Information Technology representatives.
- 3.3.10. Log Off
  - .1 Enable auto-logout timer. Be sure to have the local Workstation being used to access the equipment has an auto-logout timer set with a reasonable timer in the case that the employee leaves it unattended for any amount of time.
- 3.3.11. Anti-Virus Software
  - .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.
- 3.3.12. Filtering Techniques
  - .1 There are many types of filtering techniques and filters that can be applied and should be investigated for specific project requirements. Some of these filtering techniques are:
    - .1 Web Filtering: A Web filter adds another layer to your anti-phishing defences by blocking the web based component of phishing and malware attacks.
    - .2 Multicast Message Filtering: Filters the packets sent to multicast groups they are not subscribed to.
    - .3 Content Filtering: is the use of a program to screen and or exclude access to web pages or email deemed objectionable. A content filter will then block access to this content
- 3.3.13. Back up Regularly
  - .1 Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible. Regularly back up important files either manually or through a scheduled backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.
- 3.4. IT DEVICES AND SYSTEMS
- 3.4.1. The above listed Cyber security measures can be applied in part or in full to a wide range of Information Technology (IT) Devices. A list of some of these device types are:
  - .1 Firewalls
  - .2 Routers
  - .3 Network switches (Core and Edge Devices)
  - .4 Servers and databases

- .5 Workstation computers
- .6 Network connected system devices and controllers
- .7 Wireless Access Points and wireless controllers
- .8 Mobile phones and tablets
- .9 Any IT System or endpoint connected to the network can have some form of Cyber security measure applied to it.

### 3.5. OT DEVICES AND SYSTEMS

3.5.1. These Cyber security measures can also be applied in part or in full to a wide range of Operational Technology (OT) Network devices.

- .1 Industrial Control Systems such as:
  - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
  - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
  - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
  - .4 (CNC) Computer numerical Control is the automated control of machining tools (Drills, boring tools, lathes) and 3D printers by means of a computer.
- .2 BMS/BAS (Building Management and Building Automation Systems)
- .3 HVAC equipment
- .4 Lighting controls for both internal and external applications
- .5 Energy monitoring and metering equipment
- .6 Transportation and parking systems
- .7 Scientific equipment
- .8 Any other OT System or endpoint that can be connected to the network

3.5.2. Report Cybercrime

- .1 When performing any work on a network connected system advise the Owner and or their representatives of any indication of a Cyber Incident of a criminal nature.

3.5.3. Cyber Security Report Letter

- .1 When implementing any and or all of the Cyber Security Measures mentioned in this Specification, be sure to include a report letter in the closeout documents to the Owner stating which Cyber Security measures have been implemented.

### 3.6. SITE EXAMINATION

3.6.1. Prior to submitting their tender response, perform a site survey (when available) to familiarise their workers with the site and all conditions of the site affected by the proposed Work. No claims for extra payment will be considered because of failure to fulfil this condition.

END OF SECTION

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27 00 05.20 Definitions and Abbreviations

1. General

1.1. DEFINITIONS

1.1.1. Generally, the following definitions are used in this Division:

- |                            |   |
|----------------------------|---|
| Addendum                   | - Normative document used to provide additional requirements and recommendations to a published document (e.g., standards, contracts). When published, an addendum effectively becomes part of the document that it supports. |
| Basic Link                 | - The Basic Link configuration consists of a maximum of 90 meters (295 ft) of uninterrupted solid-copper twisted-pair cable with a termination connection on each end.  |
| Bonding                    | - The permanent joining of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.                                 |
| Bonding Conductor (BC)     | - A conductor used specifically for the purpose of bonding.   |
| Building Entrance Facility | - The room or space inside a building where telecommunications cables enter and leave the building.   |
| Category                   | - A rating that defines the performance of cabling components and systems. Describes mechanical properties and transmission characteristics of balanced twisted-pair cabling and provides a numbered designation.             |
| Channel                    | - Complete end to end connection including patch cords, cable and termination device(s).  |
| Cut Over                   | - The live date(s) when the Owner will occupy the space as indicated by date and/or phasing.  |
| Demolish                   | - Detach existing items and legally dispose of them off site.   |
| Drawings                   | - Details, diagrams, layouts, schedules, and other information in a design drawing package accompanying this specification.   |
| Grounded Conductor         | - A system or circuit conductor that is intentionally grounded.   |

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Grounding System	-	A system of hardware and wiring that provides an electrical path from a specified location to an earth ground point.
Modular Copper Patch Panel	-	A patch panel that allows each RJ-45 female jack (or port) to be removed individually.
Owner	-	Person or company that will own the system and components.
Permanent Link	-	The Permanent Link is a Basic Link that has been tested to the applicable cabling performance for the relevant standard.
Project	-	Supply and installation of a complete Structured Cabling Solution to support Voice, Data and/or Video applications as described in this document.
Provide	-	Supply, install, test, configure, and document.
Shop Drawings	-	Contractor provided construction drawings to facilitate compliance with the plans and specifications.
Telecommunications Contractor	-	The successful bidder to this Specification responsible for the supply and installation of the Structured Cabling Solution as detailed in this document and associated Drawings.
Telecommunications Engineer's Representative	-	Joshua Blizzard Smith + Andersen 1100 - 100 Sheppard Avenue East, Toronto, ON - M2N 6N5
Telecommunications Outlet	-	A fixed connecting device where the horizontal cable terminates that provides the interface to the work area cabling and is typically found on the floor, wall, ceiling or on furniture.
Work Area	-	Work area (WA) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the WA equipment.
Workstation	-	Systems Furniture Workstation, Office, Meeting Room, Boardroom, Classroom, etc.  Any Voice or Data cable originating in a Telecom, LAN, Computer Room or Consolidation Point that is not terminated on a patch panel / IDC Block at the other end.

## 1.2. ABBREVIATIONS

1.2.1. Generally, the following abbreviations are used in this Division:

A - Ampere

ac	- Alternating current
ACR	- Attenuation to Cross-Talk Ratio
ADC	- Analog to Digital Converter
ADSL	- Asymmetric Digital Subscriber Line
A/E	- Architect or Engineer
AFF	- Above Finished Floor
AHJ	- Authority Having Jurisdiction
ALPETH	- Aluminum Polyethylene
AME	- Architectural, Mechanical, Electrical
AN	- Access Node
ANSI	- American National Standards Institute
AP	- Access Point
ARPAP	- Resin-coated Aluminum, Polyethylene Aluminum, Polyethylene
ASCII	- American Standard Code for Information Interchange
ASP	- Aluminum Steel Polyethylene
ASTM	- American Society for Testing and Materials
ATD	- Asynchronous Time Division
ATDM	- Asynchronous Time Division Multiplexing
ATM	- Asynchronous Transfer Mode
Attn	- Attenuation
AV	- Audiovisual
AWG	- American Wire Gauge
BAS	- Building Automation System
BC	- Bonding Conductor
BCD	- Backbone Conduit
BCT	- Bonding Conductor for Telecommunications
BEF	- Building Entrance Facility
BER	- Bit Error Rate
BERT	- Bit Error Rate Test

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BFOC	- Bayonet Fibre Optic Connector
BIC	- Building Industry Consultant
BICSI®	- Building Industry Consulting Service International
bit	- Binary Digit
BOM	- Bill Of Material
b/s	- Bit per Second
BWA	- Broadband Wireless Access
CA	- Cable
CACSP	- Coated Aluminum Coated Steel Polyethylene
CAD	- Computer Aided Design
CATV	- Community Antenna Television (Cable Television)
CCIA	- Computer Communications Industry Association
CCTV	- Closed Circuit Television
CD	- Compact Disc
CEC	- Canadian Electrical Code
CEF	- Cable Entrance Facility
CENELEC	- European Committee for Electrotechnical Standardization
cm	- Centimetre
CMP	- Communications Plenum
CMR	- Communications Riser
coax	- Coaxial Cable
CO-OSP	- Customer-Owned Outside Equipment
CP	- Consolidation Point
CPU	- Central Processing Unit
CPVC	- Chlorinated Polyvinyl Chloride
CRTC	- Canadian Radio-television Telecommunications Commission
CSA	- Canadian Standards Institute
CSC	- Construction Specifications Canada
CSI	- Construction Specifications Institute

CT	- Cable Tray
Cu	- Copper
dB	- Decibel
dB/km	- Decibel per Kilometre
dBm	- Decibel milliwatt
dBmV	- Decibel millivolt
demarc	- Demarcation Point
D-ring	- Distribution Ring
DID	- Direct Inward Dialing
DSL	- Digital Subscriber Line
EF	- Entrance Facility
EIA	- Electronics Industry Alliance
ELFEXT	- Equal Level Far-End Crosstalk
e-mail	- Electronic Mail
EMI	- Electromagnetic Interference
EMI/RFI	- Electromagnetic Interference / Radio Frequency Interference
ER	- Equipment Room
ESD	- Electrostatic Discharge
ETL	- Edison Testing Laboratories
e/w	- Equipped With
FC	- Fibre Connector
FCC	- Federal Communications Commission
FDDI	- Fibre Distributed Data Interface
FEP	- Fluorinated Ethylene Propylene
FEXT	- Far-End Crosstalk
FOTP	- Fibre Optic Test Procedure
ft	- Foot / Feet
ft <sup>2</sup>	- Square Foot / Feet
FTTD	- Fibre To The Desk

FT 1 / FT 3	-	Fractional T 1 / Fractional T 3
G	-	Giga
Gb	-	Gigabit
GB	-	Gigabyte
Gb/s	-	Gigabit per Second
GC	-	General Contractor
GHz	-	Gigahertz
GWB	-	Gypsum Wall Board
HC		Horizontal Cross-connect
Hz	-	Hertz
I	-	Current
IC	-	Intermediate Closet
IC	-	Intermediate Cross-connect
ID	-	Identification
ID	-	Inside Diameter
IDC	-	Insulation Displacement Connection
IDC	-	Insulation Displacement Connector
IDC	-	Insulation Displacement Contact
IDF	-	Intermediate Distribution Frame
IEEE®	-	Institute of Electrical and Electronics Engineers, Inc. ®
IG	-	Isolated Ground
in	-	Inch
in <sup>2</sup>	-	Square Inch
I/O	-	Input / Output (Device)
ICEA	-	Insulated Cable Engineers Association
IEC	-	International Electrotechnical Commission
IOR	-	Index Of Refraction
ISDN	-	Integrated Services Digital Network
ISO	-	International Organization for Standardization

IT	- Information Technology
kb	- Kilobit
kB	- Kilobyte
kg	- Kilogram
Km	- Kilometre
kV	- Kilovolt
kVA	- Kilovoltampere
kW	- Kilowatt
kWh	- Kilowatt hour
LAN	- Local Area Network
laser	- Light Amplification by Stimulated Emission of Radiation
lb	- Pound
LED	- Light Emitting Diode
LEN	- Local Exchange Node
LSZH	- Low Smoke Zero Halogen
m	- Metre
m <sup>2</sup>	- Square Metre
mA	- Milliampere
MAC	- Move, Add, or Change
MAN	- Metropolitan Area Network
Mb	- Megabit
MB	- Megabyte
Mb/s	- Megabit per Second
MB/s	- Megabyte per Second
MC	- Main Cross-connect
MDF	- Main Distribution Frame
MGB	- Main Grounding Busbar
MHz	- Megahertz
mi	- Mile

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MIMS	- Mineral Insulated Metal Sheathed
min	- Minute
mm	- Millimetre
MM	- Multimode
MMF	- Multimode Fibre
MPP	- Modular Patch Panel
ms	- Millisecond
MSDS	- Material Safety Data Sheet
MUTO	- Multi-user Telecommunications Outlet
MUTOA	- Multi-user Telecommunications Outlet Assembly
mW	- Milliwatt
MW	- Megawatt
NBCC	- National Building Code of Canada
NESC	- National Electrical Safety Code
NEXT	- Near-end Crosstalk
NIC	- Network Interface Card
NIR	- Near-end crosstalk-to-Insertion loss Ratio
NRCC	- National Research Council of Canada
OD	- Outside Diameter
ODBC	- Open Database Connectivity
OEM	- Original Equipment Manufacturer
OF	- Optical Fibre
OSP	- Outside Plant
PBX	- Private Branch Exchange
PDU	- Power Distribution Unit
PSACR	- Power Sum Attenuation to Crosstalk Ratio
PSELFEXT	- Power Sum Equal Level Far-End Crosstalk
PSNEXT	- Power Sum Near-End Crosstalk
PVC	- Polyvinyl Chloride

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QA	- Quality Assurance
QC	- Quality Control
QoS	- Quality of Service
RCDD®	- Registered Communications Distribution Designer
RF	- Radio Frequency
RFI	- Radio Frequency Interference
RFQ	Request for Quote
RJ	- Registered Jack
rms	- Root Mean Square
RU	- Rack Unit (1.75")
RX	- Receive
RX	- Receiver
SAN	- Storage Access Network
SC	- Single Fibre Coupling Optical Fibre Connector
SCC	- Standards Council of Canada
SCS	- Structured Cabling System
ScTP	- Screened Twisted Pair
SFTP	- Screened Foiled Twisted Pair
SI	- International System of Units (Le Système International d'Unités)
SLA	- Service level Agreement
SM	- Singlemode
SMF	- Singlemode Fibre
SNMP	- Simple Network Management Protocol
SNR	- Signal-to-Noise Ratio
STALPETH	- Steel Aluminum Polyethylene
STP	- Shielded Twisted Pair
STP-A	- Shielded Twisted Pair A
T 1	- Trunk Level 1
TBB	- Telecommunications Bonding Backbone

TBBIBC	- Telecommunications Bonding Backbone Interconnecting Bonding Conductor
TC	- Telecommunications Closet
TDD	- Telecommunications Device for the Deaf
TGB	- Telecommunications Grounding Busbar
TGR	- Telecommunications Grounding Rod
TIA	- Telecommunications Industry Association
TMGB	- Telecommunications Main Grounding Busbar
TN	- Telecommunications Node
TP	- Twisted Pair
TR	- Telecommunications Room
TS	- Technical Standard
TSB	- Telecommunications Systems Bulletin (formerly Technical Systems Bulletin)
TTY	- Teletypewriter / Text Telephone
TV	- Television
TX	- Transmit
TX	- Transmitter
UD	- Underfloor Duct
UL®	- Underwriters Laboratories Inc.®
ULC	- Underwriters Laboratories of Canada
UPC	- Universal Product Code
UPS	- Uninterruptible Power Supply
UTP	- Unshielded Twisted Pair
V	- Volt
VA	- Volt-Ampere
VCSEL	- Vertical Cavity Surface Emitting Laser
VLAN	- Virtual Local Area Network
VoIP	- Voice over Internet Protocol
VPN	- Virtual Private Network

W	-	Watt
WAN	-	Wide Area Network
WAP	-	Wireless Application Protocol
WiFi	-	Wireless Fidelity
Wi-Fi	-	Wireless Fidelity
WLAN	-	Wireless Local Area Network
WMAN	-	Wireless Metropolitan Area Network
WWAN	-	Wireless Wide Area Network
X	-	Cross-connect
XLPE	-	Cross-linked Polyethylene
XPE-PVC	-	Expanded Polyethylene Polyvinyl Chloride

2. Products

2.1. NOT USED

3. Execution

3.1. NOT USED

END OF SECTION

27 00 05.30 Codes, Standards and Regulations

1. General

1.1.1. Code, Standard and Regulation Compliances

- .1 The Telecommunications Contractor shall adhere to all Codes, Standards, Regulations and documents listed throughout this document.
- .2 All products installed must meet or exceed all Local, Provincial and Federal Building, Fire, Health, Safety and Electrical Codes.
- .3 The non-plenum/plenum cable shall be ETL or ULC Listed and CSA Certified as type CMR/CMP, in accordance with the Binational Standard for Telecommunications Cable, UL444/C22.2 No. 214-17.
- .4 The equipment, material and installation shall conform to the latest version of the applicable Codes, Standards and Regulations of Authorities Having Jurisdiction as indicated in Table 1. In the case of conflict or discrepancy the more stringent code, standard or regulation shall apply.
- .5 Table 1: Applicable Codes, Standards and Regulations

STANDARD	TITLE
ANSI/ICEA	
S-80-576	Communication Cables.
ANSI/TIA	
568.1	Commercial Building Telecommunications Infrastructure Standard, latest version.
568.2	Balanced Twisted Pair Telecommunications Cabling and Component Standard, latest version.
569	Commercial Building Standard for Telecommunications Pathways and Spaces including all addenda, latest version
606	Administration Standard for Telecommunications Infrastructure, latest version.
607	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, latest version.
CSA	
C22.1	Canadian Electrical Code Part I: Safety Standards for Electrical Installations, latest version.
C22.2 No. 41	Grounding & Bonding Equipment
C22.2 No. 182.4-M90	Plugs, Receptacles, and Connectors for Communication Systems, latest version.
C22.2 No. 214-17	Communications Cables.
CAN/CSA-C22.2 No. 0-10	General Requirements, Canadian Electrical Code, Part II (latest version)

OTHER	
CAN/ULC-S115	Standard Method of Fire Tests of Firestop Systems, latest version.
CAN/ULC S101	Standard Method of Fire Endurance Tests of Building Construction and Materials, latest version.
CAN/ULC S102	Standard Method of Testing for Surface Burning Characteristics of Building Materials and Assemblies, latest version.
CENELEC EN 50173	Information Technology – Generic Cabling Systems Part 1: General Requirements, latest version
CLC	Canada Labour Code, Part II Occupational Health and Safety, and Provincial and Local Health and Safety regulations
IEC 60603-7	Connectors for electronic equipment - Part 7: Detail specification for 8-way, unshielded, free and fixed connectors, latest version.
ISO/IEC IS 11801-1	Information Technology - Generic Cabling for Customer Premises – Part 1: General Requirements, latest version.
NEMA WC 63.1	Performance Standard for Twisted Pair Premise Voice and Data Communications Cable, latest version.
RoHS	Restriction of Hazardous Substances Directive 2011/65/EU, latest version

- .6 Comply with all Local, Provincial and Federal codes for fire and electrical, as well as all local laws, where applicable and with requirements of the Canadian Standards Association (CSA) when mandatory. Make any changes or alterations required by the authorised inspector of the Authority Having Jurisdiction, at no extra charge to the Owner.

1.1.2. General Installation Requirements

- .1 Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment, apparatus and installation of systems cabling solution furnished into premises. Remove these items from premises when no longer required.

1.1.3. Metric Conversions

- .1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, equipment, material, and site services in both new and existing installations.

1.1.4. Cutting, Patching and Repairing

- .1 Perform all cutting, patching, repairing, and making good related to the Telecommunications Cabling Work including any penetrations through walls or floors.
- .2 Allow for all costs associated with cutting, patching, repair, and making good related to the Telecommunications Work including any penetrations through walls or floors.
- .3 Paint all visible Telecommunications conduit to match existing.
- .4 Coordinate the colour and location of all conduits, devices, and their housing with architect and architectural drawings on-site before installation.

2. Products

2.1. NOT USED

3. Execution

3.1. CODE, STANDARD AND REGULATION COMPLIANCES

- 3.1.1. Install and terminate all cables and components in accordance with CSA, the latest edition of ANSI/TIA-568 and its Amendments as well as UL/ULC Guidelines. Maintain the integrity of the pair twists, bend radius and ensuring proper distance is kept from fluorescent light fixtures, electrical cables or any other source of EMI.
- 3.1.2. Comb and bundle all cables in a neat and organised manner. The Telecommunications Engineer's Representative will determine neatness of the installation. Cables that have not been properly combed and dressed shall be re-dressed at the Telecommunications Contractor's expense. Coordinate with the Telecommunications Engineer's Representative prior to re-dressing cables.
- 3.1.3. The maximum horizontal run length for 4-pair cabling shall not exceed 90-metres. If the 90-metre constraint cannot be met, notify the Telecommunications Engineer's Representative of any cables that exceed 90-metres, prior to installation.

END OF SECTION

27 00 05.50 Contract Documents

1. General

1.1. CONTRACT DOCUMENTS

1.1.1. Read and complete the Telecommunications Tender forms.

1.1.2. All Contract Documents, including all General Conditions, Division 1 Specification Sections (if present) and Instructions to Bidders apply to this section and all other Specification sections.

1.2. WORK INCLUDED

1.2.1. Drawings List

.1 Refer to the drawing list in the Telecommunications Drawings for a list of drawings that shall be used for preparation of bids and construction.

2. Products

2.1. NOT USED

3. Execution

3.1. COORDINATION

3.1.1. Carefully examine Work and Drawings of all related trades and thoroughly plan the Work to avoid conflict or interference with other services. Report defects that would adversely affect Work. Do not commence installation until defects have been corrected. Beginning the Work constitutes acceptance of conditions as satisfactory.

3.1.2. Co-ordinate the Work of this Contract such that items will properly interface with the Work of other trades. Prepare installation drawings of critical locations and submit to the Telecommunications Engineer's Representative for review.

END OF SECTION

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27 00 05.60 Administrative Requirements

1. General

1.1. PROJECT CLOSEOUT SUBMITTALS

1.1.1. Project closeout submittals shall include:

- .1 Table of contents
- .2 As-built drawings
- .3 Cable Test Results
- .4 Warranty Letters
- .5 Manufacturer Certification
- .6 Cyber Security Report Letter

1.2. WORK INCLUDED

1.2.1. Closeout Submittal – As-built Drawings

- .1 Prepare drawing(s) to clearly mark all changes and deviations during the construction process, including the pathway of the cables from the Telecom Room(s) to the Workstations or between Telecom Rooms. Drawing(s) shall be kept up-to-date during construction and in addition to field measurements shall include field instructions and all other changes. Include all additional cables installed during the project in the as-built drawings.
- .2 The Telecommunications Engineer's Representative has the right to review the status of the as-built drawing(s) from time to time during the construction process. On completion of the project, submit to the Telecommunications Engineer's Representative a soft copy of as-built drawings indicating all such changes and deviations for review within five (5) business days of the completion of the project.
- .3 Request (in writing) from the Telecommunications Engineer's Representative a soft copy of the Drawings for use by the Telecommunications Contractor in preparation for as-built Drawings. Update the soft copy drawing(s) with correct as-built information (i.e. cable numbers, outlet locations, rack/backboard elevations, etc.) in digital format using the most current version of the Drawings native format (e.g.: AutoCAD or Revit).
- .4 All changes to drawing(s) shall follow conventional Engineering Draft Standards. All outlet locations shall be identified with proper designation.
- .5 If the Telecommunications Contractor cannot comply with this requirement, Smith + Andersen will transfer all hand drawn as-builts to the Drawing's native format (AutoCAD or Revit) at a cost to the Telecommunications Contractor. The cost for this service shall be based on per diem rates at time of completion.
- .6 Print / plot two sets of as-built Drawings at no extra cost. Final as-built print(s)/plot(s) must not contain markings or corrections by hand (i.e. marker, pen, pencil, etc.) and shall be delivered to the Owner.
- .7 The project will remain incomplete and a holdback will be retained until satisfactory as-built drawing(s) are provided.

1.2.2. Closeout Submittal – Cable Test Results

- .1 Produce a test report based on the cable schedules. The report shall indicate for each cable, when it was tested successfully and the signature of the technician that performed the test.

- .2 An authorized person certified with the Manufacturer for the Telecommunications Contractor must sign the entire report. Supply one (1) soft copy in the tester's native format, along with the appropriate software to read the test results.
  - .3 The project will remain incomplete and a holdback will be retained until satisfactory cable test results are provided.
  - .4 Provide testing and commissioning documentation for all items and their related components to the Telecommunications Engineer's Representative prior to the completion of the project or at the Telecommunications Engineer's Representatives request. Include maintenance manuals and operating instructions for Owner's staff use.
- 1.2.3. Closeout Submittal – Warranty
- .1 Provide a minimum of a 1-year unconditional parts and labour Warranty for all equipment and labour provisioned under this contract, from the date of substantial performance of the contract, for each Telecommunications cabling system.
  - .2 Response time for Warranty items shall be 24 hours. Repair deficient Cabling Solution components outside regular working hours. Bidders shall include a statement of Warranty terms and conditions with their contract documents.
- 1.2.4. Closeout Submittal – Manufacturer Certification
- .1 Arrange for a minimum of 25-year Manufacturer's Warranty and System Performance Guarantee, from the date of substantial performance of the contract, for each Telecommunications cabling system.
  - .2 Provide a manufacturer Warranty that the Structured Cabling Solution is installed and fully operating in accordance with this and the manufacturer Specifications.
  - .3 Upon request and at no additional cost to the Owner the Telecommunications Contractor must provide a manufacturer's technical representative to conduct an on-site visit to ensure complete technical compliance.
  - .4 All documentation including the certificate must be in English and French, and shall be submitted to the Telecommunications Engineer's Representative for signed acceptance prior to their production.
- 1.2.5. Closeout Submittal – Cyber Security Letter
- .1 Prepare a letter confirming the Owner's cyber security policy was reviewed, and all applicable cyber security configurations are implemented. Where the Owner does not have a cyber security policy, state in the letter what measures have been taken to protect the Owner from Cyber Incidents.
- 1.2.6. Project Submittal – Shop Drawings
- .1 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.
  - .2 Prepare specifically for this project each Shop Drawing for non-catalogue items. Clearly mark Shop Drawings and brochures for catalogue items to show what is being supplied.
  - .3 Stamp and sign each Shop Drawing or catalogue sheet shall to indicate the drawing has been checked by the Telecommunications Contractor for conformance with all requirements of the Drawings and Specifications, that they have co-ordinated this equipment with other equipment to which it is attached and/or connected and that they have 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 co-ordination is complete before submitting Shop Drawings for review.

- .4 Installation of any equipment shall not start until after final review of Shop Drawings by the Engineer's Representative has been obtained.
  - .5 When requested, supplement Shop Drawings by data explaining the theory of operation. The Engineer's Representative may also request that this information be added to the maintenance and operating manual.
  - .6 Provide space for Shop Drawing review stamps for the Telecommunications Contractor and Telecommunications Engineer's Representative. This space shall be clear of all technical information and shall not be on the back of any sheets.
  - .7 One original Shop Drawing will be returned. All copies required for the trades, suppliers or other Consultants will be printed by the Telecommunications Contractor.
- 1.2.7. Project Submittal – Permits, License Reviews and Fees
- .1 Where materials are specified which require special review and approval of CSA and/or local Authorities Having Jurisdiction, obtain such approval for the particular installation with the co-operation of the material supplier. Obtain and pay for permits and reviews required for Work performed.
  - .2 Submit required Documents and Shop Drawings to authorities having jurisdiction in order to obtain approval for the Work. Copies of Drawings and Specifications may be used for this purpose. Prepare any additional information, details and Drawings these authorities may require.
- 1.2.8. Project Submittal – Substitutions and Alternate Products
- .1 This document specifies the use of a complete end-to-end Structured Cabling Solution as manufactured, warranted and certified by a single manufacturer. Alternate materials (from the overall cabling solution) will not be accepted unless specifically noted.
  - .2 Where supply of the materials may compromise the schedule, submit a request to use alternate product to the Telecommunications Engineer's Representative. Depending on the circumstance, the Telecommunications Engineer's Representative may provide written authorisation to substitute the Product. Obtain written authorization before providing alternates.
  - .3 Where a separate price is requested in this document, prepare quotation(s) to install/provide products and/or systems as outlined. Submit the separate price quotation with the bid response. Instructions and products requested under separate price sections shall not be considered substitutions or alternate products.
  - .4 The Telecommunications Engineer's Representative's decision regarding the acceptance or rejection of the proposed substitution is final. Substitutions may be accepted if the delivery of the component or item is such that it will not jeopardise the construction schedule. Otherwise, the substitution may not be approved.
  - .5 In order to be assessed, proposed substitutions must include the following:
    - .1 Description of proposed substitution,
    - .2 Respective cost of items originally specified and the proposed solution,
    - .3 Compliance with the applicable Building Codes and the requirements of Authorities Having Jurisdiction,
    - .4 Compliance with the applicable Telecommunications standards,
    - .5 Affect concerning compatibility with and interface with adjacent building materials and components,
    - .6 Compliance with the intent of the Contract Documents, and
    - .7 Reason(s) for the request.

- .6 Substitution submissions do not relieve the Telecommunications Contractor from the obligation of preparing and submitting a contract documents that is in complete compliance with this specification document and associated Drawings. Any substitution submissions must be clearly outlined in addition to the original specified equipment as detailed in this document and associated Drawings as a separate or alternate price format.
- 1.2.9. Project Submittal – Scheduling
- .1 Within one week of award of the contract, submit a formal project schedule to the Telecommunications Engineer’s Representative showing start and finish dates of major tasks as denoted by system such as: demolition, backbone cabling, horizontal cabling, rack and cabinet installation, material order and delivery to site and testing.
  - .2 Submit updated schedules as periodically requested by Telecommunications Engineer’s Representative.
- 1.2.10. Project Submittal – Review and Testing Requirements
- .1 Develop and submit a test plan indicating the process and types of tests to be performed. The plan must indicate the testing process for each cable.
  - .2 The Telecommunications Engineer’s Representative must approve the testing procedure prior to testing commencing and may request to be present during the initial testing.
  - .3 Invite the Telecommunications Engineer’s Representative to witness field testing a minimum of five (5) business days before testing commences.
  - .4 Upon completion of the testing the Telecommunications Engineer’s Representative may request a random test of up to 10% of the links. The Telecommunications Contractor shall test these randomly selected links and the results shall be stored in accordance with this document. The results obtained shall be compared to the original test data. A penalty of \$50.00 shall be deducted from the Contract amount for each cable that fails to pass the random test. If more than 2% of the sample results differ in terms of the pass/fail determination, repeat 100% testing under the supervision of the Telecommunications Engineer’s Representative. The cost of the labour required for the testing as well as the cost for the supervision by the part of Telecommunications Engineer’s Representative shall be borne by the Telecommunications Contractor.
- 1.2.11. Keep the site and surrounding area clean, safe and free from debris at all times. Remove all debris from the site on a daily basis. The costs for cleaning are the responsibility of the Telecommunications Contractor.
- 1.2.12. Upon completion of the Work and before acceptance and final payment will be made, clean and remove from the site, all surplus and discarded materials, temporary structures and debris of every kind. Surplus and waste materials removed from the site shall be disposed of in accordance with applicable laws and regulations.
- 1.2.13. Before acceptance by the Telecommunications Engineer’s Representative, all the equipment and cabling must be cleaned and tested.

2. Products

2.1. NOT USED.

3. Execution

3.1. NOT USED.

END OF SECTION

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27 00 05.70 Project Specific Requirements

1. General

1.1. WORK INCLUDED

1.1.1. Cable Installation

- .1 The Telecommunications Contractor may assume at their own risk that the entire cable installation will be done during regular hours, except:
  - .1 Where noted otherwise in this specification;
  - .2 As outlined in the project front end documents.

1.1.2. Floor/Ceiling Tiles

- .1 Remove and re-install all floor/ceiling tiles in areas affected by the Work. This shall be done on a daily basis for all areas that are occupied during the construction period. Otherwise, remove and re-install the tiles after the Work is complete.
- .2 Any damage to ceiling tiles during the installation of any Work described in this document is the responsibility of the Telecommunications Contractor. Damages include chipping, breaking and/or soiling. Final decisions on the trade responsible for any damage to ceiling tiles shall be made by the Owner and/or the Telecommunications Engineer's Representative.
- .3 The Telecommunications Contractor shall be responsible for storage and protection of floor/ceiling tiles when they have been removed from the floor/ceiling grid.

1.1.3. Cut Over Planning and Management

- .1 Include for a total of 16 hours cut over support, to be used at the discretion of the Owner/Telecommunications Engineer's Representative. The technician shall be available to provide services to the Owner as required. This may involve additional testing or Move, Add, Change (MAC) activity. Any additional materials used shall be addressed separately.
- .2 Schedule installers such that the cut over schedule is maintained. Any shift work or overtime premiums that are required to complete the project on schedule shall be included in the Telecommunications Contractor's contract Price.

1.1.4. Safety of Persons and Property

- .1 Comply with all laws, ordinances, rules, regulations, and policies of the Owner and lawful orders of any public Authority Having Jurisdiction for safety of persons or property or to protect them from damage, injury or loss.
- .2 Moderate public pedestrian traffic should be expected around all Work locations. Ladders scaffold, installation materials, and all other hazardous conditions shall be fully protected at all times. Warning cones, signs, barricades and warning tapes shall be used to warn and protect persons and property at all times in public corridors.
- .3 Work shall not interfere with legal fire exits. Corridors, areas of egress, fire protection stand pipes, hydrants and exit stairs shall be maintained at all times.
- .4 Maintain at all times free access to fire lanes and emergency and utility control facilities such as fire alarm boxes, utility vaults, manholes and junction boxes.
- .5 No open flames/smoking shall be permitted without prior written approval of the Owner.
- .6 Set up and remove all signage and safety measures to ensure that other trades and non-trade personnel are safe from work of the Telecommunications Contractor.

- 1.1.5. Access to Site
  - .1 Coordinate site access with the Project Manager and/or Owner as determined during the initial project meeting.
- 1.1.6. Identification
  - .1 All Telecommunications Contractor personnel shall be clearly identified by either uniform or company ID. The Telecommunications Contractor may also be required to wear Owner provided ID for required card access locations or identification. All Owner ID(s) must be returned daily or at the end of the project as determined by the Owner.
- 1.1.7. Emergency Facilities
  - .1 The Telecommunications Contractor shall maintain at all times free access to fire lanes and emergency and utility control facilities such as fire alarm boxes, utility vaults, manholes and junction boxes.
- 1.1.8. Product Delivery Requirements
  - .1 Be responsible for complete delivery, handling, and installation of all materials used in the performance of the Work.
  - .2 Arrange for the delivery of Owner furnished equipment/materials related to the Specifications or Drawings and related items, including unloading of supplier's truck, elevator scheduling, storage, and placement on as indicated on Contract Drawings.
- 1.1.9. Product and Tools Storage Requirements
  - .1 Be responsible for storage and handling of all materials used in the performance of the Work.
  - .2 Job boxes may be allowed to be stored on the site during construction. The tools and the job box shall be the responsibility of the Telecommunications Contractor. The Owner and their representative shall be in no way responsible or liable for any tools of the Telecommunications Contractor.
- 1.1.10. Confined Spaces
  - .1 Where Work is performed in a confined space, comply with all code related and Owner specific safety requirements.
- 1.1.11. Coordination with Occupants
  - .1 Be responsible for co-ordinating all Work with the Owner/tenant of the floor space for their daily work.
- 1.1.12. Project Meetings
  - .1 Attend site meetings when requested by the Telecommunications Engineer's Representative and/or the Project Manager. Regular meetings may occur once per week at the Telecommunications Engineer's Representative's and/or the Project Manager's discretion.
  - .2 Attend scheduled project meetings throughout the duration of the project to review the status of current and planned activities, schedule and conduct other business associated with the project.
- 1.1.13. Progress Reports
  - .1 Prepare and issue a status report at the scheduled project meeting including status of: progress, project completion for phases, material ordering and delays.

2. Products

2.1. NOT USED

3. Execution

3.1. PRODUCT DELIVERY REQUIREMENTS

3.1.1. Unload materials from delivery trucks in such a manner as to protect the materials from damage. In particular, reels of cable shall not be unloaded by dropping them off the vehicle.

3.2. PROTECTING INSTALLED SYSTEMS AND CONSTRUCTION

3.2.1. The Telecommunications Contractor shall be responsible for the assembly of above equipment/materials and protection of the above equipment and related items until project cut over. Any damage to equipment shall be the liability of the Telecommunications Contractor. All damage shall be repaired, or at the Owner's request, the equipment shall be replaced at no extra charge to the Owner.

END OF SECTION

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27 00 06.00 Fire Stopping and Water Proofing

1. General

1.1. WORK INCLUDED

1.1.1. Fire Stopping

- .1 Provide seals in all Fire Rated Separations and Firewalls to form tight barriers to retard the passage of flame and smoke.
- .2 The installed seals shall provide and maintain the fire resistance rating of the adjacent floor, wall or other fire separation assembly in accordance with Fire Code and Building Code requirements.
- .3 Establish/re-establish the integrity of all fire-rated structures and assemblies that they have created or disturbed, or that were created by others for use by the Telecommunications Contractor.
- .4 Provide Fire Stop pillows for existing cable tray penetrations through firewalls.
- .5 For the purposes of this specification, the only acceptable Fire Stop Systems shall be those that have been tested to the CAN/ULC S115 Standard.
- .6 Provide non-permanent CSA approved Fire Stop systems that are dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required).
- .7 All fire stopping shall maintain a minimum one-hour rating and shall meet applicable Federal, Provincial and Local building codes.
- .8 All Fire Stop Systems shall be listed and tested by an SCC and accredited Third Party Testing Agency in accordance with the Standards.
- .9 Fire resistance ratings of installed Fire Stop Systems shall not be less than the fire resistance rating of the surrounding Fire Separation or Firewall.
- .10 All Smoke Seals selected for use shall comply with Fire Code, Building Code, and Building Standards.
- .11 Where moisture seals are required for floor penetrations in Operating Rooms, Morgues, and Laboratories in Hospitals, Universities and Schools, the Fire Stop Materials selected shall be compatible with Formalin.
- .12 All Fire Stop Materials and Smoke Seals shall have elastomeric characteristics to allow for building settling and seismic movement. All Fire Stop Materials and Smoke Seals shall be free of asbestos.

1.1.2. Water Proofing

- .1 Seal all foundation penetrating conduits and service entrance conduits and sleeves to eliminate the intrusion of moisture and gases into the building. This requirement also includes spare conduits.
- .2 Seal or reseal all service entrance conduits through building upon cable placement. Plug spare conduits with expandable plugs.

1.1.3. Quality Assurance

- .1 Provide fire stopping systems that comply with the following requirements following:
  - .1 Fire stopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for fire stop system acceptable to authorities having jurisdiction.

- .2 Fire stopping products bear the classification marking of qualified testing and inspection agency.
  - .2 Provide the Work of this Section using competent installers, experienced in the application of the materials and systems being used, approved and trained by the material or system manufacturer.
  - .3 Fire Stop Systems shall conform to the fire (F), hose (H) and temperature (T) ratings of Codes.
  - .4 Fire Stop Materials and Smoke Seal materials shall have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").
  - .5 For the purposes of this specification the only acceptable Fire Stop Systems are those that have been tested to the CAN/ULC S115 Standard.
- 1.1.4. Performance
- .1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes will occur.
  - .2 Where non-mechanical products are utilized, provide products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
  - .3 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
  - .4 Seal openings for cable trays using re-enterable fire stopping pillows.
- 1.1.5. Project Conditions
- .1 Do not install fire stopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer
  - .2 Do not install fire stopping products when substrates are wet due to rain, frost, condensation, or other causes.
  - .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
  - .4 Do not use materials that contain flammable solvents.
  - .5 Coordinate construction of openings and penetrating items to ensure that through-penetration fire stop systems are installed according to specified requirements.
  - .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
  - .7 Schedule installation of fire stopping after completion of penetrating item installation but prior to covering or concealing of openings.
2. Products
- 2.1. GENERAL
- 2.1.1. Use only fire stopping products that have been tested for specific fire resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire rating involved for each separate instance.

## 2.2. MANUFACTURERS

- 2.2.1. Products manufactured by Hilti Corporation (or approved equivalent) are acceptable.
- 2.2.2. Obtain fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.

## 2.3. MATERIALS

- 2.3.1. Firestop Sealants: The following products are acceptable.
  - .1 Hilti FS-ONE MAX high performance Intumescent Firestop Sealant
  - .2 Hilti CP 601S Elastomeric Firestop Sealant.
  - .3 Hilti CP 606 Flexible Firestop Sealant
  - .4 Hilti CP 604 Self-Leveling Firestop Sealant
  - .5 Or equivalent
- 2.3.2. Cast-In Firestop Device: A one-step cast-in firestop device for a variety of pipe materials and diameters. The following product is acceptable.
  - .1 Hilti CP 680-M Cast-in Firestop Device or equivalent.
- 2.3.3. Firestop Putty: An intumescent, non-hardening, firestop putty for cable and pipe penetrations. The following product is acceptable:
  - .1 Hilti CP 618 Firestop Putty Stick or equivalent.
- 2.3.4. Firestop Plug: Ready-to-use intumescent and reusable plug for small openings. The following product is acceptable:
  - .1 Hilti CFS-PL Firestop Plug or equivalent.
- 2.3.5. Fire Rated Cable Pathways: Re-penetrable cable management device:
  - .1 Hilti CP 653 Speed Sleeve or equivalent.

## 3. Execution

### 3.1. FIRE STOPPING

- 3.1.1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of fire stopping in accordance with manufacturer's installation instructions and technical information.
- 3.1.2. Examine sizes and conditions of voids to be filled to establish correct thickness and installation of Fire Stop Materials.
- 3.1.3. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion.
- 3.1.4. Prepare surfaces in contact with Fire Stop Systems and Smoke Seals to manufacturer's instructions. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.
- 3.1.5. Install/replace sound barrier/fire stopping materials as soon as cables have been pulled through the opening.
- 3.1.6. In all Fire Stop Systems that require mineral wool or ceramic fibre backer or filler materials, these materials shall be dry and free of other contaminants before, during and after installation of sealant Fire Stop Materials. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.

- 3.1.7. Apply Fire Stop Systems and Smoke Seals in strict accordance with manufacturer's instructions to prevent the passage of fire and smoke, and where required and / or specifically designated, the passage of fluids.
- 3.1.8. Provide temporary forming and packing as required. Tool or trowel all exposed surfaces to smooth, neat and tidy finish.
- 3.1.9. Fire Stop and smoke seal gaps and holes in all Fire Separation and Firewall construction through which cables pass as a result of Work in this document.
- 3.1.10. In Combustible Construction (membrane GWB type) where the framing members are wood or where paper faced insulation is incorporated within the separation, a Fire and Temperature rise "FT" rating is required equal to that of the rating of the Fire Separation. Include openings which have been formed and sleeved.
  
- 3.2. WATER PROOFING
  - 3.2.1. Conduits with cables in them shall be permanently sealed by firmly packing the void around the cable with oakum and capping with a hydraulic cement or water proof duct seal.
  
- 3.3. EXPOSED SERVICE PENETRATIONS IN CEILING OF UNDERGROUND PARKING AREAS
  - 3.3.1. Where the bottom of a Fire Stop System is exposed, seal bottom side of the assembly with a fire rated elastomeric Fire Stop sealant.
  
- 3.4. CLEAN UP
  - 3.4.1. Remove excess materials and debris and clean adjacent surfaces immediately after application to satisfaction of the Telecommunications Engineer's Representative. Remove and or correct staining and discolouring of adjacent surfaces as directed.

END OF SECTION

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27 00 07.10 Cable and Equipment Removal

1. General

1.1. WORK INCLUDED

1.1.1. Labour Allowance

- .1 Allow for cable removal in the contract, based on the scope of Work indicated in this section and on any associated demolition Drawings.
- .2 Confirm with the Telecommunications Engineer's Representative prior to any cable being removed. Forward a schedule indicating the locations and times for cable removal to the Telecommunications Engineer's Representative.
- .3 In occupied areas where there is no hoarding, remove and re-install ceiling tiles on a per shift basis unless directed otherwise by the Owner.

1.1.2. Cable and Equipment Removal

- .1 Include the extent of demolition work in the contract which is delineated in demolition Drawings and associated detail Drawings.
- .2 Where identified on drawings, remove cable and equipment only within specified areas; otherwise, cable and equipment removal area in scope shall encompass the entire floor(s).
- .3 Co-ordinate all Work with the current use of the building(s).
- .4 Maintain all Telecommunications services to all parts of the building which are to remain in use. Schedule all Work and inform the owner in writing at least one week in advance for permission of any necessary shutdowns or outages indicating proposed time(s) and duration(s) of interruptions.
- .5 Consult with the owner and determine the equipment required to be online 24 hours per day and provide temporary services and wiring as necessary. Reschedule Work accordingly when requested by the project manager and/or owner.
- .6 Include the cost of premium time in the contract for Work during nights, weekends, holidays, or other time outside normal working hours necessary to maintain all Telecommunications services in operation.
- .7 Scope of Demolition:
  - .1 Include removal, relocation and reinstallation of Telecommunications devices/systems/infrastructures in the areas noted on the Drawings. This shall include, but is not limited to:
    - .1 Disconnection, removal and/or reinstallation of all Telecommunications devices/systems/infrastructures to accommodate new Work. Refer to relevant electrical, architectural, structural, mechanical, and other project design Drawings to determine exact scope of work.
    - .2 All Work and material disposal shall be done in accordance with the established schedule and general conditions.
    - .3 All services passing through the area of Work, but servicing other areas of the building shall be identified, protected and left in place, unless otherwise noted.
    - .4 Disconnect and remove all existing services, devices and wiring materials which are abandoned.

- .5 Trace and identify all Telecommunications devices/systems/infrastructure for review by the Telecommunications Engineer's Representative and/or Owner in order to determine if services are to remain or to be removed. Once identified, the Telecommunications Contractor must remove those as directed.
- .8 Disposal of Materials
  - .1 Dispose of all material removed from the site in accordance with all applicable environmental legislation and regulations and as noted elsewhere in the specifications.
  - .2 Separate and recycle materials to be disposed to the maximum extent possible.
- .9 Hazardous Materials
  - .1 If at any time during course of Work hazardous materials are encountered or suspected, cease Work in area in question and immediately report, in accordance with local regulation on hazardous materials to the project manager.
  - .2 Do not resume Work in affected area without approval from the project manager.
- 2. Products
- 2.1. NOT USED
- 3. Execution
- 3.1. CABLE IDENTIFICATION
  - 3.1.1. Prior to removal of Telecommunications cabling, identify all existing non-active cabling (as well as active cabling to remain), and verify the location and extent of removal with the Owner. Tone out cables to ensure the intended cables are demolished.
- 3.2. REMOVAL OF MATERIALS
  - 3.2.1. Protect all removed (to be retained) equipment from damage. Repair or replace without adjustment to the contract price all existing equipment which is damaged in process of relocation.
  - 3.2.2. Turn over to the Owner all racks, cabinets, accessories, patch panels and voice connectivity hardware. If items are not to be re-used, confirm disposal with the Project Team prior to disposal.
  - 3.2.3. Dispose of on a daily basis all cabling and components that are removed. Include all costs of removal and disposal in the contract price.
  - 3.2.4. No equipment may be burned or sold on site.
- 3.3. SYSTEMS TO REMAIN
  - 3.3.1. All services and equipment not shown on the Drawings shall be maintained in operation during the construction phase. Provide new wiring for any existing systems to remain so that the existing systems do not interfere with the Work. Remove existing devices and reconnect to new services accordingly.
  - 3.3.2. Maintain operation of all systems outside of the renovated area which may be affected by the renovation.

- 3.3.3. Any device and/or related connectivity which have been made inoperative as a result of this Work but are not in an area to be demolished shall be reactivated at no cost to the Owner.
- 3.3.4. Trace out and catalogue all outlets within the renovated area and adjacent areas. Mark this information on a set of drawing prior to any Work commencing as these devices and/or related connectivity will be reused as part of this work as noted on the Drawings or called for in the contract documents.
- 3.3.5. Clean and test existing equipment/cabling which is to remain and equipment/cabling being reinstalled in areas being renovated for proper operation and repair as necessary before being put back into service.
- 3.3.6. Verify operation of all existing devices and report any discrepancies to the Communications Engineer's Representative and/or Owner prior to proceeding with the Work.
- 3.3.7. Unless noted otherwise provide additional equipment of the same type and manufacturer where required to supplement existing equipment.
  
- 3.4. INTERFACE WITH EXISTING SYSTEMS
  - 3.4.1. Provide interfacing components between new and existing systems as necessary for proper performance and operation.
  - 3.4.2. Check and coordinate all systems in the renovated area and in the new building addition (if applicable), which are extended to existing systems to ensure their proper operation.
  
- 3.5. FIRE STOPPING AND WATERPROOFING
  - 3.5.1. As per Section 27 00 05.70 – PROJECT SPECIFIC REQUIREMENTS, make good all Fire Stopping and Waterproofing where Fire Stopping and/or Waterproofing has been disturbed during cable removal, or where Fire Stopping and/or Waterproofing was non-existent.

END OF SECTION

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27 05 26.00 Grounding and Bonding for Telecommunications Systems

1. General

1.1. WORK INCLUDED

1.1.1. Applicable Codes & Standards

1.1.2. Provide grounding & bonding in accordance with good industry practices and in accordance with the following Codes and Standards:

- .1 ANSI/TIA-607 – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises, latest version,
- .2 ANSI/TIA-942-B – Telecommunications Infrastructure Standard for Data Centers,
- .3 CSA Standard C22.2 No.41 latest version – Grounding & Bonding Equipment,
- .4 Local Codes & Bylaws, and
- .5 BICSI requirements.

1.1.3. Refer to Electrical Specifications for Electrical Codes and Building Codes.

2. Products

2.1. APPROVED MANUFACTURERS

2.1.1. All components of the Grounding & Bonding Infrastructure shall be by Panduit Canada or equivalent.

2.1.2. Typical part numbers are as follows;

- .1 Rack Grounding Strips: Part# RGS134-1Y
- .2 Rack Jumper Kits: Part# ACG24K
- .3 Thread forming screws shall be used: Part # RGTS-CY or RGTS6-C, and
- .4 Bonding screws: Part# RGTBS-C or RGTBS6-C.

2.1.3. A Green Jacketed #6 AWG Stranded Copper Conductor shall be used to ground the Telecommunications grounding system to all;

- .1 Telecommunications Cabinets,
- .2 Telecommunications Racks,
- .3 Telecommunications Metallic Pathways including cable tray, conduit, etc,
- .4 Metallic sheath of all Backbone Cables (use appropriate manufacturer's bond clamp), and
- .5 All Telecommunications enclosures including consolidation point enclosures, building entrance protection panels, etc.

2.2. CABLE BONDING

2.2.1. Bond all backbone cables containing armouring or a metallic sheath using bonding clamps.

2.2.2. Approved Products:

- .1 Commscope 12A1 CLAMP 700025513,
- .2 Belden X9905753, or

.3 Equivalent.

### 2.3. GROUNDING LUG KITS

2.3.1. All Building Entrance Terminal frames must be grounded to the busbar provided by Division 26 using Grounding Lug Kits. One Grounding Lug Kit must be used per Building Entrance Terminal frame.

2.3.2. Approved Products:

- .1 TE Connectivity 556438-1, or
- .2 Equivalent.

## 3. Execution

### 3.1. INSTALLATION

3.1.1. Determine if the grounding conductor shall be placed near the bottom or top of the Telecommunications cabinets, racks, or enclosures. Do not proceed to install the conductor(s) until direction has been given. Ensure that complete metal-to-metal contact is made when grounding to painted or powder coated metal surfaces.

3.1.2. Coordinate the installation of a properly sized Copper Grounding Busbar and associated hardware in the Telecommunications Room with the Electrical Contractor. The Busbar shall be permanently connected to the building ground system by the Electrical Contractor.

3.1.3. Grounding & Bonding Infrastructures installed by the Contractor shall not interfere with the existing grounding practices within the customer premises.

3.1.4. Provide one (1) rack grounding strip c/w #6 AWG green grounding wire connection back to grounding Busbar for each Telecommunications rack or cabinet as depicted on room layouts.

3.1.5. Provide one (1) rack jumper kit for each piece of network equipment as depicted on rack elevation drawings.

3.1.6. Use thread forming screws, bonding screws & any other hardware necessary to complete the ground system.

### 3.2. CABLE BONDING

3.2.1. All backbone cables containing armouring or a metallic sheath shall be grounded using a bonding clamp. All bond clamps must attach the cable shield and be connected to the grounding Busbar using minimum #6 AWG green grounding wire.

3.2.2. Ensure that the teeth of the bond clamp penetrate the cable sheath of all shielded cables.

END OF SECTION

27 05 28.00 Pathways for Telecommunications Systems

1. General

1.1. WORK INCLUDED

- 1.1.1. Supply and install cabling as detailed in the Contract Documents. Use pathways installed by the Electrical Contractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangers.
- 1.1.2. Do not use any mechanical or electrical fittings to support the Telecommunications cabling.
- 1.1.3. Independently support the cables above all ceiling tiles in such a manner that the cables do not interfere with the removal of the ceiling tiles. Maintain a minimum of 75 mm 3”(in) of clear vertical space above the ceiling tiles shall .
- 1.1.4. Obtain the Telecommunications Engineer’s Representative approval for all deviations from the contract documents and Drawings in relation to cable routing, outlet and equipment locations.

1.2. INDOOR CABLE DISTRIBUTION

- 1.2.1. Utilise all indicated and available cable pathways such as conduits, Telecommunications cable tray, ducts, surface raceways installed by the Electrical Contractor, and furniture system channels except where otherwise noted.
- 1.2.2. Inside buildings minimize any possibilities of interference by maintaining the following minimum clearances from electrical and heat sources when routing cables.

Item	Minimum Separation Distances		
	(<2kVA)	(2-5kVA)	(>5kVA)
Unshielded power lines or electrical equipment in proximity to open or non-metallic pathway.	127 mm (5”(in))	305 mm (12”(in))	610 mm (24”(in))
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5”(in))	152 mm (6”(in))	305 mm (12”(in))
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	---	76 mm (3”(in))	152 mm (6”(in))
Motors	1.2 m (4’-0”)		
Transformers	1.2 m (4’-0”)		
Fluorescent Luminaires	300 mm (12”)		
Pipes (gas, oil, water, etc.)	120 mm (5”)		
HVAC (equipment, ducts, etc.)	150 mm (6”)		

2. Products

2.1. NON-CONTINUOUS CABLE SUPPORT

- 2.1.1. Supply and install cable support for the distribution of horizontal and backbone cables where conduit or cable tray has not been provided.

- 2.1.2. Use non-continuous cable supports up to the maximum density of cables permitted, as specified by the manufacturer.
- 2.1.3. Provide adequate supports to suit the quantity of cables in runs used for distribution.
- 2.1.4. Include any other miscellaneous hardware (angled hanger bracket, hammer/screw on clamps) required to support horizontal and backbone cabling.
- 2.1.5. Approved Manufacturers:
  - .1 Erico,
  - .2 Panduit, or
  - .3 An equivalent and sized as per manufacturer recommendations.
- 2.1.6. Approved Products
  - .1 Panduit J-Pro, J-Mod, or equivalent cable supports shall be used where ceiling space rating dictates.

Description	Panduit Part#	J-Mod
Wall Mount	JP2W-L20	Equivalent
Ceiling Mount	JP2CMB-L20 SPEC	Equivalent
Drop Wire and Threaded Rod Clip	JP2DW-L20	Equivalent
Screw-On Beam Clamps	JP2SBC50-L20 or JP2SBC50RB-L20	Equivalent
Hammer On Beam Clamps	JP2HBC25RB-L20 or JP2HBC50RB-L20 or JP2HBC75RB-L20	Equivalent
Purlin Clips	JP2ZP-L20 or JP2CP-L20	Equivalent
Under Floor Pedestal Support Clamp	JP2UF100-L20	Equivalent

- 2.2. VELCRO STRAPS
  - 2.2.1. Provide only Velcro straps for bundling of cable. Under no circumstance shall plastic tie-wraps be used.
  - 2.2.2. Acceptable Manufacturers
    - .1 Panduit: HLS/HLM-15R0 (Black), or
    - .2 Approved equivalent
  - 2.2.3. If plastic tie-wraps are used the Telecommunications Contractor shall remove and replace all affected cables at their own expense.
- 2.3. SPIRAL WRAP
  - 2.3.1. Size Spiral Wrap according to quantity of cables being fed into the system furniture. Spiral Wrap colour shall match system furniture manufacturer's power feed.
  - 2.3.2. Approved Manufacturers:
    - .1 Panduit part number: T50F-CX, or
    - .2 Approved equivalent.

3. Execution

3.1. CABLE DISTRIBUTION

- 3.1.1. Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.
- 3.1.2. Install and terminate all cables and components in accordance with applicable Codes, Standards and Regulations.

3.2. CABLE SUPPORT

- 3.2.1. Supply and install supports, hanger supports, and any other miscellaneous hardware required to support Telecommunications cabling where conduit/cable tray has not been provided. Any conduit and cable tray shall be provided by the Electrical Contractor as indicated on Division 27 Drawings, unless otherwise noted. Telecommunications Contractor is responsible for determining these requirements based on Telecommunications and/or Electrical Drawings.
- 3.2.2. Install hangars at 4' intervals (maximum). Do not exceed a cable sag greater than 4". Secure all cables to J-hooks/supports with Velcro straps. Comb and dress cables for all visible portions of the install. Comb and redress any cables that do not meet this criteria at no additional cost.
- 3.2.3. Run all cable support hangers and inner duct parallel to building lines.
- 3.2.4. Cable support hangers or hanger supports must not be drilled into post-tensioned beams under any circumstances.
- 3.2.5. Be responsible for coordinating the best time to install the supports with the General Contractor. After hours Work may be required for this portion of the Work.
- 3.2.6. Size supports to accommodate the number of cables in each run. Provide other hardware such as hammer on clamps, screw on clamps and angled hanger brackets to support the backbone and/or horizontal cabling.
- 3.2.7. In the Cable Support Hanger System, each individual run or pathway shall not contain more than fifty (50) UTP horizontal cables. Provide an additional hanger pathway to divide the cable bundle where the quantity exceeds this.
- 3.2.8. Completely and independently support the hangar system from the structural ceiling or walls (concrete slab/deck). Do not support the cable support hanger system from the suspended ceiling. Do not drill anchors for hangers into post tensioned beams under any circumstances. Do not use pneumatic hammers. All anchors must be drilled into slab.
- 3.2.9. Minimize the disturbance or removal of 'fire spray' insulation during installation of cable supports.

3.3. VELCRO STRAPS

- 3.3.1. Use Velcro straps to neatly dress cables; they shall be placed at a maximum of 4' intervals for horizontal distribution (centre points between cable supports).
- 3.3.2. Use Velcro straps to dress horizontal cables into racks/cabinets. For each row of the patch panel, the maximum spacing of Velcro for horizontal cables into or along vertical cable managers shall be no more than 6", this includes cabling dropped from the ladder tray or ceiling above.

3.4. SPIRAL WRAP

- 3.4.1. Install spiral wrap from system furniture feed points to system furniture entry point. Spiral Wrap shall be butted so that no cables are exposed.

### 3.5. CABLE DISTRIBUTION

- 3.5.1. Ensure ANSI/TIA-568.1, latest edition standard installation practices are followed for indoor cable distribution and ANSI/TIA-758, latest edition standard installation practices are followed for outdoor cable distribution.
- 3.5.2. Station personnel at each access point (i.e. Handhole, maintenance hole, etc.) to observe the cables being pulled. Submit tension pull calculation for installation of cables to Telecommunications Engineer's Representative.
- 3.5.3. Do not exceed the Copper/Fibre cables maximum tensile rating during installation. Monitor tension of the cable during installation. Use a dynamometer to record installation tension. Use a tension limiting device to prevent the exceeding of maximum pulling tension Specifications during installation. Set the tension limit at or below the manufacturer's limit. The cable shall be taken up at intermediate pulling points with an intermediate take-up device as approved by the Telecommunications Engineer's Representative, to prevent over tension on the cable.
- 3.5.4. Do not exceed the minimum bend radius as per the manufacturer's recommendations.
- 3.5.5. Make cable pulls continuous and steady between pull points. Do not interrupt the pull unless necessitated by excessive tension on the cable.
- 3.5.6. Protect exposed cable ends from moisture ingress.
- 3.5.7. Provide sufficient slack for cable passing through maintenance holes for expansion/contraction and install clips to prevent sagging.

### 3.6. CABLE LUBRICANT

- 3.6.1. The use of pulling lubricants of any kind is strictly prohibited

### 3.7. DUCT AND CONDUIT

- 3.7.1. Clean out each section of duct or conduit by pulling a steel wire brush and mandrel of the correct size through the duct or conduit before pulling cables. Bush, ream and remove any sharp projections on all conduits prior to installation of Telecommunications cables. When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Telecommunications Engineer's Representative of the problems encountered.
- 3.7.2. Pull cables in bottom ducts/conduits first, leaving top ducts/conduits for future use. Cable grip shall be attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip shall have a ball bearing swivel to prevent the cable from twisting during pulling.

END OF SECTION

27 05 53.00 Identification for Telecommunications Systems

1. General

1.1. WORK INCLUDED

1.1.1. Labelling

- .1 Confirm the cable designations with the Telecommunications Engineer's Representative prior to installation.
- .2 Adhere to CSA T528-93 (ANSI/TIA-606-latest version) colour codes.
- .3 Confirm labelling schemes with the Telecommunications Engineer's Representative prior to installation. The cable labelling scheme for all cables at both ends shall be as follows:

1.1.2. Horizontal Cable Labelling Schema

- .1 Refer to the latest version of the University of Toronto Communications Infrastructure Specifications, Standards and Practices document.

2. Products

2.1. CABLE LABELS

- 2.1.1. All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in ANSI/UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in ANSI/UL 969 for indoor use.
- 2.1.2. Provide self-laminating vinyl cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area shall be of sufficient length to wrap around the cable at least one and one-half times.
- 2.1.3. Approved Manufacturers:
  - .1 Panduit: Part# LS8E,
  - .2 Easy-mark labeling software: Part# PROG-EMCD, or
  - .3 Equivalent.

2.2. LAMACOID LABELS

- 2.2.1. Provide black lamacoid plates with white 60 point Arial Narrow, engraved upper case letters enclosed by a white border on black background for racks, cabinets, and enclosures.

3. Execution

3.1. INSTALLATION

- 3.1.1. All active and passive equipment shall be labeled.

3.2. LABELLING

- 3.2.1. All labels must be mechanically printed using a laser printer. Hand-written labels are not permitted.

3.2.2. Provide 25% spare labels in each telecommunications room.

3.3. LABEL LOCATIONS

3.3.1. Cable identification labels shall appear at the following locations with the numbers indicated on the cable schedule and Drawings:

- .1 102 mm 4" (in) from each end of the cable after termination,
- .2 Front of Patch Panels,
- .3 Front of IDC termination blocks,
- .4 Front of workstation/Telecommunications outlet faceplates, and
- .5 Each end of each Telecommunications Conduit.

3.3.2. Labels must be visible during installation and normal maintenance of the infrastructure.

3.3.3. Affix lamacoid labels to the front and rear of equipment in racks, cabinets.

END OF SECTION

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27 08 00.00 Commissioning for Telecommunications Sections

1. General

1.1. WORK INCLUDED

1.1.1. General Testing Requirements

- .1 Test 100% of the installed cabling links. All cables must pass the requirements of the Standards as defined within this document. Any failing link must be diagnosed and corrected. Re-test to prove that the corrected link meets the performance requirements. Provide the final and passing result of the tests for all links in the test results documentation.
- .2 Correct all deficiencies before the Telecommunications Engineer's Representative will provide a certificate to release the Holdback on the project.
- .3 Submit a soft copy of test results in PDF and another ODBC compatible database format.
- .4 Test Patch Cords for portable tester must be designed for testing by the manufacturer. Field assembled Patch Cords are not acceptable. Field testers must use the appropriate jack/tester adapter specified for use with the cabling jack(s) specified within this document.
- .5 Submit a test plan to the Telecommunications Engineer's Representative for approval prior to testing.
- .6 Submit a test report based on the cable schedules. Indicate for each cable, when it was tested successfully and the signature of the technician that performed the test, location, cable type, cable number and tester make and model. An authorised person shall sign the test report at the completion of the project.

1.1.2. Copper Cabling Test Requirements

- .1 Test every cabling link in the installation (as required by the Cabling specified) in accordance with the Telecommunications Industry Association (TIA) Standard ANSI/TIA-1152, latest edition.
- .2 Test installed twisted-pair horizontal links from the Telecommunications Room to the workstation against the "Permanent Link" performance limits Specification as defined in ANSI/TIA-568.2, latest edition.
- .3 Only trained technicians who have successfully attended an appropriate training program and have been certified must execute the tests. Appropriate training programs include installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals) and Vendor supplied certifications for their product.
- .4 Test equipment shall comply with or exceed the accuracy requirements for enhanced level II and/or level III and/or level IIIe field testers (according to Cabling specified) as defined in ANSI/TIA-1152, latest edition. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in ANSI/TIA-1152, latest edition.
- .5 The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. Provide proof that the interface has been calibrated within the period recommended by the Manufacturer. Ensure that

normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

- .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail\* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass\*.
- .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. Submit all Pass\* categorized cable test results to the Owners' Engineering Representative for review and approval. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. (Reference TIA-568, latest edition;).

#### 1.1.3. Copper Cabling Performance Test Parameters

- .1 The test parameters for Category 6a are defined in TIA Category 6a Standard, which refers to TIA-568.2, latest edition. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test all measurements (at each frequency in the range from 1 MHz through 500 MHz) must meet or exceed the limit value determined in the above-mentioned Standard.
- .2 Testing of all 4 pairs of the horizontal cable (as specified in this document) shall include but not be limited to the following:
  - .1 Wire Map including; end to end continuity, open and shorts, pair polarity,
  - .2 Cable length,
  - .3 Attenuation,
  - .4 Return Loss,
  - .5 NEXT/FEXT,
  - .6 ACR,
  - .7 ELFEXT, PSELFEXT,
  - .8 Propagation Delay, Delay skew, and
  - .9 PSNEXT, PSACR.
- .3 Permanent link testing of all horizontal and backbone cables shall be completed in accordance with the follow test criteria:
  - .1 Wire Map including; end to end continuity, open and shorts, pair polarity,
  - .2 Cable length, and
  - .3 Basic Link.
- .4 The nominal velocity of propagation (NVP) must be set specific to each cable manufacturer before testing. The portable tester shall be within the calibration period recommended by the manufacturer in order to achieve the manufacturer-specified measurement accuracy. Refer to manufacturer's test procedure.

#### 1.1.4. Cable Test Result Documentation

- .1 Record the test result information for each link in the memory of the field tester upon completion of the test.
- .2 The tester must transfer saved test result records into a Windows™-based database utility that allows for the maintenance, review and archiving of these test records. Provide a guarantee that the measurement results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test and that these results cannot be modified at a later time.

- .3 Provide a PDF copy of the test results that lists all the links that have been tested with the following summary information:
    - .1 The identification of the link in accordance with the naming convention defined in the overall system documentation,
    - .2 The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst case margin (margin is defined as the difference between the measured value and the test limit value),
    - .3 The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number, and
    - .4 The date and time the test results were saved in the memory of the tester.
  - .4 Provide general information in the electronic data base containing the test result information for each link:
    - .1 The identification of the Owner site as specified by the end-user,
    - .2 The overall Pass/Fail evaluation of the link-under-test,
    - .3 The name of the Standard selected to execute the stored test results,
    - .4 The cable type and the value of the 'index of refraction' used for length calculations,
    - .5 The date and time the test results were saved in the memory of the tester,
    - .6 The brand name, model and serial number of the tester, and
    - .7 The revision of the tester software and the revision of the test Standards database in the tester.
  - .5 Provide detailed test results data in the electronic database and PDF for each tested Copper Cable including:
    - .1 The identification of the link in accordance with the naming convention defined in the overall system documentation,
    - .2 The cable type and the value of NVP used for length calculations,
    - .3 The identification of the tester interface, and
    - .4 The test results information must contain information on each of the required test parameters that are listed in this document.
2. Products
- 2.1. APPROVED MANUFACTURERS
    - 2.1.1. Copper Testers
      - .1 HP/Agilent, or
      - .2 Fluke DSP-4000.
  - 2.2. WARRANTY AND CERTIFICATION
    - 2.2.1. Provide to Owner, one system certification at the end of the project.

3. Execution

3.1. WARRANTY AND CERTIFICATION REQUIREMENTS

3.1.1. Submit the Structured Cabling Solution certification and the user manual.

3.1.2. Provide letter(s) of Certification within two weeks of the date of substantial performance of the contract of the project to the Telecommunications Engineer's Representative. This document will include the following:

- .1 Verification of the performance of the installed system,
- .2 Identification of the installation by location and project number, and
- .3 A copy of the Warranty.

3.1.3. Within 7 days of the award of contract, submit copies of the Structured Cabling Solution certification request for Certification form complete with certification number(s) for the project. Provide a copy of the form with Specification submission.

END OF SECTION

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27 11 16.00 Telecommunications Cabinets, Racks, Frames and Enclosures

1. General

1.1. WORK INCLUDED

1.1.1. Equipment Locations

- .1 Devices, Racks, Cabinets, Brackets and Backboards may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3.05m (10'-0') without adjustment to the Contract price.

1.1.2. Plywood Backboards

- .1 Provide plywood backboards for mounting of voice fields, data fields, wall mount racks, wall mount brackets, wall mount cabinets, swing-out racks, termination of horizontal and backbone cables, or for any other use as specified in the scope of Work and/or on drawings including but not limited to for use by others. Refer to detail drawings for location of backboards.

1.1.3. Telecommunication Racks and Cabinets

- .1 Provide all wall mount brackets, racks, cabinets and components as indicated in this document and on the Contract drawings.
- .2 Provide all racks, cabinets, wall mount brackets and components from the same manufacturer and identical style shall be used throughout the project, unless specifically noted in this section.
- .3 All racks, cabinets, wall mount brackets and components shall meet or exceed requirements as defined by ANSI/EIA-310-E, Cabinets, Racks, Panels and Associated Equipment.
- .4 All racks, cabinets, wall mount brackets and components required for this project will be reflected on Telecommunications Room Layout & Rack Elevation Detail drawings (If required).
- .5 At a minimum, provide one (1) new 2U horizontal cable management panel for each new patch panel installed, when no rack elevation drawing is provided. Quantities shown on rack elevation drawing(s) shall supersede this requirement.
- .6 In all cases wall mount brackets, racks, cabinets and components shall be powder-coated black.
- .7 Approved Manufacturers:
  - .1 APC by Schneider Electric,
  - .2 Chatsworth Products Canada
  - .3 Belden Incorporated,
  - .4 D.L. Custom,
  - .5 Hammond Manufacturing Company Limited,
  - .6 International ElectronMetal, or
  - .7 Panduit Corporation.

1.1.4. Cabling

- .1 Reference General requirements and the Execution requirements as applicable under Sections 27 15 00.19 DATA TELECOMMUNICATIONS HORIZONTAL CABLING.

2. Products

2.1. TELECOMMUNICATIONS RACK & CABINET COMPONENTS

2.1.1. Horizontal Cable Management Panel

- .1 Welded construction, fabricated of a minimum of 16 GA (0.060") steel & shall be a minimum of 2U and 76mm (3")D.
- .2 Panel shall have hinged cover with nonmagnetic closing mechanism. A fully shielded magnetic closing mechanism shall also be accepted.
- .3 Openings for cable routing shall have grommets to ensure smooth transition of the cables.

2.2. PLYWOOD BACKBOARDS

- 2.2.1. Backboards must be constructed of 3/4" G1S CANPLY Exterior Grade plywood (4'x8' sheet), one side good and painted with two (2) coats of white fire retardant non-conductive paint

3. Execution

3.1. TELECOMMUNICATIONS WALL MOUNT BRACKETS, RACKS, CABINETS AND COMPONENTS

- 3.1.1. Properly secure the racks on top of the finished floor and wall. Ground all racks and cabinets in accordance with the parameters within this specification document.
- 3.1.2. Refer to detail drawings for location(s) of Telecommunications wall mount brackets, racks and cabinets.
- 3.1.3. Provide all Telecommunications rack and cabinet components as per the detail drawings. Provide (including levelling and ganging) all racks, cabinets and their components for a complete functioning system.
- 3.1.4. Secure all wall mounted equipment (i.e. rotating rack & wall mount cabinet) backboards.

3.2. TELECOMMUNICATIONS RACK & CABINET COMPONENTS

3.2.1. Horizontal Cable Management Panel

- .1 Install one horizontal cable manager per rack plus an additional one for every patch panel and every network switch when no rack elevation is provided, otherwise quantities on rack elevation drawing supersede this requirement. Assume 48 port switches, one port for every horizontal cable installed.

3.3. PLYWOOD BACKBOARDS

- 3.3.1. Place plywood sheets vertically mounted directly on the wall. Refer to Drawings for location(s) of Backboard(s). Provide backboards unless otherwise noted.

3.3.2. Flush Backboards

- .1 Use backboards for wall mounted racks, wall mounted cabinets, wall mount brackets, telephone equipment, service provider equipment, lightning protection, horizontal cables, riser cables, IDC punch down blocks, and/or any other use as identified in the scope of Work for this project, including for use by others. Install flush backboards where required as shown on drawings.

END OF SECTION

27 11 19.00 Telecommunications Termination Blocks and Patch Panels

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2. COPPER PATCH PANELS

1.2.1. The Patch Panel shall support the appropriate applications, and facilitate cross connection and inter-connection using Modular Patch Cords.

2. Products

2.1. COPPER PATCH PANELS

2.1.1. 482 mm (19”) rack mountable MDVO or High Density style 1U 24-port or 2U 48 Port Patch Panel. Refer to Rack Elevation Detail(s) for correct style.

2.1.2. Minimum 50 microns of hard gold over nickel or copper on outlet contact wires.

2.1.3. Patch Panels shall be suitable for rack mounting and shall incorporate integral labeling spaces for port identification. Provide blank labeling strips.

2.1.4. Colour: Black

3. Execution

3.1. PATCH PANELS

3.1.1. Provide Patch Panels in each rack location in sufficient quantities to terminate all horizontal cables specified with no less than 6 spare ports per Patch Panel to be left vacant for future use.

END OF SECTION

---

27 15 00.19 Data Telecommunications Horizontal Cabling

1. General

1.1. WORK INCLUDED

- 1.1.1. Supply and install cabling as detailed in the Contract Documents. The Telecommunications Contractor shall use pathways by the Electrical Contractor to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point they shall use cable support hangars.
- 1.1.2. Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
- 1.1.3. Ensure ANSI/TIA-568.2, latest edition installation practices are followed. Install horizontal cables in accordance with manufacturer's specifications ensuring that proper installation techniques are adhered to.
- 1.1.4. Terminate all pairs of cable at each cable end.
- 1.1.5. Inform the Telecommunications Engineer's Representative immediately of any horizontal cable runs exceeding 90 m 295'(ft). Minimum horizontal cable run (if required) shall not be less than that specified in manufacturer's specifications.
- 1.1.6. The Telecommunications Engineer's Representative shall determine the quality of workmanship during installation. Cables that have not been properly installed will be reinstalled by the Telecommunications Contractor at no additional expense to the contract.

1.2. CABLE ROUTING

- 1.2.1. Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Telecommunications Engineer's Representative prior to installation.
- 1.2.2. Any deviation from the cable routing, outlet and equipment locations shown on drawings must be approved by the Telecommunications Engineer's Representative and documented on as-built drawings.

2. Products

2.1. 4-PAIR HORIZONTAL COPPER CABLE

- 2.1.1. Four pair, twisted pair cable consisting of #22-26 AWG solid conductors, formed into four individually twisted pairs and enclosed in an appropriately rated thermoplastic jacket as required by local codes. All individual conductors to be insulated with fluorinated ethylene propylene (FEP).
- 2.1.2. All cabling must be CSA certified and stamped accordingly
- 2.1.3. Cable to withstand a bend radius of 25.4 mm (1") at a temperature of  $-20^{\circ}\text{C} \pm 1^{\circ}\text{C}$  without jacket or insulation cracking.

2.1.4. All cables shall have an outer jacket colour as identified below:

Cable Designation	Colour
All Cable Types	Blue

## 2.2. SYSTEM PERFORMANCE

### 2.2.1. 4-Pair Horizontal Copper Cabling

.1 All components of the horizontal data channel shall meet the minimum performance characteristics of:

Cable Designation	Performance
All Cable Types	Category 6a – 500MHz and a data rate of 10Gb/s, with an outside diameter no greater than 0.27”.

## 2.3. CERTIFICATION

### 2.3.1. Acceptable manufacturers for the complete Structured Cabling Solution:

- .1 Manufacturer / Contractor Certification
  - .1 Belden Incorporated / CSV – Certified Systems Vendor
  - .2 Panduit Corporation / PCI – Panduit Certified Installer
  - .3 CommScope Holding Company Incorporated (Uniprise) / CPP – CommScope Partner Pro

## 3. Execution

### 3.1. GENERAL CONDITIONS

3.1.1. Remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 mm (1/2”) for Category 5 to 6a cables and 25 mm (1”) for Category 3 cables. Any specific manufacturer’s installation guidelines shall supersede the above.

3.1.2. Do not splice any cables for any reason, unless prior consent is given by the Engineer’s Representative.

### 3.2. INSTALLATION

3.2.1. Avoid scraping, denting, painting, or otherwise damaging cables, before, during or after installation. Replace damaged cables without any additional compensation.

3.2.2. Ground all cables and components to manufacturer’s specifications and standard practices.

### 3.3. HORIZONTAL CABLE DISTRIBUTION

3.3.1. Provide a minimum of 3.05 m (10’-0”) of slack at both ends of each cable to permit future cable relocation. Neatly coil slack in ladder tray. If ladder tray is not available ceiling space and cable supports may also be used to coil slack. For completely enclosed zone conduit distribution systems, provide 3.05 m (10’-0”) of slack at the Telecommunications room end only.

- 3.3.2. Follow proper installation and termination practices for UTP copper and Optical Fibre cables. Do not kink or exceed the cable minimum bend radius or maintain a minimum of four (4) times cable diameter as bend radii if the manufacturer specifies no bend radius. For Optical Fibre cables maintain a minimum of ten (10) times the cable diameter or 30 mm (1.2") whichever is larger for a bend radius.
- 3.3.3. Bundle all horizontal cables on the Telecommunications Racks using Velcro straps. Separate Voice, Data and fibre cables into separate distinct bundles for identification purposes where applicable.
- 3.3.4. Strap bundles in Telecommunications rooms, at a maximum of 203 mm 8"(in) separation. Bundles shall contain no more than fifty (50) cables to eliminate any excessive stress on the cable jackets.
- 3.3.5. When bundling cables, comply with manufacturer's recommended bundling practices for installation. Ensure that excess pressure is not placed on the cable at any point that may result in the compression or deformation of the cable jacket and internal pair/conductor geometry.
- 3.3.6. All exposed cabling at the workstation between wall/floor-input point locations and systems furniture is to be wrapped with black split loom tubing, size and length as required to suit.
- 3.3.7. Route/install Telecommunications cabling in systems furniture, lab casework furniture & mill work as denoted on floor plans.
- 3.3.8. Provide Data cables to each outlet indicated on the drawings. The Telecommunications Contractor shall refer to the legends on the drawing to determine the number of cables to each outlet location.

#### 3.4. TERMINATION REQUIREMENTS

##### 3.4.1. UTP Cables

- .1 Terminate cabling using TIA 568A configuration, unless noted otherwise.
- 3.4.2. Terminate test and label each cable in accordance to the parameters stated in this specification document.

END OF SECTION

27 15 43.00 Telecommunications Faceplates and Connectors

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2. OUTLET LOCATIONS

1.2.1. Horizontal Cable outlets may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3.05m (10'-0') without adjustment to the Contract price.

1.3. OUTLET COVER PLATES

1.3.1. When Electrical and Telecommunications receptacles are ganged together, cover plates shall be supplied and installed by the Electrical Contractor, unless otherwise noted. Where Telecommunications receptacles are stand alone or separate from Electrical receptacles, cover plates shall be supplied and installed by the Telecommunications Contractor.

2. Products

2.1. EIGHT-POSITION MODULAR CONNECTORS

2.1.1. The eight-position modular connectors must be matched appropriately with the cables to ensure that end to end Manufacturer Warranties will be applicable.

2.1.2. Eight-position modular style outlet with insulation displacement contacts for termination of all eight conductors.

2.1.3. Outlets shall be suitable for installation in faceplates at work station locations, surface raceway, or surface mount boxes.

2.1.4. All Data and Voice modules shall have the following minimum performance parameters:

- .1 Modular Jack Current rating: 1.5 amperes maximum
- .2 Modular Jack Durability: 1,000 mating cycles
- .3 Modular Jack Contact Pressure: 100 grams, minimum per contact
- .4 Dielectric Voltage Strength: 1,000 V RMS at 60 Hz for 1 minute
- .5 Insulation Resistance: 200 MΩ minimum
- .6 Contact Resistance: 1 M Ω per contact

2.1.5. All Horizontal 4-pair cables shall be terminated with the jack colours as described below. Where the specified Copper Patch Panels are modular, the same jack colours shall be used at both ends of each cable:

Function	Colour	Quantity
Data	Blue	As per Drawing
Wireless Access Point	White	As per Drawing (workstation end)

Wireless Access Point	White	As per Drawing (Telecom Room end)
AV Data	Green	As per Drawing
Security	Grey	As per Drawing

2.1.6. Outlets shall be suitable for installation in faceplates at workstation locations, surface raceway, or surface mount boxes.

## 2.2. CATV CABLE CONNECTORS

2.2.1. All CATV cable connectors shall be Snap-N-Seal "F" Connectors.

2.2.2. The Snap-N-Seal "F" Connectors shall have the following minimum performance parameters:

- .1 Permanently stamped part number and colour-coded sleeves for easy identification before and after installation.
- .2 Quad sealed system prevents moisture from migrating into the connection.
- .3 360° radial compression provides superior RF integrity (-95dB typical, 60% bonded foil cable).
- .4 1/4"x 1/4" cable preparation.
- .5 Connector to cable retention 40 lbs minimum.
- .6 Minimum return loss performance of -30dB to 1GHz.
- .7 Manufactured of high quality 360 brass, cadmium plated with yellow chromate coating for maximum corrosion resistance. Plastic and O-ring providing a reliable environmentally sealed connector.

2.2.3. Terminate all CATV cable drops in Telecom Rooms on Snap-N-Seal "F" connectors. The Telecommunications Contractor shall coordinate with the CATV service provider, the exact termination locations and amount of slack to be left on each cable.

## 2.3. WORKSTATION OUTLETS

2.3.1. Modular Furniture Faceplate

2.3.2. Use 3 or 4-port modular furniture faceplate adapters for furniture outlets that have modular furniture knockouts. Equip each outlet with the appropriate UTP modules as indicated in this section.

2.3.3. Use recessed blanks for all unused ports. Blanks must match the frame colour.

2.3.4. Verify furniture manufacturer prior to ordering.

2.3.5. Provide a 1/2" spacer/adaptor, if required, to ensure faceplate can be properly installed on systems furniture maintaining proper bend radius

## 2.4. DECORA ADAPTERS

2.4.1. UTP Cables

- .1 Where Telecommunications wall boxes are ganged with electrical outlet boxes, floor or raceway outlets shall utilise 3 or 4-port Decora style adapters/inserts. Equip each outlet with the appropriate UTP modules as indicated in this section.
- .2 Provide all Telecommunications workstation adapters/inserts for all Telecommunications outlets (ganged or single) when decora style faceplates are utilized. Provide decora style faceplates for all Telecommunications wall box locations where not ganged with Electrical.

2.5. BLANK INSERTS

2.5.1. Install Blank Inserts in unused Telecommunications ports. Blank inserts shall match faceplates.

2.6. SURFACE MOUNT BOXES

2.6.1. All systems furniture raceways that do not have a modular furniture knockout shall utilise 2- or 4-port surface mount boxes. Each outlet shall be equipped with the appropriate UTP modules as indicated in this section.

2.7. FLOOR MONUMENT

2.7.1. Floor monuments and faceplates shall be provided by Division 26 (Electrical). Refer to Division 26 Specifications and Drawings for further information

2.7.2. Telecommunications Contractor shall determine type of module required to suit floor monument (i.e. MDVO, Keystone, etc.)

2.7.3. Where applicable, use recessed blanks for all unused ports. Blanks to match faceplate colour.

3. Execution

3.1. GENERAL CONDITIONS

3.1.1. When terminating Copper Cables remove only enough cable jacket to perform termination, untwist pairs a maximum of 13 mm (1/2") for Category 5e / 6 / 6A cables and 25 mm (1") for Category 3 cables.

3.1.2. At the workstation end, terminate each 4-pair Horizontal Cable on an appropriately colored 8-position module, located in the specified style faceplate. At the Telecommunications Room end, terminate cables within their respective termination fields. Refer to Detail Drawings for further details.

3.2. WORKSTATION OUTLET ORIENTATION

3.2.1. Verify the position of jacks with the Telecommunications Engineer's Representative prior to installation.

3.2.2. Modular Furniture Faceplate

.1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below:

Data 1	Top		Data 1	Left
Data 2	Middle	or	Data 2	Middle
Voice	Bottom		Voice	Right

3.2.3. Decora Adapters

.1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below

Data 1	Top		Data 1	Left
Data 2	Middle	or	Data 2	Middle
Voice	Bottom		Voice	Right

3.2.4. Surface Boxes

- .1 The orientation of the Data and Voice modules at the Workstation from the perspective of the user is as indicated below:

Data 1	Top Left		Data 1	Bottom Left
Data 2	Top Right	or	Data 2	Top Left
Voice 1	Bottom Left		Voice 1	Bottom Right
Voice 2	Bottom Right		Voice 2	Top Right

3.3. COVER PLATES AND DECORA STYLE BLANKS

- 3.3.1. Provide cover plates and decora style blanks to all unused Telecommunications rough-ins.

3.4. BLANK INSERTS

- 3.4.1. All unused Telecommunications ports must be installed with blank inserts. For copper patch panels, use Black. For workstation outlets match existing/electrical.

END OF SECTION

27 16 19.00 Telecommunications Patch Cords and Cross Connect Wire

1. General

1.1. WORK INCLUDED

1.1.1. Conform to Section 27 00 05.10 – GENERAL INSTRUCTIONS FOR TELECOMMUNICATIONS SECTIONS.

1.2. COPPER PATCH CORDS

1.2.1. Connect UTP Patch Cords in the Telecom Room to the active equipment using 8 position 4 pair T568A/B:T568A/B Patch Cords.

1.2.2. The Patch Cords shall be CMR (FT4) rated and stamped accordingly and shall be consistent with the diameter, grade, and manufacturer of the Telecommunications cable that is being Warranted.

2. Products

2.1. UTP PATCH CORDS AND PIGTAIL ASSEMBLIES

2.1.1. All Data Patch Cords shall be connected in the Telecom Room to the Owner supplied active equipment using 8 position 4 pair patch cords.

2.1.2. The Patch Cords shall be CMR (FT4) rated and stamped accordingly and shall be consistent with the diameter grade and manufacturer of the Telecommunications cable that is being warranted.

2.1.3. Patch cords shall have stranded copper conductors (where system dictates) and designed to provide a mated-connection performance that exceeds the requirements per ANSI/TIA-568-D.

2.1.4. Patch cords and pigtail assemblies to be factory assembled and not site prepared, complete with snag less boot.

2.1.5. Patch Cord / Pigtail requirements:

Designation	Termination	Colour	Length	Location
Data	RJ45/RJ45	TBA	10' (ft) 3m	Telecom. Room
Data	RJ45/RJ45	TBA	7' (ft) 2.13m	Workstation
Wireless Access Point	RJ45/RJ45	TBA	10' (ft) 3m	Telecom. Room
Wireless Access Point	RJ45/RJ45	TBA	1' (ft) 0.3m	Workstation
AV Data	RJ45/RJ45	TBA	10' (ft) 3m	Telecom. Room
AV Data	RJ45/RJ45	TBA	3' (ft) 0.91m	Workstation
Security	RJ45/RJ45	TBA	10' (ft) 3m	Telecom. Room
Security	RJ45/RJ45	TBA	1' (ft) 0.3m	Workstation

3. Execution

3.1. INSTALLATION

3.1.1. Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The Telecommunications Contractor without any additional compensation shall replace damaged cables.

3.2. UTP COPPER PATCH CORDS

3.2.1. At Telecommunications Room end, provide one (1) patch cord for each data cable installed. Communications Contractor shall be responsible for patching all data cabling. A patching schedule shall be provided to the Communications Contractor prior to installation. Patch Cords provided must maintain the Channel Solution.

3.2.2. At workstation end, provide one (1) patch cord for each data cable installed. Patch Cords supplied and installed must maintain the Channel Solution.

END OF SECTION

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END OF SECTION

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27 00 00.10 Audiovisual Compliance Statement

Our company has reviewed all specifications identified on the Audiovisual Index 27 00 00.00, all addenda and contract drawings as identified on AV-000 and confirm our bid submission is compliant with the requirements described in these contract documents. We commit to delivering the project in compliance with the contract documents at the price submitted on the tender form.

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Signing Officer Signature

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Signing Officer Name

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Company

END OF SECTION

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27 40 05.00 Audiovisual Definitions and Abbreviations

1. General

1.1. DEFINITIONS

1.1.1. Generally, the following definitions are used in this Division:

- |                        |   |  |
|------------------------|---|--|
| Addendum               | - | Normative document used to provide additional requirements and recommendations to a published document (e.g., standards, contracts). When published, an addendum effectively becomes part of the document that it supports.  |
| AV Contractor          | - | The successful bidder to this Specification responsible for the supply and installation of the Audiovisual Systems as detailed in this document & associated drawings.   |
| AV Consultant          | - | Smith + Andersen Consulting Engineers  |
| Deficiency Review      | - | A meeting between the Owner, AV Contractor and AV Consultant to review the Project to determine whether the work meets the requirements of the Owner as detailed in this document and associated drawings.   |
| Final Acceptance       | - | The date which the Owner and AV Consultant have agreed the Project is complete, functional, free of deficiencies and the AV Contractor has submitted all required documentation for project closeout. Refer to section 27 40 10 "Final Acceptance" for greater detail. |
| Project                | - | Supply and installation of a complete and functional Audiovisual System as described in this document.   |
| Provide                | - | Supply, install, terminate, test and commission.   |
| Retainage              | - | Contract amount equating to 10% of the value of the audiovisual contract. This is the value of testing, training, commissioning, deficiency correction and close out documentation submittal.  |
| Substantial Completion | - | The period between the deficiency review meeting date and the date of final acceptance. The audiovisual system physical installation, programming and Contractor commissioning is complete and ready for review by Consultant and Owner.                               |

1.2. ABBREVIATIONS

1.2.1. Generally, the following abbreviations are used in this Division:

- |     |   |                                 |
|-----|---|---------------------------------|
| ADA | - | Americans with Disabilities Act |
| AES | - | Audio Engineering Society       |

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AFF	- Above Finished Floor
AGC	- Automatic Gain Control
AHJ	- Authority Having Jurisdiction
ALS	- Assistive Listening System
AV or A/V	- Audiovisual
AVB	- Audio Video Bridging
AVC	- Advanced Video Coding
AWG	- American Wire Gauge
BACnet	- Building Automation and Control Networking Protocol
BAS	- Building Automation System
BICSI®	- Building Industry Consulting Service International
BOM	- Bill Of Material
BTU	- British Thermal Unit
CAD	- Computer Aided Design
CATV	- Community Antenna Television (Cable Television)
CCIA	- Computer Communications Industry Association
CCTV	- Closed Circuit Television
CSA	- Canadian Standards Institute
CTS	- Certified Technology Specialist
CTS-D	- Certified Technology Specialist Design
CTS-I	- Certified Technology Specialist Installation
DANTE	- Digital Audio Network Through Ethernet
dB	- Decibel
dBa	- A-weighted Decibels
dBm	- Decibel milliwatt
dBmV	- Decibel millivolt
DCI	- Digital Cinema Initiatives
DHCP	- Dynamic Host Configuration Protocol
DM	- DigitalMedia
DNS	- Domain Name System
DSP	- Digital Sound Processing
DVI	- Digital Visual Interface
EBU	- European Broadcasting Union
EDID	- Extended Display Identification
EIA	- Electronics Industry Alliance
EMI	- Electromagnetic Interference
EMI/RFI	- Electromagnetic Interference / Radio Frequency Interference
FCC	- Federal Communications Commission
ft	- Foot / Feet
ft <sup>2</sup>	- Square Foot / Feet
FTP	- File Transfer Protocol
Gb/s	- Gigabit per Second
GC	- General Contractor
GHz	- Gigahertz
GUI	- Graphical User Interface
HDCP	- High-Bandwidth Digital Content Protection
HDMI	- High-Definition Multimedia Interface
Hz	- Hertz
IEC	- International Electrotechnical Commission
IEEE®	- Institute of Electrical and Electronics Engineers, Inc.®
IG	- Isolated Ground
in	- Inch
in <sup>2</sup>	- Square Inch
I/O	- Input / Output (Device)
IPv4	- Internet Protocol version 4

---

IR	- Infrared
ISDN	- Integrated Services Digital Network
ISO	- International Organization for Standardization
IT	- Information Technology
kb	- Kilobit
kB	- Kilobyte
kg	- Kilogram
Km	- Kilometre
KSVs	- Key Selection Vectors
kV	- Kilovolt
kVA	- Kilovoltampere
kW	- Kilowatt
kWh	- Kilowatt hour
LAN	- Local Area Network
laser	- Light Amplification by Stimulated Emission of Radiation
lb	- Pound
LCD	- Liquid Crystal Display
LED	- Light Emitting Diode
LSZH	- Low Smoke Zero Halogen
m	- Metre
m <sup>2</sup>	- Square Metre
mA	- Milliampere
Mb	- Megabit
MB	- Megabyte
Mb/s	- Megabit per Second
MB/s	- Megabyte per Second
MHz	- Megahertz
MIDI	- Musical Instrument Digital Interface
mm	- Millimetre
MM	- Multimode
MMF	- Multimode Fibre
ms	- Millisecond
mW	- Milliwatt
MW	- Megawatt
NFPA	- National Fire Protection Association
NIC	- Network Interface Card
OD	- Outside Diameter
OEM	- Original Equipment Manufacturer
OFE	- Owner-furnished equipment
OLED	- Organic Light Emitting Diode
OTDR	- Optical time domain reflectometry
PBX	- Private Branch Exchange
PDU	- Power Distribution Unit
PoE	- Power-Over-Ethernet
POTS	- Plain Old Telephone Service
PTZ	- Pan, Tilt, Zoom
PVC	- Polyvinyl Chloride
QA	- Quality Assurance
QC	- Quality Control
QoS	- Quality of Service
QXGA	- Quad Extended Graphics Array
RCA	- Radio Corporation of America
RCDD®	- Registered Communications Distribution Designer
RF	- Radio Frequency
RFI	- Radio Frequency Interference

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rms	-	Root Mean Square
RU	-	Rack Unit (1.75")
RX	-	Receiver
SDI	-	Serial Digital Interface
SI	-	International System of Units (Le Système International d'Unités)
SIP	-	Session Initiation Protocol
SLA	-	Service level Agreement
SM	-	Singlemode
SNR	-	Signal-to-Noise Ratio
S/PDIF	-	Sony/Phillips Digital Interface
SPL	-	Sound Pressure Level
STP	-	Shielded Twisted Pair
STP-A	-	Shielded Twisted Pair A
TCP	-	Transmission Control Protocol
TDR	-	Time Domain Reflectometer
TFT	-	Thin Film Transistor
TIA	-	Telecommunications Industry Association
TP	-	Twisted Pair
TR	-	Telecommunications Room
TRS	-	Tip, Ring, Sleeve
TS	-	Technical Standard
TV	-	Television
UHD	-	Ultra high definition
ULC	-	Underwriters Laboratories of Canada
UPC	-	Universal Product Code
UPS	-	Uninterruptible Power Supply
USB	-	Universal Serial Bus
UTP	-	Unshielded Twisted Pair
V	-	Volt
VA	-	Volt-Ampere
VESA	-	Video Electronics Standards Association
VGA	-	Video Graphics Array
VLAN	-	Virtual Local Area Network
VoIP	-	Voice over Internet Protocol
VPN	-	Virtual Private Network
W	-	Watt
WAN	-	Wide Area Network
WAP	-	Wireless Application Protocol
WiFi	-	Wireless Fidelity
Wi-Fi	-	Wireless Fidelity
WLAN	-	Wireless Local Area Network
WUXGA	-	Widescreen Ultra Extended Graphics Array
WXGA	-	Wide Extended Graphics Array
XGA	-	Extended Graphics Array
XLR	-	External Line Return

- 2. Products
  - 2.1. NOT USED
  
  - 3. Execution
  - 3.1. NOT USED
- END OF SECTION

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27 40 10.00 General Instructions for Audiovisual System Installation

1. General

1.1. GENERAL

1.1.1. Conform to the requirements of Division 0, Division 1 and Division 25 which applies to and forms part of all sections of the work. If these are not included within Tender package, AV Contractor can request a copy from the Owner's representative.

1.1.2. This Specification is for the supply and installation of AV Systems at the 'facility' for the following project:

University of Toronto  
5th Floor  
Toronto/Ontario

1.2. WORK INCLUDED

1.2.1. Read and comply with all sections of this document.

1.2.2. This Specification is to be read in conjunction with the corresponding Tender Drawings, which together, describe the complete scope of work, associated systems and system requirements necessary to achieve the intended performance, installation and functions of the Audiovisual Systems to be provided. Equipment shown on drawings but not written specifications or vice versa does not preclude the AV Contractor from supplying equipment. Take note of the "Division of Responsibility" table on drawing AV-000.

1.2.3. The Specification is divided into Sections which are not intended to identify contractual limits between Sub-Contractors nor between the AV Contractor and any Sub-Contractors. The requirements of any one Section apply to all Sections. Refer to other Divisions and Sections to ensure a complete and operational system.

1.2.4. Provide AV components and accessories which may not be specifically shown on the Drawings or stipulated in the Specifications, but are required to ensure complete and operational systems.

1.2.5. Provide all labour, materials, tools, and equipment required for the complete installation of work called for in all sections of the Contract Documents.

1.3. ERRORS AND OMISSIONS

1.3.1. Errors and/or omissions in the proposal documents shall be reported to the AV Consultant and Owner immediately during the time of response. Items not reported during this time shall not relieve the AV Contractor of the responsibility for providing properly functioning systems as specified or intended in the Contract Documents.

1.3.2. The AV Contractor shall review all reference drawings and site conditions, and report any discrepancies prior to award of contract, including additional electrical infrastructure requirements, to the AV Consultant as part of the review drawing submission.

1.3.3. While every attempt has been made to ensure all information is correct at the time of publication, verification for the availability of products specified and correct part numbers shall be the responsibility of the AV Contractor. Some products and components may be discontinued at the time of procurement. It shall be the responsibility of the proponent to provide the most current replacement model for all discontinued products that meet the requirements of these specifications at no additional cost to the Owner. Any errors and/or omissions in this Specification shall be included with their bid submissions.

#### 1.4. BID SUBMISSION

##### 1.4.1. Bidder Information

1.4.2. Supply a description of the firm complete with the following information:

- .1 Main contact information
- .2 Number and type of full-time staff
- .3 Corporate history
- .4 Office performing the work (if not the main office)
- .5 Product Representation
- .6 Certifications and Service Authorizations
- .7 Test Equipment (eg. Fluke, Sencore, SMAART)
- .8 Facilities
- .9 Financial Information
- .10 Average Gross Receipts (for past 5 years)
- .11 Bonding Capacity – state whether Performance Bond ever exercised
- .12 Insurance Limits
- .13 Bank Credit References
- .14 Recent and current litigation experience, both project and non-project related

##### 1.4.3. Project Experience

- .1 Provide summary and references for project experience of similar scope and scale.
- .2 Qualified bidders should have completed a minimum of two projects of similar scope and scale within the past 24 months. Contact names and telephone numbers are required for these projects.

##### 1.4.4. Statement of Qualifications

- .1 The AV Contractor shall provide all required manufacturer certifications to procure, install and support all products and solutions indicated in this specification.
- .2 The AV Contractor shall identify service technicians that shall service the project. It is expected that the Service depot for the project is within 100km of the project.
- .3 Please see “Warranty” section 1.12 for further submission requirements.

##### 1.4.5. Project Schedule

- .1 Provide a project schedule with milestones and completion dates. Milestones should include:
  - .1 Kick-off meeting (with Owner, general Contractor and AV Consultant)
  - .2 Approval drawing submission
  - .3 Coordination meeting with client’s IT department (if required)
  - .4 Equipment delivery to site

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- .5 Room-by-room completion dates
  - .6 Substantial Completion date
  - .7 Date for submission of Owner manuals and as-built drawings
  - .8 Training
- 1.4.6. Project Execution
- .1 Provide a description of all techniques used to meet major deliverables including schedules, meeting reports, escalation procedures, approval drawings, testing, on-site installation, equipment and user manuals, training and commissioning.
- 1.4.7. Post Commissioning
- .1 Provide a description of the Bidder's post commissioning service procedures including response times, extended warranty information and extended services.
  - .2 The AV Contractor shall identify service technicians that shall service the project. It is expected that the Service depot for the project is within 100km of the project.
  - .3 Please see section 27 40 10 clause 1.12 "Warranty" for further submission requirements.
- 1.4.8. Compliance Statement
- .1 The Bidder is required to review and sign the included compliance statement. The bidder's Compliance Statement must be provided with the bid response.
- 1.4.9. Project Personnel
- .1 Provide Curriculum Vitae or Statement of Qualifications for all project personnel. CVs should include past project experience, educational background and relevant certifications. Contractor must have personnel with AVIXA Certified Technology Specialist (CTS) designation.
  - .2 Bid response should include CVs for the following personnel:
    - .1 Account Executive/Client Contact
    - .2 Project Manager
    - .3 Project Engineer
    - .4 Programmers (Control systems and DSP)
    - .5 Site Lead
    - .6 All other assigned technical personnel
  - .3 Approved SubContractors
    - .1 All subContractors must be declared at the time of bid submission. Owner reserves the right to withdraw its purchase order at any time should the Systems Contractor engage a subContractor that does not meet the approval of the Owner.
- 1.4.10. Bill of Materials
- .1 Responses should include a complete and accurate itemized list of all equipment to be supplied including wire and all hardware. The list should indicate the manufacturer, manufacturer's model number and unit of quantity. The list should be divided according to subsections in section 27 41 00.00. Proposed substitutions should be explicitly stated. If the manufacturer has permanently stopped fabrication of a specific item or has replaced an item with an almost identical item but with new model number, this item should be explicitly noted in this list.
  - .2 The AV Contractor shall review and submit a final Bill of Materials to the Owner four weeks prior to ordering product from the manufacturer/distributors.

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- .3 Include in bid all labour, materials, plant, transportation, storage costs, training, equipment, insurance, temporary protection, permits, inspections, taxes and all necessary and related items required to provide complete and operational systems shown and described.
  - .4 Substitutions
    - .1 The AV Contractor is encouraged to review the equipment specified herein and suggest alternates that may provide increased functionality and savings to the Owner without degradation to system performance or functional requirements.
    - .2 The AV Consultant's decision regarding the acceptance or rejection of the proposed substitution shall be final. Substitutions may be accepted if the delivery of the component or item is such that it shall not jeopardise the construction schedule. Otherwise substitution shall not be allowed.
    - .3 The Owner reserves the right to accept or reject any alternate without question.
    - .4 Substitutions shall be proposed during the question period of the bid process.
- 1.4.11. Pricing
- .1 Provide each of the following in this section as separate sections of the bid.
  - .2 Base Price
    - .1 The respondent shall state a stipulated price to provide all work shown and described in the System Specification that shall include all premium and/or overtime charges involved to finish the stages of work before the milestones stated under Schedule. This price shall exclude all Add/Delete and Option pricing
  - .3 Detailed Pricing
    - .1 Responses are to include a complete and accurate list of all AV equipment to be supplied including wire. Include name of manufacturer, model number, unit quantity and itemized pricing. Provide subtotals according to subsections in Audiovisual System Scope of Work.
  - .4 Add/Delete Option Pricing
    - .1 An Add/Delete Option specifies work which may be added to/deleted from the Base Price at the discretion of the Owner. It can be carried separately at the discretion of the Owner. The bidder shall state a separate price for each Add/Delete option which shall increase/decrease to the total purchase price of the work, including all premiums/overtime charges.
  - .5 Alternate Pricing
    - .1 Indicate increase/decrease to overall purchase price of work as a result of switching from one specified item to another.
  - .6 Unit Labor Rate
    - .1 State hourly rates for all audiovisual specific trades on a separate page as part of the submission.
  - .7 Taxes TO BE ADDED
    - .1 Include as a separate line item applicable taxes.
- 1.5. CODES, STANDARDS AND REGULATIONS COMPLIANCES
- 1.5.1. The AV Contractor must ensure all federal, provincial, and municipal laws, codes, regulations are adhered to.
- 1.5.2. All products installed must meet or exceed all Local, Provincial and Federal Building, Fire, Health, Safety and Electrical Codes.

- 1.5.3. The AV Contractor is also responsible for any Sub-Contractors that are providing work or services under the same contract. The AV Contractor, where applicable, shall provide proof that final inspections have been adhered to and are completely satisfactory and clear with regards to the authority having jurisdiction, including any work performed by any and all Sub-Contractors. All costs associated with meeting these requirements shall also be carried within the price of the project.
- 1.5.4. Comply with the following industry standards:
- .1 CSA Standard T527 (ANSI/TIA/EIA-607) - Grounding and Bonding for Telecommunication in Commercial Buildings
  - .2 ANSI/AVIXA 10:2013– Audiovisual Systems Performance Verification
  - .3 EIA RS-310-C – Racks and Associated Equipment
  - .4 AVIXA International - AV Installation Handbook, 2<sup>nd</sup> Ed. – The Best Practices for Quality Audiovisual Systems
  - .5 ANSI/AVIXA 2M-2010 – Standard Guide for Audiovisual Systems Design and Coordination Processes
  - .6 ANSI/AVIXA 1M-2009 – Audio Coverage Uniformity
  - .7 ANSI/AVIXA 3M-2011 – Projected Image Contrast Ratio
  - .8 AVIXA F502.01:2018 – Rack Building for Audiovisual Systems
  - .9 AVIXA F501.01:2015 – Cable Labeling for Audiovisual Systems
  - .10 ANSI/TIA-568.0-D – Generic Telecommunications Cabling for Customer Premises
  - .11 TIA-568.1-D – Commercial Building Telecommunications Cabling Standard
- 1.6. SUMMARY OF WORK AND AV CONTRACTOR PERFORMANCE
- 1.6.1. The A/V systems described herein, shall include providing and integrating a fully functional and seamlessly integrated Audiovisual system complete with high quality professional and commercial grade audiovisual and electronic products, which include for the following equipment and systems but not limited to:
- .1 Media Control Systems
  - .2 Flat Panel Displays
  - .3 Multimedia Projectors
  - .4 Motorized Projection Screens
  - .5 AV Control Systems including Touch Panel and other controllers
  - .6 Audio Conferencing Systems
  - .7 Loudspeakers
  - .8 Audio-Video Source Equipment
  - .9 Audio-Video Reinforcement and Distribution Systems
  - .10 Audio-Video Switching
  - .11 Audio-Video Interface Equipment
  - .12 Audio-Video Cabling and Terminations
  - .13 Ethernet and Control Support
  - .14 Architectural Elements and Mounting Hardware
  - .15 Display or projector lifts
  - .16 Video cameras (fixed or PTZ)
  - .17 Audiovisual production and broadcast consoles

- 1.6.2. Quantities or lengths indicated in any of the Contract Documents are approximate only and shall not be held to gauge or limit the work. All dimensions and conditions must be verified at the job site prior to installation. The AV Contractor to include for any additional components, slack of cabling etc. as required to complete and neatly finish the installation throughout the interior design.
- 1.6.3. In assessing differences between customer specifications and vendor equipment specifications, the AV Contractor shall ensure customer's maximum specified parameters are met.
- 1.6.4. Some products and components may be discontinued at the time of procurement. It shall be the responsibility of the proponent to provide the most current replacement model for all discontinued product that meets the requirements of these specifications.
- 1.6.5. The AV Contractor shall be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective material, equipment and part of equipment and repair related damages.
- 1.6.6. In addition to providing the services and materials as described, the AV Contractor is required to provide for the following services and perform the following on-site work.
- .1 Coordinate all AV requirements and system components with the project and construction team of all disciplines as required or specifically stated within the package.
  - .2 If required, remove any existing AV equipment not required for reuse and dispose of the equipment using environmentally accepted electronic waste disposal methods. Provide a disposal report to the project team of equipment being disposed of, include make, model and serial number for each item. Removal and disposal of all existing cabling from the ceiling space, walls and within conduit including all accessories (jacks, furniture adapters, decora straps, faceplates, surface mount boxes, patch panels, patch cords, punch down blocks, cross-connect wire etc.)
  - .3 Coordinate and ensure all AV cabling is provided via conduit infrastructure and raceways correctly installed to support the AV systems and related cabling networks. Where conduit infrastructure is not required, supply and install cable slings and J-hooks to supports any free cables. Any discrepancies shall be reported to the AV Consultant immediately.
  - .4 Coordinate and verify the AV infrastructure required for all equipment including, but not limited to, projectors, loudspeakers and associated mounting hardware prior to installation. The AV Contractor to provide for any infrastructure that has not been coordinated (i.e. backboards).
  - .5 Any other structural support, blocking or infrastructure to be provided by others and required to support the AV systems shall be coordinated by the AV Contractor. The AV Contractor to provide for any infrastructure that has not been coordinated.
  - .6 Coordinate and ensure all AV related millwork is correctly implemented and provided to support the AV systems. The AV Contractor shall review all furniture shop drawings and report to the AV Consultant if there are any issues with cutouts, pathways, ventilation, etc.
  - .7 Pre-build and test all systems possible prior to delivery of equipment to project site.
  - .8 Supply all items to be built in ample time for rapid progress of the work. Schedule and proceed with work as required to satisfy the construction schedule.
  - .9 Include for on-going project management, coordination among trades for all AV work and any required site meetings.
  - .10 Label all equipment to correlate with operation and maintenance manuals. Labelling schemes shall be confirmed with the AV Consultant prior to installation.

- 1.6.7. Supply all AV outlets, terminating hardware and selected connectivity devices as outlined in this Specification. All outlet shall be metal. Plastic decora plates are not acceptable.
- 1.6.8. Supply all hoists and scaffolds necessary to install AV equipment.
- 1.6.9. Visually inspect all equipment for damage or defects prior to installation. Damaged or defective materials shall be reported to the AV Consultant and the Owner.
- 1.6.10. The AV Contractor is responsible for loss or damage of any and all system equipment until it is permanently fastened to the building or signed over to the Owner.
- 1.6.11. All materials and equipment obtained for this contract shall be through manufacturer authorized distribution channels and the warranty shall be supported in the jurisdiction of the Owner. Under NO circumstances shall 'Grey Market' or 'Refurbished' items be acceptable
- 1.7. DRAWINGS, CHANGES AND INSTALLATION
- 1.7.1. The location, arrangement and connection of equipment and material as shown on the drawings represent a close approximation to the intent and requirements of the contract. The right is reserved by the AV Consultant to make reasonable changes required to accommodate conditions arising during the progress of the work, at no extra cost to the Owner.
- 1.7.2. The location and size of existing services shown on the drawings are based on the best available information. The AV Contractor shall verify the actual location of existing services in the field before work is commenced.
- 1.7.3. Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions, shall be made at no extra cost to the Owner.
- 1.7.4. Adequate space and provisions shall be left for removal of components and servicing of equipment, with minimum inconvenience to the operation of systems.
- 1.7.5. Where equipment is shown to be 'roughed in only' obtain accurate information from the AV Consultant before proceeding with the work.
- 1.7.6. Location of outlets, luminaires, diffusers, grilles, registers, thermostats, sprinklers and all other equipment shown on drawings (if shown) is diagrammatic. The AV Contractor to coordinate on-site or ask direction from AV Consultant to address any discrepancies on site.
- 1.7.7. The AV Contractor is responsible to mark-out their work and fully co-ordinate with all other trades. The AV Contractor shall review architectural and interior design drawings for exact locations of equipment. Review with AV Consultant prior to rough in.
- 1.8. FINAL ACCEPTANCE
- 1.8.1. Final acceptance is the date which the Owner and AV Consultant agree the project is complete, functional, free of deficiencies and the AV Contractor has submitted all required documentation for project closeout.
- 1.8.2. A retainage equating to 10% of the value of the base contract shall be released on the date of Final Acceptance. 10% is equated as the value of testing, training, commissioning, deficiency correction and close-out documentation submittal.
- 1.8.3. The step-by-step process to reach Final Acceptance is as follows:
- .1 AV Contractor declares the project is substantially complete and ready for the deficiency walk-through.
  - .2 AV Contractor to complete the Compliance Checklist as supplied by the AV Consultant prior to deficiency walk-through.
  - .3 Deficiency walk-through visit between AV Consultant, AV Contractor and Owner Representative to review all systems to ensure compliance with the design intent.

- .4 Following the deficiency walk-through, a final Job Report shall be issued by the AV Consultant outlining any deficiencies or outstanding items to be completed. The AV Contractor shall be responsible for making all corrections as identified in the report. A second visit may be required depending on the extensiveness of deficiencies.
- .5 Submittal of as-built drawings, control and DSP program source code and manuals as stated in section 3.
- .6 Training sessions supplied as described in this specification. Training sign-off sheets from each training session including a list of participants.
- .7 Warranty letter with the start of service period marked as the date of final acceptance.

1.9. LABOUR

- 1.9.1. The AV Contractor must comply with all job-site requirements for the duration of the project.
- 1.9.2. The AV Contractor shall not assign or sub-contract any work without the prior written consent of the Project Manager. A list of sub-Contractors shall be submitted with the Tender response.
- 1.9.3. The AV Contractor agrees to use only tradesmen who are fully trained, qualified and experienced on the installation, termination and testing of the AV System Solution. The AV Contractor must have their AVIXA Certified Technology Specialist designation.
- 1.9.4. The AV Contractor shall supply unionized workers on construction sites where this is a requirement.

1.10. PROGRESS BILLING EVALUATIONS

- 1.10.1. Monthly progress billings shall be issued by the AV Contractor and payment certificates shall require approval from AV Consultant. The AV Contractor shall bill according to an estimate of the percentage of the completed AV sub-systems. Progress billings shall not be reviewed unless they are submitted in the format outlined in the following example:

<b>BASE CONTRACT</b>	
Total Contract Amount	\$250,000.00
Tender Completed to Date	\$125,000.00
Amount Previously Approved	\$25,000.00
Amount of this Draw	\$100,000.00
Less 10% Holdback	\$10,000.00
Amount of this Draw (less 10% holdback)	\$90,000.00
<b>CHANGES</b>	
Total Contract Changes:	\$5,000.00
Total Changes Completed to Date	\$2,500.00
Amount Previously Approved	\$0.00
Amount of this Draw	\$2,500.00
Less 10% Holdback	\$250.00
Amount of this Draw (less 10% holdback)	\$2,250.00

- 1.10.2. The AV Contractor shall not bill for materials that are not on-site and in the process of installation.
- 1.10.3. The AV Contractor may be asked to revise the amount being billed based on the AV Consultant's assessment of project progress and completed systems.
- 1.10.4. The AV Contractor shall provide current site progress photos with each draw to support the amounts requested.
- 1.10.5. The following milestones shall be deemed as acceptable for monthly draw (holdback not included):

- .1 Deposit and kick off – 25%
- .2 Shops submitted & Reviewed – 35%
- .3 Cables pulled/Site prepared – 45%
- .4 Equipment delivered – 60%
- .5 Equipment installed – 80%
- .6 Substantial Completion – 90%
- .7 Project Complete & Close out Document Received – 100%
- .8 all above do not include holdback

1.11. TRAINING

- 1.11.1. The AV Contractor shall provide a comprehensive review with the Owner to cover all system operation and maintenance.
- 1.11.2. Training shall be provided in multiple sessions, within a minimum total of sixteen (16) hours. Each session shall be a minimum of two (2) hours in length.
- 1.11.3. One (1) training session shall be scheduled immediately following final acceptance by the AV Consultant of the system.
- 1.11.4. Training materials shall be provided to the users prior to scheduled session.
- 1.11.5. The Owner shall have the ability to schedule sessions within the warranty period at mutually acceptable dates and times.
- 1.11.6. Provide a sign-off sheet for each training session. The sign-off sheet shall include:
  - .1 A list of attendees
  - .2 Topics covered within session
  - .3 Date, time and duration of session
  - .4 Signature by an Owner's representative to confirm session was performed and completed to the satisfaction of the Owner.

1.12. WARRANTY

- 1.12.1. Provide a written warranty for all work of the AV system for a period no less than one (1) year from the date of substantial completion as certified by the AV Consultant. Warranty certificate shall be submitted as part of the close out documentation as described in Final Acceptance
- 1.12.2. Warranty shall cover the installation and equipment to be free of all defects resulting from faulty components, workmanship, installation or incorrect calibration. Replacements and repairs shall be made without cost to the Owner.
- 1.12.3. Provide the name of a contact, phone number and 24 hour emergency number and insert into all manuals and update as required. Ensure that all contact information is kept current.
- 1.12.4. All service calls should be answered or returned within four hours between 8:00am and 6:00pm (local time). All onsite responses should be within 24 hours.
- 1.12.5. Perform onsite replacement of failed equipment. All failed equipment must be replaced by identically functional and technically equivalent device. Timelines for equipment replacement have been separated into two types:
  - .1 Critical Equipment
    - .1 Replacement must be provided by next business day of the initial service call.
    - .2 This includes any piece of equipment that renders the system of a room not useable for either conferencing or presentation capabilities.

- .3 Temporary/rental equipment of similar functionality is acceptable upon approval from Owner at no additional cost.
  - .2 Non-critical
    - .1 Replacement must be provided at best effort within a week of the initial service call.
    - .2 This includes any piece of equipment that limits the functionality of a room system.
- 1.12.6. The system warranty shall include parts and labour for the duration of the warranty.
- 1.12.7. Warranties offered by manufacturers that exceed the AV Contractors installation warranty, shall be reported and noted with the Owner and recorded in the manuals. The AV Contractor shall be responsible for managing these extended warranties. Additional costs regarding removal, shipping and re-installation after the installation warranty period has expired, shall be reported to the Owner prior to commencing work.
- 1.12.8. All custom programming shall be warranted against faults and deficiencies for the duration of the installation warranty commencing at certificate of substantial completion. Any and all necessary changes under this warranty are to be at no cost to the Owner and the AV Contractor shall notify the AV Consultant of such changes.
- 1.12.9. When custom programming is used to mimic a manufacturer's graphical user interface to provide a consistent graphical user experience, the AV Contractor shall update the custom programming at no cost during the warranty period in the event that a firmware updated changes the manufacturer's graphical user interface. For example, if a project contains both Cisco and Crestron Touch panels, any changes made by Cisco to their graphical interface shall result in the AV Contractor adjusting the custom programming to reflect that change. Allow for one update to be complete within the last 60-days of the warranty period.
- 1.12.10. The AV Contractor must follow-up with the Owner ninety days after substantial completion to investigate any potential issues or concerns relating to the completed system. Any concerns raised shall be addressed appropriately and with the AV Consultant for clarification.
- 1.12.11. The AV Contractor shall provide one (1) preventative maintenance visit for the extent of the warranty period at no additional cost to the Owner. This system maintenance visit shall not be required until after duration of six (6) months after substantial completion. Subsequent services shall be coordinated and agreed to by Owner.
- 1.13. EXTENDED WARRANTY
  - 1.13.1. Any extended warranty or service plan commencing after the installation warranty, may be offered by the AV Contractor to the Owner. Communications regarding this service must commence at least sixty (60) days prior to warranty expiration, at which time, the AV Contractor is responsible to update any firmware and software available for system components to the latest version and verify that update has not affected the functional requirements and system performance as outlined in within this scope of work.

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- 2. Products
    - 2.1. NOT USED
  
  - 3. Execution
    - 3.1. WORKMANSHIP AND BEST PRACTICES
      - 3.1.1. The AV Contractor is responsible for the requirements of the practices and testing requirements detailed in this section.
      - 3.1.2. Equipment installed by the AV Contractor shall not present safety hazards to the public, to other trades, or to equipment operators.
      - 3.1.3. All equipment must be sufficiently ventilated when operating under worst-case power and heat dissipation scenarios.
      - 3.1.4. Any equipment or material not directly specified within this document but still required for a fully functioning system shall be of commercial standard and high quality.
      - 3.1.5. Submit proposed equipment and device samples to AV Consultant if requested.
      - 3.1.6. Workmanship is as important a consideration for the overall job as functionality. Fabricate and install all equipment in accordance with the manufacturers' recommendations and the AV Consultant's specifications. Coordinate with other trades and the AV Consultant to provide an installation of the highest quality.
      - 3.1.7. Before the system is deemed complete and ready for final acceptance, all hardware and software issues shall be rectified by AV Contractor and reviewed by AV Consultant.
    - 3.2. APPROVAL DOCUMENTATION
      - 3.2.1. General
        - .1 Prior to ordering equipment, commencing work on site or expending labor on programming time provide the information detailed in this section.
        - .2 Maintain a copy all documentation and software files for a minimum of three (3) years and provide accessibility to the Owner at any time within that time frame.
      - 3.2.2. Equipment Cutsheets
        - .1 Prior to ordering equipment, submit all equipment cutsheets to be included in the project. Identify all colour choices. Ensure cutsheets are submitted through the established construction process. The general Contractor, architect, interior designer and AV Consultant shall review the cutsheets.
        - .2 Provide a spreadsheet of all items that are available to be ordered.
        - .3 Organize and name the cutsheets according to product specification types identified in 27 41 00 Audiovisual System Scope of Work Part 2 "Products".
        - .4 Indicate all colour choices on the spreadsheet.
        - .5 Submit the spreadsheet for approval by the Owner or their representatives and the project team prior to ordering of any equipment.
        - .6 Cutsheets for different equipment shall have their own dedicated file. The cutsheet file title shall be formatted as follows: "MANUFACTURER – MODEL NUMBER". Identify the file format naming convention in the spreadsheet.
      - 3.2.3. Approval (Shop) Drawings

- .1 The AV Contractor must obtain written approval of shop drawings from the AV Consultant and/or Owner prior to procurement of equipment and commencement of work on site unless directed otherwise by the AV Consultant.
- .2 Approval drawings are defined as drawings required to execute the job to the standards and conformance of the specification and contract drawings.
- .3 Approval drawings are used to ensure conformance with the project system design. Only compliance with the Contract Documentation shall be reviewed as part of the approval process. Corrections or comments submitted by the AV Consultant do not relieve the AV Contractor of conformance to the specification and contract drawings.
- .4 The AV Contractor shall provide to the AV Consultant a complete set of electronic approval drawings in PDF format. Bound hard copies of shop drawings / engineering specifications must be made available on request by the AV Consultant and/or Owner.
- .5 Approval drawings should include:
  - .1 Cable pull schedules which includes wire numbers, source and destination locations, cable type, AV system serviced and conduit the cable is to be run within.
  - .2 AV system functional diagrams that show the interconnection of all equipment. For each wire indicate wire number (numbering scheme should indicate wire type). At each device connection indicate connector and termination type. For each device or device group identity type, model and location. For each multi-pin connection provide pin/conductor/function detail. For 70 V speakers indicate transformers with loudspeaker tap connections.
  - .3 Front and rear equipment rack elevations including rack accessories. Provide all specifications for equipment rack and accessories. Provide AC rack power distribution scheme.
  - .4 Wall plate, bulkhead and floorbox plate layouts. Give each plate a unique identifier. Give each connector a unique identifier.
  - .5 Sightline studies, equipment installation and any other details that clearly communicates the AV Contractor's installation methodology to the AV Consultant.
    - .1 For devices or systems in weight over 22kg (50lbs), shop drawings will be reviewed for design intent. After no comments by the AV Consultant, the AV Contractor shall obtain a Structural Engineer stamp with appropriate jurisdiction in the region of that installation on the drawing. The shop drawing with the stamp shall be resubmitted for record. Installation of device or system shall not commence without a stamped drawing.
  - .6 Software flow diagrams and any preliminary control system programming code.
- .6 Include annotations, amendments and or comments as required. These must be corrected where noted and if modifications are needed or if added equipment is needed for the system to function as intended, there shall be no changes to the contract value as the AV Contractor is responsible to provide a proper working system. Corrections shall be made in a timely manner as to not impact Construction schedule or delivery of system.

#### 3.2.4. Graphical User Interfaces

- .1 Provide preliminary graphical user interfaces for touch panels, custom software, button interfaces or any other control surfaces. Format the document in a method that clearly indicates menu navigation hierarchies.
- .2 Submit user interfaces for review prior to the commencement of system programming. See section 27 41 16.15 Control Systems for further details.

- .3 Coordinate an on-site workshop with the Owner's user group to review the proposed interfaces for Owner feedback. This workshop should occur after GUIs are developed, before detailed programming is completed. Allow for one (1) major revision and one (1) minor revision to the interfaces following the workshop.

### 3.3. AS-BUILT DRAWINGS

#### 3.3.1. As-Built Drawings

- .1 As-Built Drawings shall include:
  - .1 Approval drawings revised to reflect as-built changes.
  - .2 Device locations showing all floor, wall and ceiling equipment locations
  - .3 Elevation drawings of all mounted AV equipment.
  - .4 Riser/cable diagrams indicating system conduit, back boxes, connector, and cable interconnections. Indicate cable quantity and type for each cable run.
  - .5 Functional line diagram of the completed system per specification
  - .6 Metalwork fabrication drawings can be excluded.
  - .7 Include any other drawings indicated in the specification.
  - .8 Any diagrams that is required for a complete description of the system.
  - .9 Supply two (2) soft copies of As-Built Drawings in PDF and AutoCad format. One copy shall be for the Owner, the other for the AV Consultant.

### 3.4. SYSTEM MANUALS

#### 3.4.1. Approval System Manuals

- .1 Provide two soft copies of the System Manual, one to the AV Consultant and one to the Owner in PDF format by email/FTP for review and approval.
- .2 All operation and maintenance manuals and all testing and commissioning reports shall be provided to Owner and Owner's representative. Any deficiencies found during the testing or commissioning phase of work, shall be reported immediately to the Owner and the Owner's representative.
- .3 Manuals shall contain a minimum of the following:
  - .1 Detailed table of contents
  - .2 Title page which clearly indicated Project Name and Document Title.
  - .3 Contacts and credits page.
  - .4 User operating instructions with detailed views of various systems for the day-to-day user. Include all control panel layouts, screen dumps, DSP control interfaces, and any other GUI.
  - .5 Manufacturer product manual(s) and literature for all components. Include technical system manuals for all systems described in the specification which should include all service procedures.
  - .6 Software instruction manuals.
  - .7 Copies of all approvals, stamps and inspection certificates.
  - .8 Optimally configured settings for all signal processing equipment, zone selections, gain settings and control systems.
  - .9 Performance data of completed system test results.
  - .10 Amplifier connections and corresponding test results at normal operation.
  - .11 Termination records, for strips, switches, floor plug connections.

- .12 Warranty Certificate with statement of completion.
- .13 List of manufacturer's warranties by date of expiration.
- .14 Room configuration procedures.
- .15 Troubleshooting activities
- .16 Service support contact numbers divided by Account Manager and 24/7 support staff.

#### 3.4.2. As-Built System Manuals

- .1 After AV Consultant sign-off of Approval Manuals, Provide two soft-copy sets in PDF format by cloud storage/FTP/email to the project team, AV Consultant and the Owner. At the request of the Owner or AV Consultant, supply one bound hard copy set of manuals.
- .2 The Owner reserves the right to reproduce all documents for internal corporate use.
- .3 The AV Contractor shall ensure an electronic copy of the close-out documentation are available to the Owner for a period of three years following the date of substantial completion.

#### 3.4.3. Quick Reference Guide

- .1 Provide (qty: 1) laminated quick reference guide for each custom user interface described in the Scope of Work. The quick reference sheet is intended to assist with training end-users on the AV systems in order to minimize unnecessary helpdesk calls. Quick reference sheet shall visually depict user interfaces and describe how the user is to interact with the system.

### 3.5. EQUIPMENT STORAGE

- 3.5.1. The AV Contractor shall coordinate with the General Contractor/Construction Manager for any required on-site storage during construction.
- 3.5.2. The AV Contractor is responsible for loss or damage of any and all system equipment until it is signed over to the Owner on the date of final acceptance.
- 3.5.3. The AV Contractor shall include all storage costs as required to meet the project timelines at time of bid.

### 3.6. OFF-SITE SYSTEM STAGING

- 3.6.1. All items within this section shall be completed offsite, at the AV Contractor facility.
- 3.6.2. All equipment shall be tested prior to delivery to site to ensure fully functionality.
- 3.6.3. All equipment shall be configured and shall be ready for use upon installation onsite.
- 3.6.4. All equipment shall have it's firmware updated prior to testing.
- 3.6.5. All equipment racks shall be configured and populated with equipment to allow for pre-delivery inter-rack cabling termination and labeling.
- 3.6.6. All digital signal processors shall have the site file loaded to ensure that only calibration is required to occur on site.
- 3.6.7. All control processors shall have the compiled files uploaded and tested.
- 3.6.8. All touch panels shall have the control interface uploaded and fully operational.
- 3.6.9. All AV network switches shall be configured with port assignments and VLANs.
- 3.6.10. All systems shall be connected to simulate the onsite installation as close as possible prior to delivery on site to test interconnectivity so that upon arrive and installation, the systems shall be ready for testing and commissioning to minimize schedule impacts.

3.6.11. All systems shall be left functioning as per the above for a minimum of two (2) days to allow for a burn-in cycle to occur and identify any possible defective equipment.

### 3.7. CONTROL HARDWARE AND USER INTERFACES

3.7.1. All custom graphical user interfaces for touch panels and other control system user interfaces shall be submitted to the AV Consultant and the Owner for review and approval prior to system commissioning.

3.7.2. All hardware used to control and interface with the computer system shall be tested and fully functional prior to installation on site.

3.7.3. Software programs that control operable machinery must require tally from said devices.

3.7.4. Any control hardware located on walls that may be subject to impacts shall include an impact resistant cover to prevent damage.

### 3.8. DEVICE SECURITY (PASSWORDS)

3.8.1. All device access and configuration passwords for devices shall be changed from default to a custom password.

3.8.2. All passwords shall be created to the maximum security level of the device.

3.8.3. Passwords shall include the below criteria items based on the level of security of the device:

- .1 Include a combination of upper and lower case letters
- .2 Include a minimum of one number
- .3 Include a minimum of one special character
- .4 Minimum length of 8 characters

3.8.4. All passwords shall be recorded and included in close out documents.

### 3.9. SOFTWARE STANDARDS (CONTROL SYSTEM, DSP AND COMPUTER-BASED)

3.9.1. Supply two copies of custom developed software (compiled and uncompiled) and documentation along with System Manuals. The documentation shall describe all GUIs, modes of operation, licenses, presets, and programming so service personnel can competently operate and troubleshoot the system.

3.9.2. Upon request of AV Consultant, supply licensed development environment, compiler software, project-specific source code with source commenting, custom executables and libraries, uncompiled script files and any other code required for program evaluation and debugging.

3.9.3. The AV Contractor can expect that the AV Consultant shall expect the manufacturer to review the AV Contractor's programming. The AV Contractor may be requested to modify program according to manufacturer's recommendations.

3.9.4. All custom software shall be created by programmers with the appropriate manufacturer certification or by manufacturer authorized personnel.

3.9.5. Where security passwords are used, ensure that each security level is properly defined and all users have appropriate access as directed by the AV Consultant. The AV Contractor must submit to the AV Consultant for review all security features prior to commissioning.

3.9.6. When utilizing DSP processing for loudspeaker optimization, consult the manufacturer of the loudspeaker system to obtain recommended settings and/or macros. Include any custom loudspeaker setting within the system documentation.

- 3.9.7. Prior to commissioning, submit all software programming files to AV Consultant for review. All software submissions must be accompanied by documentation indicating the intent of the program, table of presets, flow diagrams, revision date and any omissions to overall functionality.
- 3.10. COMPUTER SYSTEMS
- 3.10.1. Computer system shall not be installed on site during construction with the presence of dust and debris.
- 3.10.2. All computer system components should be of premium quality and sourced from reputable vendors.
- 3.10.3. All computer-based systems should meet the Owner's specifications.
- 3.10.4. All computer systems should be 19" rack-mountable.
- 3.10.5. Backup all hard drives and ensure a duplicate image of the hard disk exists at time of Owner acceptance.
- 3.10.6. Integrate any security features with Windows Security standard suite where possible.
- 3.11. WIRING AND CABLE TERMINATION
- 3.11.1. The AV Contractor should take all measures to prevent electromagnetic and electrostatic interference.
- 3.11.2. All precautions should be taken to avoid inadvertent grounding of shield. All terminations of shielded twisted pair cables shall have the shield drain wire covered with a Teflon sleeve and a heat shrink or neoprene sleeve covering the point where the cable jacket and shield end. At the termination point, the unshielded leads should be less than 50 mm in length.
- 3.11.3. All wiring entering equipment racks should have a 2-meter service loop neatly dressed and harnessed within the equipment rack.
- 3.11.4. All cable bundles within equipment racks should be neatly and logically routed and organized. Bundles of varying signal level should be spaced at least 10 cm apart and secured using lacing bars. AC power cabling should be separated from low voltage cabling.
- 3.11.5. All runs of shielded twisted pair and coaxial cable shall be continuous.
- 3.11.6. Only cables and connectors listed in specifications and drawings shall be used.
- 3.11.7. All cable run free-air in ceiling spaces and in raised-access floors shall be FT-6 rated.
- 3.11.8. All IP-based audiovisual solutions utilizing category cabling shall terminate to patch panels at the equipment rack.
- 3.12. INTERCONNECTION BEST PRACTICES
- 3.12.1. All audio level wires shall be balanced and floating unless otherwise specified.
- 3.12.2. Where audio cables share conduits with control cables, appropriate precautions should be taken to prevent pops, clicks and noise in the system.
- 3.12.3. All shielded cables shall have their shields isolated from both the conduit system and any other shielded cables.
- 3.12.4. All BNC-type video connectors shall be of high quality with crimp style strain relief.
- 3.12.5. All BNC-type RF connectors shall be of high quality with compression style strain relief.
- 3.12.6. All XLR connectors should be inserted into panels from the rear. Ensure labelling strips do not interfere with the connector releasing mechanisms.

3.13. LABELLING

3.13.1. Wire Labelling

- .1 All adhesive cable labels shall meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition the labels shall meet the general exposure requirements in UL 969 for indoor use.
- .2 Cable Labels shall be of self-laminating vinyl construction with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
- .3 All labels must be mechanically printed using a laser printer. Hand-written labels are not permitted.
- .4 All wires shall be marked as indicated on functional diagrams and cable schedules.

3.13.2. Wall Plate, Floorbox Plate and Patch Panels

- .1 Ensure each wall plate and floorbox plate is identified to indicate the physical location of the outlet, the designation and the circuit number of termination.
- .2 All panels are to be laser engraved or marked with lamacoid label strips.
- .3 Submit samples to AV Consultant for approval prior to manufacturing.

3.13.3. Network Cabling

- .1 Ensure all new network cable naming conventions are consistent with building infrastructure as specified by the Owner.

3.14. FIELD PANELS

- 3.14.1. All plates shall be 0.125" aluminum stock with 0.125" bevelled edges. All panels shall have anodized finishes.
- 3.14.2. Plastic decora style plates are unacceptable for field connections.
- 3.14.3. All panels shall be labelled and laser engraved.

3.15. METALWORK

- 3.15.1. All metalwork shall have a minimum tolerance of 0.63 mm (0.025"). All edges shall be smooth and free of burrs and other defects.
- 3.15.2. Holes on panels should line up on centers with consistent spacings as shown on fabrication drawings.
- 3.15.3. Finished panel surfaces should be free of any surface defects. Coordinate finishes with Owner.
- 3.15.4. Provide fabrication drawings to AV Consultant for approval prior to fabrication.

3.16. POWER

- 3.16.1. Verify all AC power on site serves the needs of the AV systems and report any concerns to the AV Consultant and the Owner prior to final acceptance testing.
- 3.16.2. Equipment racks shall be wired to AC circuits dedicated to AV systems.
- 3.16.3. The AV Contractor is responsible for AC power distribution within the racks. For fixed equipment racks, provide plug strips (free of switches, fuses and circuit breakers) and direct connect to supply provided by electrical Contractor.

- 3.16.4. All power cords of rack-mounted equipment shall be neatly dressed so the plug is easily associated with the connected equipment. Where this is not possible clearly label the plug and associated piece of equipment.
- 3.16.5. Ensure that low voltage cabling is dressed separately from high voltage cabling.
- 3.17. RIGGING AND OVERHEAD EQUIPMENT
- 3.17.1. All suspended systems shall use load-rated metallic fitting designed for a load safety factor of five or greater. All fasteners should be a minimum grade 8 steel.
- 3.17.2. All suspended systems shall be independently supported from structure using appropriate rigging fixtures approved by the manufacturer.
- 3.17.3. When total suspended mass exceeds 90 kg, a Structural Engineer with appropriate jurisdiction in the province of that installation shall approve all custom-built rigging fixtures.
- 3.18. PORTABLE CABLING
- 3.18.1. All portable cable shall be stranded copper, flexible and durable for heavy use.
- 3.18.2. Portable cable exposed to damp environments shall be tinned copper.
- 3.18.3. All portable cable for AC power distribution shall conform to all National regulations.
- 3.18.4. All portable cables shall be permanently identified with system information and function. All labels should be heavy-duty type and covered with clear shrink-wrap.
- 3.19. SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP
- 3.19.1. Clean all equipment that has been exposed to construction dust and dirt.
- 3.19.2. The AV Contractor to clean all electrical equipment, inside and out, prior to turn over to Owner. Equipment is subject to inspection by AV Consultant and/or Owner.
- 3.19.3. The AV Contractor is responsible to remove their own waste from the site. All re-usable materials shall be recycled.
- 3.19.4. There shall be no smoking, and the site shall be kept clean at all times.
- 3.20. PREPARATION
- 3.20.1. Clean surfaces thoroughly prior to installation.
- 3.20.2. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- 3.21. EXISTING SERVICES AND EQUIPMENT
- 3.21.1. All changes and connections to existing services shall be made only in a manner and at a time approved by the AV Consultant and/or the Owner so as to avoid any interruption of such services during normal working hours. If necessary, changes and connections to existing services shall be made outside of normal working hours, at no extra cost to the Contract.
- 3.21.2. Where connections are made to existing services, existing fire stopping shall be made good under this Division.
- 3.22. OWNER FURNISHED EQUIPMENT
- 3.22.1. All Owner Furnished Equipment (OFE) specified shall be installed by the AV Contractor.
- 3.22.2. Warranty for Owner Furnished Equipment shall be the equipment's warranty. The AV Contractor shall be responsible for any new programming that is supporting the system.

3.23. ACCESS DOORS

- 3.23.1. Adequate access or an Access Door shall be provided or arranged for with Division responsible for installation, for all audiovisual equipment that is concealed and requires accessibility, maintenance and or adjustment.
- 3.23.2. Exact details showing size, type and location shall be submitted to the AV Consultant for review and inclusion in floor plans and shop drawings.
- 3.23.3. Access Door details shall also be captured on as-built drawings and notations shall be included to indicate frequency of maintenance required for concealed equipment.

3.24. CUTTING, PATCHING AND REPAIRING

- 3.24.1. It is the responsibility of the AV Contractor to coordinate all cutting and patching required for AV Cabling work with the General Contractor.

3.25. PROTECTION

- 3.25.1. Protect installed products until completion of project.
- 3.25.2. Touch-up, repair or replace damaged products before Substantial Completion.

3.26. TESTING

- 3.26.1. Provide a test plan for approval by the Owner. Test plan shall identify all testing activities, include sample test reports and accommodate scheduling and sequencing.
- 3.26.2. Typical test plans/reports shall include full testing of all: Video inputs, Video outputs and switching, all device control. Touch panel/programming testing report. Audio inputs, Audio outputs and switching. DSP settings and test calls. Video conferencing test calls.
- 3.26.3. Supply completed testing reports verifying accurate implementation of all signal connections. Provide a written report to the AV Consultant verifying accuracy prior to software deployment on site.
- 3.26.4. Provide test reports of commissioning process for each area according to approved test plan prior to deficiency walk-through by AV Consultant.
- 3.26.5. Include in report confirmation of system implementation as per specification and whether it is inspection ready. Installation Supervisor shall sign-off.
- 3.26.6. All test results and set-ups must be reproducible by the AV Contractor.
- 3.26.7. AV Consultant may elect to perform additional testing during the deficiency walk-through, with the assistance of the AV Contractor.
- 3.26.8. All wiring shall be tested for continuity and short-circuits between conductors and shields. Confirm isolation of conductors and shields, back boxes and conduit systems. Failure of any equipment, system or functionality as intended, shall be revised or replaced by the AV Contractor in full.
- 3.26.9. The following includes, but is not limited to, a list of sub-systems anticipated that shall require testing:
  - .1 Equipment testing
  - .2 Power, Cable Systems and Isolated Ground
  - .3 Audio Systems
  - .4 Distribution outputs and inputs
  - .5 Computer System Hardware
  - .6 Control and Switching

- .7 Video Systems
- .8 Network Cable Systems
- .9 Digital AV Systems
- .10 RF Systems
- .11 Signal System.
- .12 Control Applications
- .13 Cabling systems

3.27. PROJECT CLOSE OUT DOCUMENTATION

- 3.27.1. Provide the following items in this section upon project completion to form as-built documentation.
- 3.27.2. As-built Drawings
  - .1 Refer to section 3.3.1 in this specification for requirements.
- 3.27.3. Compliance Checklist
  - .1 Refer to section 3.26.5 in this specification for requirements
- 3.27.4. Control System Code
  - .1 Refer to section 3.9.1 and 3.9.2 in this specification for requirements
- 3.27.5. Manuals
  - .1 Refer to section 3.4 in this specification for requirements.
- 3.27.6. Network Information with Systems Passwords
  - .1 For passwords, refer to section 3.8.4 this specification for requirements.
  - .2 For network information, refer to specification 27 51 50 – Audiovisual Networking.
- 3.27.7. Test Reports
  - .1 Refer to section 3.26.3 and 3.26.4 in this specification for requirements.
- 3.27.8. Training
  - .1 Refer to section 1.11.2 in this specification to provide a written sign off by the Owner of completed training sessions.
- 3.27.9. Warranty
  - .1 Refer to section 1.12.1 in this specification to provide a written warranty letter.
- 3.27.10.

END OF SECTION

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27 41 00.00 Audiovisual System Scope of Work

1. General

1.1. IMPORTANT NOTES AND RELATED SECTIONS

- 1.1.1. Bidders are required to review the Tender Specifications and Drawings in their entirety in order to understand the complete scope of work described herein.
- 1.1.2. Errors and omissions are to be addressed during the tender period. Refer to subsection 1.3 of 27 40 10.00 – General Instructions for Audiovisual System Installation for further detail.
- 1.1.3. All clarifications and substitution requests must be submitted to the Tender administrator before the end of question period, otherwise a response shall not be provided by the Consultant.
- 1.1.4. Provide all interconnecting cables required to complete a fully functioning system. Refer to section 27 41 23.11 - Audiovisual Cabling for further detail.
- 1.1.5. All graphical user interfaces (GUI) must be simple to operate and developed with input from Owner. GUI's must be consistent between system types. Refer to sections 27 40 10.00 – General Instructions for Audiovisual System Installation and 27 41 16.15 - Control Systems for further detail.
- 1.1.6. Throughout the entirety of the tender Specifications and Drawings, the term 'provide' means 'supply, install, terminate, test and commission'.

1.2. TYPE 1A – COLLABORATION ROOMS

- 1.2.1. These meeting rooms are configured with the meeting room table against the wall, with seating for 6-users.
- 1.2.2. This room type shall feature the following functionality for users:
  - .1 Presentation
    - .1 Wired
  - .2 Integrated Web-based Conferencing
    - .1 BYOD (Bring Your Own Device)
- 1.2.3. A table mounted input shall be provided by the furniture vendor to allow users to connect devices. The AV Contractor shall provide inserts for this and presentation cables 6' in length. This shall have connectivity for:
  - .1 USB-C (Video)
    - .1 Presentation
    - .2 For BYOD web-based conferencing
- 1.2.4. A docking station/port replicator shall be supplied by the Owner and installed by the AV Contractor. This unit shall allow for a users to connect to the room system using a single cable. This unit shall be mounted under table with a mounting solution provided by the AV Contractor.
- 1.2.5. Provide a wall-mounted 55" flat panel display for playback of video. This unit shall also include a wall-mount system for installation.
- 1.2.6. Provide a web-conference bar with integrated ultra-wide tracking camera, microphones and speakers. This unit shall include a mounting system that shall mount to the display mount as required. The web-conference bar shall be mounted beneath the display.

- 1.2.7. Provide all required interconnecting video, control and audio interface cables for a full functional system.
- 1.3. TYPE 1B – COLLABORATION ROOMS
- 1.3.1. These meeting rooms are configured with the meeting room table against the wall, with seating for 10-users.
- 1.3.2. This room type shall feature the following functionality for users:
- .1 Presentation
    - .1 Wired
  - .2 Integrated Web-based Conferencing
    - .1 BYOD (Bring Your Own Device)
- 1.3.3. A table mounted input shall be provided by the furniture vendor to allow users to connect devices. The AV Contractor shall provide inserts for this and presentation cables 6' in length. This shall have connectivity for:
- .1 USB-C (Video)
    - .1 Presentation
    - .2 For BYOD web-based conferencing
- 1.3.4. A docking station/port replicator shall be supplied by the Owner and installed by the AV Contractor. This unit shall allow for a users to connect to the room system using a single cable. This unit shall be mounted under table with a mounting solution provided by the AV Contractor.
- 1.3.5. Provide a wall-mounted 75" flat panel display for playback of video. This unit shall also include a wall-mount system for installation.
- 1.3.6. Provide a web-conference bar with integrated ultra-wide tracking camera, microphones and speakers. This unit shall include a mounting system that will mount to the display mount as required. The web-conference bar shall be mounted beneath the display.
- 1.3.7. Provide all required interconnecting video, control and audio interface cables for a full functional system.
- 1.4. TYPE 2 – DIGITAL LOUNGE
- 1.4.1. This room type shall feature the following functionality for users:
- .1 Digital Signage
- 1.4.2. Provide two (2) digital media players. These units shall be mounted behind each display. All content shall be centrally managed to display digital signage content. Content shall be created and managed by the Owner's marketing department. The AV Contractor shall provide training sessions as outlined further in this document.
- 1.4.3. Provide two (2) wall-mounted 110" flat panel displays for playback of video. The digital media player provided shall be used for control of this device for daily power on/off. This unit shall also include a wall-mount system for installation.
- 1.4.4. Provide all required interconnecting video, control and audio interface cables for a full functional system.
- 1.5. TYPE 3 – TEACHING LAB
- 1.5.1. This room type shall feature the following functionality for users:
- .1 Presentation

- 
- .1 Wired
  - .2 Wireless
  - .3 In-room PC
  - .2 Integrated Web-based Video Conferencing
    - .1 BYOD (Bring Your Own Device)
    - .2 In-Room PC
  - .3 Public Address
- 1.5.2. Provide a table-top graphical control touchscreen interface in each room. This unit will be located on the instructor's desk. The control interface shall allow for:
- .1 System on/off
  - .2 Input source selection
  - .3 Volume controls
  - .4 Camera controls
  - .5 Lighting controls
  - .6 Room controls
  - .7 Room presets
  - .8 Administrator controls
- 1.5.3. A table mounted input shall be provided by the furniture vendor to allow users to connect devices. The AV Contractor shall provide inserts for this and presentation cables 6' in length. This shall have connectivity for:
- .1 USB-C (Video)
    - .1 Presentation
    - .2 For BYOD web-based conferencing
- 1.5.4. A docking station/port replicator shall be supplied by the Owner and installed by the AV Contractor. This unit shall allow for a users to connect to the room system using a single cable. This unit shall be mounted under table with a mounting solution provided by the AV Contractor.
- 1.5.5. Provide two (2) wireless collaboration systems to allow for laptops to conveniently connect to the display via the corporate network.
- 1.5.6. A dedicated in-room computer, with dual monitors, keyboard and mouse, shall be supplied by the Owner and installed by the AV Contractor. This device shall be located in the instructor's desk. The AV Contractor shall provide the requirement mounting solution to secure this device.
- 1.5.7. Provide a video matrix switcher to allow for the routing of video signals within the space. The system shall be programmed to allow different video sources to be displayed.
- 1.5.8. Provide two (2) wall-mounted 110" flat panel display with integrated speakers for playback of video. This unit shall also include a wall-mount system for installation.
- 1.5.9. Provide two (2) cameras, with motorized pan, tilt and zoom features, to capture video of local participants.
- .1 One (1) camera shall be mounted the camera at the display location, to capture the students. The AV Contractor shall provide a mounting solution for this camera.
  - .2 The second camera shall be ceiling mounted, to capture the instructor. This camera shall have auto-tracking features to automatically focus and follow the instructor. The AV Contractor shall provide a mounting solution for this camera.

- 1.5.10. Provide ceiling-mounted digital microphones to allow users in the room be heard on the far-end of web-based conference calls.
- 1.5.11. Provide table-mounted gooseneck microphone to allow the instructor be heard on the far-end of web-based conference calls. This shall also be used for voicelift in the space.
- 1.5.12. Provide a wireless microphone system and shall include a pin-on lavalier microphone with a body pack transmitter and receiver. This shall be used for voicelift in the space.
- 1.5.13. Provide an audio digital signal processor (DSP) to allow for automated microphone processing, routing, acoustic echo cancellation and USB connectivity.
- 1.5.14. Provide an audio amplifier to drive the local speakers.
- 1.5.15. Provide ceiling-mounted speakers to support audio playback in the space.
- 1.5.16. Provide a wireless assistive listening system to support user with hearing challenges or disabilities. Typically, this is a requirement by the regional Disabilities Act.
- 1.5.17. Provide a control processor and will be used as a central control point for the space.
- 1.5.18. Provide a credenza equipment rack that shall be installed within instructor's desk provided by others. This shall include:
  - .1 A runner mounted to the bottom of the rack to protect the credenza finish.
  - .2 An uninterruptable power supply
  - .3 All rack accessories required.
- 1.5.19. Provide a network switch. This unit shall be provided to connect to all field equipment to allow all the AV equipment to reside on a common local area network. This network switch shall also provide an uplink to the client local area network.
- 1.5.20. An interconnection to the fire-alarm system shall be supplied by others and shall be connected to the AV system by the AV Contractor. This connection shall trigger a mute of the AV systems when a fire alarm is activated.
- 1.5.21. Provide all required interconnecting video, control and audio interface cables for a full functional system.
  
- 1.6. TYPE 4 – OPEN COLLABORATION TABLES
- 1.6.1. These spaces are configured with the meeting room table against a half-height wall, with seating for 6-users.
- 1.6.2. This room type shall feature the following functionality for users:
  - .1 Presentation
    - .1 Wired
- 1.6.3. A table mounted input shall be provided by the furniture vendor to allow users to connect devices. The AV Contractor shall provide inserts for this and presentation cables 6' in length. This shall have connectivity for:
  - .1 USB-C (Video)
    - .1 Presentation
- 1.6.4. A docking station/port replicator shall be supplied by the Owner and installed by the AV Contractor. This unit shall allow for a users to connect to the room system using a single cable. This unit shall be mounted under table with a mounting solution provided by the AV Contractor.
- 1.6.5. Provide a wall-mounted 43" flat panel display for playback of video. This unit shall also include a wall-mount system for installation.

- 1.6.6. Provide all required interconnecting video, control and audio interface cables for a full functional system.
- 1.6.7. TYPE 5 – DIGITAL SIGNAGE
- 1.6.8. Total location quantity is one (1).
- 1.6.9. This room type shall feature the following functionality for users:
  - .1 Digital Signage
- 1.6.10. Provide a wall-mounted 55" flat panel display with integrated speakers for playback of video. This unit shall also include a wall-mount system for installation in portrait format.
- 1.6.11. Provide a digital media player and shall be mounted behind the display. All content shall be centrally managed to display digital signage content. Content shall be created and managed by the Owner's marketing department. The AV Contractor shall provide training sessions as outlined further in this document.
- 1.6.12. Provide all required interconnecting video, control and audio interface cables for a full functional system.

1.7. ITEMS IN THE SCOPE OF OTHERS

1.7.1. Furniture manufacturer to provide required millwork modifications in coordination with AV Contractor.

1.7.2. Refer to the following table for the division of responsibility for IT department regarding AV systems:

IT Systems Information		
Phone System:	Broadconnect	
Unified Communications System:	BrightSign Bright Author	
Digital Signage	Various (Microsoft Teams, Zoom, WebEx, etc...)	
AV / IT Division of Responsibility Matrix		
System Type	AV Contractor	IT
Network Configuration	<ul style="list-style-type: none"> <li>- Spreadsheet List of devices to be attached to network with device information</li> <li>- Document Data Jack AV network switch will connect to</li> <li>- Configuration of Devices for Multicast and static IP addressing</li> <li>- Update of Spreadsheet with IP addresses once assigned.</li> </ul>	<ul style="list-style-type: none"> <li>- Network Security Rules</li> <li>- Wall jack patching in Telecom Room</li> <li>- Provide IP addresses or IP subnet ranges for devices that will reside on the Owner's network.</li> </ul>
Video Conferencing	<ul style="list-style-type: none"> <li>- Hardware Supply and Installation (Displays, cameras, speakers, microphones)</li> <li>- Hardware configuration</li> </ul>	<ul style="list-style-type: none"> <li>- Network Configuration</li> <li>- Bandwidth Management</li> <li>- Allocation of Network Drop and Activation</li> </ul>

Audio Conferencing	<ul style="list-style-type: none"> <li>- Hardware Supply, Installation and Calibration (Microphones, speakers, signal processors)</li> <li>- Hardware Configuration</li> </ul>	<ul style="list-style-type: none"> <li>- Telephone System Configuration</li> <li>- Allocation of Telephone Drop and Activation</li> </ul>
Digital Signage	<ul style="list-style-type: none"> <li>- Hardware Supply Installation (Flat Panel Displays, Mounting hardware, media players and cabling)</li> <li>- Signage Player Configuration</li> <li>- Software training as per specifications.</li> </ul>	<ul style="list-style-type: none"> <li>- Network Configuration</li> <li>- Bandwidth Management</li> <li>- Allocation of Network Drop and Activation</li> <li>- Display content</li> <li>-</li> </ul>

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2. Products
- 2.1. FLAT PANEL DISPLAY - 55" 4K COMMERCIAL (TYPE – FPD1 & DS1)
- 2.1.1. Flat panel display shall have a minimum diagonal of 55" and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.
- 2.1.2. Flat panel display shall have either LED edge lit or full LED array backlight system.
- 2.1.3. Flat panel display shall have a minimum brightness of 500 cd/m2 (nits).
- 2.1.4. Flat panel display shall have built-in audio speakers.
- 2.1.5. Flat panel display shall be commercial grade and have an operational rating of 24-hours per day, for 7-days a week for a minimum period of three years.
- 2.1.6. Flat panel display shall have the following inputs and not limited to:
- .1 HDMI (Qty: 2)
  - .2 RS232C
  - .3 RJ45 for IP-based control
- 2.1.7. Flat panel display screen shall have a haze value between 25%-50%.
- 2.1.8. Provide a mounting solution.
- 2.1.9. Provide trim kit for the display to provide an aesthetic as well as tamper-resistant coverage for the sides of the display.
- 2.1.10. Typical device shall be LG UH-series or approved equivalent.
- 2.2. FLAT PANEL DISPLAY - 75" 4K COMMERCIAL (TYPE – FPD2)
- 2.2.1. Flat panel display shall have a minimum diagonal of 75" and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.
- 2.2.2. Flat panel display shall have either LED edge lit or full LED array backlight system.
- 2.2.3. Flat panel display shall have a minimum brightness of 500 cd/m2 (nits).
- 2.2.4. Flat panel display shall have built-in audio speakers.
- 2.2.5. Flat panel display shall be commercial grade and have an operational rating of 24-hours per day, for 7-days a week for a minimum period of three years.
- 2.2.6. Flat panel display shall have the following inputs and not limited to:
- .1 HDMI (Qty: 2)
  - .2 RS232C
  - .3 RJ45 for IP-based control
- 2.2.7. Flat panel display screen shall have a haze value between 25%-50%.
- 2.2.8. Provide a mounting solution.
- 2.2.9. Provide trim kit for the display to provide an aesthetic as well as tamper-resistant coverage for the sides of the display.
- 2.2.10. Typical device shall be LG UH-series or approved equivalent.

- 2.3. FLAT PANEL DISPLAY - 110" 4K COMMERCIAL (TYPE – FPD3 & FPD5)
- 2.3.1. Flat panel display shall have a minimum diagonal of 110" and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.
- 2.3.2. Flat panel display shall have either LED edge lit or full LED array backlight system.
- 2.3.3. Flat panel display shall have a minimum brightness of 500 cd/m2 (nits).
- 2.3.4. Flat panel display shall have built-in audio speakers.
- 2.3.5. Flat panel display shall be commercial grade and have an operational rating of 24-hours per day, for 7-days a week for a minimum period of three years.
- 2.3.6. Flat panel display shall have the following inputs and not limited to:
- .1 HDMI (Qty: 2)
  - .2 RS232C
  - .3 RJ45 for IP-based control
- 2.3.7. Flat panel display screen shall have a haze value between 25%-50%.
- 2.3.8. Provide a mounting solution.
- 2.3.9. Provide trim kit for the display to provide an aesthetic as well as tamper-resistant coverage for the sides of the display.
- 2.3.10. Typical device shall be LG UM-series or approved equivalent.
- 2.4. FLAT PANEL DISPLAY - 43" 4K COMMERCIAL (TYPE – FPD4)
- 2.4.1. Flat panel display shall have a minimum diagonal of 43" and resolution of 4K UHD (3840 x 2160) with an aspect ratio of 16:9.
- 2.4.2. Flat panel display shall have either LED edge lit or full LED array backlight system.
- 2.4.3. Flat panel display shall have a minimum brightness of 500 cd/m2 (nits).
- 2.4.4. Flat panel display shall have built-in audio speakers.
- 2.4.5. Flat panel display shall be commercial grade and have an operational rating of 24-hours per day, for 7-days a week for a minimum period of three years.
- 2.4.6. Flat panel display shall have the following inputs and not limited to:
- .1 HDMI (Qty: 2)
  - .2 RS232C
  - .3 RJ45 for IP-based control
- 2.4.7. Flat panel display screen shall have a haze value between 25%-50%.
- 2.4.8. Provide a mounting solution.
- 2.4.9. Provide trim kit for the display to provide an aesthetic as well as tamper-resistant coverage for the sides of the display.
- 2.4.10. Typical device shall be LG UH-series or approved equivalent.
- 2.5. WALL DISPLAY MOUNT
- 2.5.1. Display Mount shall have a leveling control for post-installation for fine tuning of height and leveling to provide post-installation height adjustment and lateral shift for faster and easier installation.

- 2.5.2. Display Mount shall be an ultra-low-profile display mounting solution.
- 2.5.3. Display Mount shall have a minimum tilt range of -12 to 2-degree.
- 2.5.4. Display Mount shall be rated for the appropriate required display being mounted.
- 2.5.5. Provide a CPU mounting accessory and extenders for a low-profile installation (FCA series) as required if mentioned above.
- 2.5.6. Typical device shall be Chief Fusion Series or approved equivalent.
  
- 2.6. DM RECEIVER
  - 2.6.1. DM Receiver shall have a build-in 4K scaler and audio extractor.
  - 2.6.2. DM Receiver shall support HDBaseT and HDCP.
  - 2.6.3. DM Receiver shall at minimum support the following video resolutions: UHD, 4K60, WUXGA, 1080p and WXGA.
  - 2.6.4. DM Receiver shall support 4:4:4 chroma sampling.
  - 2.6.5. DM Receiver shall support and management of EDID (Extended Display Identification Data).
  - 2.6.6. Conform to requirements in section 27 41 16.16 – Audio Video Over Structured Cabling.
  - 2.6.7. Typical device shall be Crestron HD-RXC-4KZ-101 or approved equivalent.
  
- 2.7. VIDEO SWITCHER 8X2
  - 2.7.1. Video Switcher shall support HDBaseT and HDCP.
  - 2.7.2. Video switcher shall have (Qty:6) six HDMI inputs.
  - 2.7.3. Video switcher shall have (Qty:2) two HDMI outputs.
  - 2.7.4. Video switcher shall have (Qty:2) two HDBaseT inputs.
  - 2.7.5. Video switcher shall have (Qty:2) two HDBaseT outputs.
  - 2.7.6. Video switcher shall at minimum support the following video resolutions: UHD, 4K DCI, WUXGA, 1080p and WXGA.
  - 2.7.7. Video switcher shall support management of EDID (Extended Display Identification Data).
  - 2.7.8. Typical device shall be Crestron HD-PS622 or approved equivalent.
  
- 2.8. NETWORKED WIRELESS PRESENTATION SYSTEM
  - 2.8.1. Wireless Presenter shall support wireless video connections for content sharing both via proprietary software that allows for AirPlay, as well as MiraCast.
  - 2.8.2. Wireless Presenter shall support audio and video playback up to 30 fps.
  - 2.8.3. Wireless Presenter shall support the following operating systems for full screen sharing:
    - .1 Windows 7/8/10 32 & 64 bit
    - .2 Mac OSX 10.6/10.7/10.8/10.9
    - .3 Android, Chrome OS and iOS through mobile applications
  - 2.8.4. Wireless Presenter shall support input resolutions of up to 1920 x 1200 (WUXGA).
  - 2.8.5. Wireless Presenter shall support the following output resolutions:
    - .1 HDMI: 1280x720 (720P), 1920x1080 (1080p), 3840x2160 (2160p)
  - 2.8.6. Wireless presenter shall allow for remote network management.

- 2.8.7. Typical device shall be Crestron AirMedia AM-3200 or approved equivalent.
- 2.9. DIGITAL SIGNAGE PLAYER
- 2.9.1. Digital signage player shall support audio and video playback up to 4K resolution.
- 2.9.2. Digital Signage Player shall be network-based and include a content management system.
- 2.9.3. Digital Signage Player shall include a HDMI input for a local source to connect.
- 2.9.4. Digital Signage Player shall include a HDMI output for connection to a display.
- 2.9.5. Digital Signage Player shall be HDCP compliant.
- 2.9.6. Digital Signage player shall allow for remote network management
- 2.9.7. Digital Signage Player shall encode and decode H.264, H.265 and MPEG-4.
- 2.9.8. Digital signage player shall be able to synchronize playback across multiple units for videowall applications.
- 2.9.9. Digital Signage Player shall include one (1) year of cloud service.
- 2.9.10. Typical device shall be BrightSign XT1144 with BN Cloud or approved equivalent.
- 2.10. WEB CONFERENCING BAR
- 2.10.1. Web Conference Bar shall Three 13-megapixel cameras
- 2.10.2. Web Conference Bar shall 8 built-in professional-grade microphones.
- 2.10.3. Web Conference Bar shall 4 zero-vibration, stereo set-up speakers for high-definition audio.
- 2.10.4. Web Conference Bar shall have intelligent zoom and auto-framing features.
- 2.10.5. Web Conference Bar shall be certified for Microsoft Teams & Zoom
- 2.10.6. Web Conference Bar shall have 180-degree field of view.
- 2.10.7. Typical device shall be Jabra PanaCast 50 or approved equivalent.
- 2.11. USB PTZ CAMERA (TYPE – CAM1 & CAM2)
- 2.11.1. USB PTZ Camera shall have 1/2 inch CMOS image sensor.
- 2.11.2. USB PTZ Camera shall have group framing and presenter tracking capabilities.
- 2.11.3. USB PTZ Camera shall have the ability to transmit video signal from one camera to another and auto-switching between cameras using a single video or USB port from one of the cameras.
- 2.11.4. USB PTZ Camera shall have a 12X optical zoom lens.
- 2.11.5. USB PTZ Camera shall have 1920x1080 pixels progressive at 60 fps.
- 2.11.6. USB PTZ Camera shall have RS-232 and network connectivity for external controls.
- 2.11.7. USB PTZ Camera shall transmit video to the connected personal computer utilizing standard USB UVC protocols.
- 2.11.8. Typical device shall be Crestron IV-CAM-I12-B series or approved equivalent.
- 2.12. USB EXTENDER
- 2.12.1. USB extender shall extend USB peripherals up to 450 feet on standard cat 5/5e/6 cabling.
- 2.12.2. USB extender shall support USB 1.0, 2.0, and 3.0 with transfer rates up to 480 Mbps.

- 2.12.3. USB extender shall utilize category cabling for extension.
- 2.12.4. Provide all mounting hardware as required.
- 2.12.5. Typical device shall be Crestron USB-EXT-3 series or approved equal.
  
- 2.13. 2 INPUT USB SWITCHER
  - 2.13.1. USB switcher shall allow for switching between host devices and peripherals.
  - 2.13.2. USB switcher shall have a minimum of two (2) USB host ports and a minimum of four (4) USB device ports.
  - 2.13.3. USB switcher shall support up to USB 3.0 protocol with transfer rates up to 10 Gbps.
  - 2.13.4. USB switcher shall support selectable Host and Peripheral emulation.
  - 2.13.5. USB switcher shall support control via RS-232, ethernet and contact closure.
  - 2.13.6. Provide all mounting hardware as required.
  - 2.13.7. Typical device shall be Crestron USB-SW-200 Pro or approved equal.
  
- 2.14. DSP 8
  - 2.14.1. Audio DSP shall have inputs and outputs as shown on drawings (with minimum two spare inputs and outputs).
  - 2.14.2. Conform to requirements of 27 41 16.10 – Sound System General Requirements.
  - 2.14.3. Frequency response shall be 20-20,000 Hz, +0.1/-0.4 dB with a dynamic range of minimum 100dB.
  - 2.14.4. Audio DSP shall have acoustic echo cancellation on each of the input channel.
  - 2.14.5. Audio DSP shall have support AES67 and DANTE protocols as required by the project.
  - 2.14.6. Audio DSP shall have a VoIP interface. VoIP interface card shall have the following:
    - .1 SIP protocol support
    - .2 10/100/1000 Mbps LAN interface
    - .3 Conforms to IEEE802.3-2005 (Clause 40) for Physical Media Attachment
    - .4 Conforms to IEEE802.3-2002 (Clause 28) for Link Partner Auto-Negotiation
    - .5 Manual or dynamic host configuration protocol (DHCP) network setup
    - .6 IPv4
    - .7 TCP
    - .8 UDP
    - .9 DNS-SRV
  - 2.14.7. Typical device shall be QSC CORE 8 FLEX or approved equivalent.
  
- 2.15. GOOSENECK MICROPHONE
  - 2.15.1. Gooseneck Microphone shall have a frequency response of 50 to 17,000 Hz.
  - 2.15.2. Gooseneck Microphone shall include base.
  - 2.15.3. Typical device shall be Shure Microflex Gooseneck Microphone w/Base or approved equivalent.

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- 2.16. CEILING MICROPHONE ARRAY (DIGITAL) (TYPE – MIC)
- 2.16.1. Ceiling Microphone shall have a 360 degree directional pick-up pattern with eight (8) steerable lobes.
- 2.16.2. Ceiling Microphone shall have onboard audio digital signal processing.
- 2.16.3. Ceiling Microphone shall have utilize DANTE digital audio network transport protocol.
- 2.16.4. Ceiling Microphone shall be sized to fit within standard ceiling tile size opening.
- 2.16.5. Typical device shall be Shure Microflex MXA920W-S or approved equivalent.
- 2.17. LAVALIER WIRELESS MICROPHONE SYSTEM
- 2.17.1. Type 1 Wireless Microphone System with Lavalier
- 2.17.2. Wireless Microphone System shall operate on multiple frequency bands (up to 900MHz) as appropriate for the location the system shall be installed into.
- 2.17.3. Wireless microphone system shall have a minimum frequency bandwidth response of 45 Hz to 15 kHz.
- 2.17.4. Transmitters shall operate a minimum of eight hours on two “AA” size batteries.
- 2.17.5. Receivers shall have XLR and ¼ inch outputs.
- 2.17.6. Receivers shall have detachable antennas.
- 2.17.7. Receivers shall be ethernet controlled.
- 2.17.8. Refer to drawings for antenna mounting locations. Provide all appropriate antenna distribution (combiners, power distribution amplifiers, splitters/combiners) for systems of two or more.
- 2.17.9. Provide ½ wave antennas.
- 2.17.10. Wireless Microphone System shall include a bodypack style transmitter.
- 2.17.11. Wireless Microphone System shall include a detachable lavalier microphone.
- 2.17.12. Lavalier microphone shall have a directional pick-up pattern with a condenser cardioid element per microphone.
- 2.17.13. Typical device shall be Shure QLXD series with QLXD1 transmitter and WL185 or approved equal.
- 2.18. ASSISTIVE LISTENING SYSTEM - RF
- 2.18.1. Assistive Listening Transmitter shall operate on multiple frequency bands (72 MHz or 216MHz) as appropriate for the location the system shall be installed into.
- 2.18.2. Assistive Listening Transmitter shall have a minimum frequency bandwidth response of 50 Hz to 15 kHz.
- 2.18.3. Assistive Listening Transmitter shall have 57 selectable transmitting channels.
- 2.18.4. Assistive Listening Transmitter shall have 60 dB SNR (mono) or greater, end-to-end.
- 2.18.5. Assistive Listening Transmitter shall have XLR and ¼ inch outputs.
- 2.18.6. Assistive Listening Transmitter have detachable antennas.
- 2.18.7. Provide antennas as required.
- 2.18.8. Assistive Listening Transmitter shall include a rack mounting kit.
- 2.18.9. Receivers shall incorporate a stereo headset jack that allows the user to plug in either a mono or stereo headset and listen to audio normally.
- 2.18.10. Assistive Listening System shall come complete with:

- .1 Listening receivers
    - .1 Provide quantities in accordance with local ADA requirements.
  - .2 Rechargeable batteries
  - .3 Ear speaker
  - .4 Charging and carrying case for receivers.
- 2.18.11. Typical device shall be Listen LT-800 with LR-4200 unit as required.
- 2.19. AUDIO AMPLIFIER 4CH 75W
- 2.19.1. Amplifier shall have four (4) channels and provide 75 watts of power per channel.
  - 2.19.2. Conform to requirements of 27 41 16.10 – Sound System General Requirements.
  - 2.19.3. Amplifier shall support stereo low impedance, or mono 70V, loudspeaker systems.
  - 2.19.4. Typical device shall be Crestron AMP-X300 or approved equivalent.
- 2.20. CEILING SPEAKER (TYPE – S1)
- 2.20.1. Ceiling Speaker shall have a coaxially mounted 165mm (6.5 inch) woofer and 25mm (1”) dome high frequency unit for full range sonic reproduction.
  - 2.20.2. Ceiling Speaker shall have a minimum (-3 dB) frequency response of 65 Hz to 20 kHz measured on axis at a distance of 1 metre.
  - 2.20.3. Ceiling Speaker shall have a minimum 88db sensitivity measured at 1 watt and 1 meter from the speaker on the central axis.
  - 2.20.4. Speaker shall have a minimum 135° conical coverage.
  - 2.20.5. Speaker shall be rated for minimum program wattage of 60W.
  - 2.20.6. Speaker shall have a line transformer for 70V operation. Minimum transformer taps shall be 30W, 15W and 7.5 W.
  - 2.20.7. Typical device shall be QSC AD-C6T or approved equivalent.
- 2.21. DISPLAY CONTROLLER
- 2.21.1. HDMI CEC Control Device shall automate display control via RS-232 or CEC control.
  - 2.21.2. HDMI CEC Control Device shall support resolutions up to 8K/60 @ 4:4:4.
  - 2.21.3. HDMI CEC Control Device shall have the ability to turn on a display to a specific input when a user plugs in their HDMI device.
  - 2.21.4. Typical device shall be Crestron HD-CTL-101 or approved equivalent.
- 2.22. CONTROL PROCESSOR - SMALL
- 2.22.1. Control Processor shall have real-time, pre-emptive multi-threaded/multitasking kernel; Transaction-Safe Extended FAT file system; supports up to 10 simultaneously running programs.
  - 2.22.2. Conform to requirements of 27 41 16.15 – CONTROL SYSTEMS.
  - 2.22.3. Control System shall have the following minimum specifications – 1 GB of SDRAM, 8 GB of Flash and supports USB mass storage devices.
  - 2.22.4. Control System shall support Ethernet connectivity with the following features:

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- .1 10/100 Mbps
  - .2 Auto-switching
  - .3 Auto-negotiating
  - .4 Auto-discovery
  - .5 Full/half duplex
  - .6 TCP/IP stack
  - .7 BACnet/IP
- 2.22.5. Control Processor shall support 2-way device control and monitoring, all ports support RS-232 up to 115.2k baud with software handshaking, one port also supports RS-422 or RS-485 and hardware handshaking.
- 2.22.6. Control Processor shall have IR/Serial shall support 1-way device control via infrared up to 1.2 MHz or serial TTL/RS-232 (0-5 Volts) up to 115.2k baud.
- 2.22.7. Control Processor shall have a minimum quantity of the following ports:
- .1 COM – Qty:1
  - .2 IR – Qty:2
  - .3 Relay – Qty:2
  - .4 Digital In – Qty:2
  - .5 Ethernet – Qty:1
  - .6 USB Configuration/Storage – Qty:1
- 2.22.8. Provide an Ethernet switch to create an audiovisual control network as shown on drawings.
- 2.22.9. Provide all required power supplies for connected equipment as required.
- 2.22.10. Typical device shall be Crestron RMC4 or approved equivalent.
- 2.23. TOUCH PANEL - 10"
- 2.23.1. 10" Touch Panel shall have a 10" TFT active matrix colour LCD display with aspect ratio of 16:9 pixels and resolution of 1920x1080 pixels.
- 2.23.2. 10" Touch Panel shall provide 400 nits brightness.
- 2.23.3. 10" Touch Panel shall utilize capacitive touch technology.
- 2.23.4. 10" Touch Panel shall support H.264 streaming.
- 2.23.5. 10" Touch Panel shall utilize PoE protocol.
- 2.23.6. 10" Touch Panel shall not have an onboard camera or microphone unless required in scope. Confirm with project team prior to ordering.
- 2.23.7. 10" Touch Panel shall include a swivel base.
- 2.23.8. Typical device for table-top mounting provide TS-1070 series or approved equivalent.
- 2.24. NETWORK SWITCH
- 2.24.1. Network Switch shall support Layer-3 Gigabit Ethernet switching.
- 2.24.2. Network Switch shall provide Power Over Ethernet (PoE) on all ports.
- 2.24.3. Network Switch shall be managed.

- 2.24.4. Network Switch shall support 10Base-T/100Base-TX/1000Base-T Ethernet with network standards of IEEE 802.3, 802.3u, 802.3ab, 802.3x, & 802.3af.
- 2.24.5. Network Switch shall have sufficient ports to accommodate all system AV devices, with an additional 4-ports for expansion or uplink.
- 2.24.6. Network Switch shall be compatible with digital audio and video multicast protocols required as part of this project.
- 2.24.7. Network Switch shall be network stackable.
- 2.24.8. Network Switch shall be allow for proper bandwidth traffic to traverse across switches as required.
- 2.24.9. Network Switch shall be rackmountable.
- 2.24.10. Typical device shall be NetGear M4250 series or approved equivalent.
  
- 2.25. CREDENZA RACK - 12RU
  - 2.25.1. Credenza Rack shall have a removable enclosure allows in-shop integration and on-site installation of equipment
  - 2.25.2. Credenza Rack shall have proper thermal management include active fans where required for equipment protection. Refer to 27 40 10.00 section 3 – VENTILATION and EQUIPMENT RACKS IN MILLWORK
  - 2.25.3. Credenza Rack shall have a rear cable support for effective cable management.
  - 2.25.4. Credenza Rack shall have 12 useable rack spaces with maximum weight capacity of 250 lb.
  - 2.25.5. Credenza Rack shall have a rack-mounted power strip including surge and spike protection.
  - 2.25.6. Provide appropriate sized runner kit for Credenza Rack.
  - 2.25.7. Provide an active exhaust fan.
  - 2.25.8. Typical device shall be Middle Atlantic CFR Series with 5-RSXX and CAB-COOL-2 or approved equivalent.
  
- 2.26. UNINTERRUPTABLE POWER SUPPLY - MEDIUM
  - 2.26.1. Uninterruptable power supply shall be a series mode UPS.
  - 2.26.2. Uninterruptable power supply shall provide 1000VA capacity.
  - 2.26.3. Uninterruptable power supply shall be rack mountable.
  - 2.26.4. Uninterruptable power supply shall have a maximum transfer time of 4 milliseconds.
  - 2.26.5. Uninterruptable power supply shall have automatic voltage regulation.
  - 2.26.6. Uninterruptable power supply shall have a minimum of eight (8) NEMA5-20R outlets that are able to be remotely controlled in two (2) banks.
  - 2.26.7. Uninterruptable power supply shall provide the ability to connect an expansion battery.
  - 2.26.8. Uninterruptable power supply shall have ethernet connectivity.
  - 2.26.9. Typical device shall be Middle Atlantic UPX-RLNK-1000R-2 or approved equivalent.
  
- 2.27. AV FIELD PANEL
  - 2.27.1. All field panels shall be 0.125" aluminum stock with 1/8" bevelled edges. Alternate metal stock shall be submitted to AV Consultant for approval.
  - 2.27.2. Standard finish shall be anodized with vertical brush

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- 2.27.3. Submit shop drawings of panels for Owner/architect/AV Consultant approval before fabrication. Indicate on drawings locations for each type of panel and finish.
- 2.27.4. Panels to be engraved and paint filled.
- 2.27.5. XLR connectors shall be inserted into panels from rear. Ensure labelling strips do not interfere with the operation of the connector release mechanisms. Holes shall be sized to suit male or female shell interchangeably.
- 2.28. WIRE
- 2.28.1. Refer to section 27 41 23.11 Cables and Pathway for Audiovisual Systems for all cabling requirements.
- 2.29. CONNECTORS
- 2.29.1. All input and output connectors for field plates and equipment rack patch panels shall be Neutrik D-series.
3. Execution
- 3.1. GENERAL REQUIREMENTS
- 3.1.1. All equipment supplied as part of this project shall conform to the requirements described in the following sections:
- .1 SECTION 27 40 10.00 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION

END OF SECTION

27 41 16.10 Sound System General Requirements

1. General

1.1. PROGRAM SOUND SYSTEM REQUIREMENTS

- 1.1.1. These are the minimum specifications unless otherwise stated in specific subsections. All equipment selected must meet or exceed these expectations.
- 1.1.2. All AC powered equipment shall be CSA or ULC approved devices.
- 1.1.3. Input and output power levels are expressed in dBm.
- 1.1.4. It is not the intention of the AV Consultant to direct the AV Contractor to verify all manufacturer performance specifications on an individual component level unless it is a necessary process to identify and resolve a fault in the system.

1.2. LOUDSPEAKER PERFORMANCE CRITERIA DEFINITIONS

1.2.1. Equipment

Performance Criteria	Definition
Measured Sound Pressure Level (SPL)	This is the long term SPL capability as measured with a sound level meter using A-weighting and slow response using pink noise. It is measured on axis of the loudspeaker at ear height at the intended listening position. It is measured in free field (direct plus reverberant) with an omnidirectional microphone. It is measured after the system is equalized to installed frequency response.
Predicted Sound Pressure Level (SPL)	This is the maximum long term SPL capability as calculated from manufacturer's data and location design data using inverse square law or approved computer design package, A weighted, slow response (average). It is calculated on axis of loudspeaker at ear height at the intended listening position.
Coverage area	This area is defined as the area where the off-axis attenuation of the direct SPL of the loudspeaker is less than 6 dB at 2 kHz.
Coverage variance	This is the variation in A-weighted SPL due to listener location within the coverage area of the loudspeaker as measured in the room free field. It is measured at ear height at the intended listening position.
Passband (bandwidth)	This is the nominal operating range of unequalized loudspeakers. It is determined by the 3 dB down points of the raw frequency response.
Installed frequency response	This is measured on-site after optimization of aiming and equalization. It is flat (maximum deviation of +1/-3 dB on tone-third octave intervals) within pass band at maximum SPL.
Loudspeaker Headroom	This is the nominal long term power handling capability above that needed to achieve maximum desired SPL. It is expressed in dB.

Amplifier headroom	The difference between the EIA power rating of power amplifier and the power required to achieve maximum SPL, expressed in dB
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1.3. ELECTRONIC SIGNAL CHAIN PERFORMANCE REQUIREMENTS

1.3.1. The following minimum end-to-end specifications must be met by the electronic signal chain:

Performance Criteria	Value
Distortion	Less than 0.01% at full output
Nominal signal level	+4 dBm
Maximum output level	+22 dBm
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Signal to noise	Greater than 90 dB
Balanced input common mode rejection	Minimum 70 dB at 15 kHz
Nominal line input impedance	10 K
Balanced line output impedance	600 $\Omega$ or less
Crosstalk (for multi-channel units)	More than 70 dB down

1.4. PROGRAM AUDIO SYSTEM PERFORMANCE REQUIREMENTS

1.4.1. Provide an audio system to meet the requirements defined in the Audiovisual System Scope of Work.

1.4.2. The following minimum must be met by the audio system:

Performance Criteria	Value
Measured sound pressure level capability	85 dBA (minimum)
Minimum bandwidth (-3 dB points)	125 Hz to 8 kHz
Distortion and noise (electronic)	Less than 3%
Coverage variance	+/- 3 dB SPL
Acoustic noise (as measured with SPL meter at any and all normal seated positions)	Greater than 25 dBA SPL
Switching noise (due to relays and electronics)	70 dB below nominal signal level

1.4.3. Program Loudspeakers Performance Requirements:

Performance Criteria	Value
Frequency response (minimum)	80 Hz to 12.5 kHz, +/- 3dB
Distortion	Less than 3% at 6 dB down from full output throughout stated frequency response
Drivers	Minimum 2-way

1.4.4. 70V Loudspeaker minimum performance requirements:

Performance Criteria	Value
Frequency response (minimum)	100 Hz to 12kHz, +/- 4dB
Minimum sensitivity	90dBm 1 watt @ 1m
Dispersion	90 degrees at 5 kHz
Distortion	Less than 3% at 6 dB down from full output throughout stated frequency response

1.4.5. For alternates to the proposed system design in the Audiovisual System Scope of Work aimed at providing value to the Owner while reducing cost, provide computer modelled speaker design data using industry standard speaker modelling software with the predicted SPL to meet the performance criteria described above.

1.5. AUDIO TRANSFORMER PERFORMANCE REQUIREMENTS

1.5.1. The following criteria must be met by any audio transformer except loudspeakers which are specified elsewhere:

Performance Criteria	Value
Frequency Response	30 Hz to 30 kHz +/- 1 dB
Insertion loss	Less than 1 dB
Primary nominal impedance	10k/40k
Secondary nominal impedance	10k/40k
Shield	Electrostatic shield between primary and secondary windings
Winding	Balanced winding

1.6. DIGITAL SIGNAL PROCESSOR (DSP) REQUIREMENTS

1.6.1. Digital signal processors provide audio signal mixing, routing and processing for sound system applications.

1.6.2. Provide a rack-mount digital signal processor. Include all rack-mounting and cabling accessories as required.

1.6.3. DSP platform shall allow the creation/connection of system components within each hardware unit. Available system components shall include (but not be limited to) mixers, equalizers, filters, crossovers, dynamics/gain controls, routers, delays, remote controls, meters, generators, and diagnostics.

1.6.4. Inputs/outputs of the DSP shall be sized accordingly to support the mic/line functionality illustrated as per AV concept functional drawings. Provide a minimum of two additional input and output channels to support user design changes.

1.6.5. Ethernet communications shall be utilized for software control and configuration. Provide all PC-based software and files to the Owner to allow programming access through the AV IP network or Owner network when specified.

1.6.6. DSP platform shall be RS-232 controllable for interface to third party control systems.

1.6.7. DSP platform shall have selectable Phantom Power per channel. Phantom Power, Signal Present and Clip information per channel is preferred without the requirement for a PC.

1.6.8. Performance requirements:

Performance Criteria	Value
Distortion	Less than 0.01% at full output
Nominal signal level	+4 dBm
Maximum input level	+18 dBm
Maximum output level	+22 dBm
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Signal to noise	Greater than 90 dB
Balanced input common mode rejection	Minimum 70 dB at 15 kHz
Balanced nominal line input impedance	10 kΩ
Balanced line output impedance	600 Ω or less
Crosstalk (for multi-channel units)	Greater than 70 dB down
Minimum sampling frequency	48 kHz
Minimum converter resolution	20 bit
Processing resolution	24 bit minimum

1.7. AUDIO CONFERENCING DSP REQUIREMENTS

- 1.7.1. Provide a digital signal processor with wide-band AEC mic/line inputs, standard mic/line inputs, mic/line outputs, and a telephone interface.
- 1.7.2. Where the Owner phone system is analog, provide an RJ-11 port to enable the DSP to interface with a standard POTS (aka PSTN or Analog PBX) telephone network.
- 1.7.3. Where the Owner phone system is VOIP, provide an RJ45 VOIP port or else external VOIP adapter to enable the DSP to interface to Owner's network.
- 1.7.4. Provide dedicated acoustic echo cancellation (AEC) processing on all audio channels used for audio and video conferencing. The AEC algorithm can be applied to signals coming from the local analog inputs or from the digital audio bus. All microphone inputs shall be fed into an AEC channel.
- 1.7.5. Automatic Gain Control (AGC) and Noise Cancellation (NC) should also be provided per AEC algorithm. AGC ensures that microphone levels remain at an optimum level, and NC removes steady state noise (such as from a projector fan or air conditioning device) from the signal path.

1.8. AMPLIFIERS

- 1.8.1. Program amplifiers must be capable of providing 200% of the power required by the loudspeaker.

1.8.2. Low Impedance Amplifier Performance Requirements:

Performance Criteria	Value
Frequency response	20 Hz to 20 kHz, +/- 0.5 dB
Distortion	Less than 0.1% THD at rated output
Signal to noise ratio 20 Hz to 20 kHz	> -106 dB
Amplifier headroom in watts	200% above load requirement
Mechanical noise	At ambient or below
Dampening Factor	>500

1.8.3. 70V Amplifier Performance Requirements:

Performance Criteria	Value
Output Voltage	70.7 V
Distortion	Less than 0.05% THD at rated output
Frequency Response	60 Hz to 20 kHz, +/- 0.5 dB
Signal to noise ratio	Greater than 90 dB
Amplifier headroom in watts	50% above load requirement
Mechanical noise	At ambient or below

2. Products

2.1. DSP

- 2.1.1. Acceptable DSP brands are: QSC and BIAMP. Any other brand/model must be approved by AV Consultant.

2.2. AMPLIFIERS

- 2.2.1. Acceptable amplifier brands are: QSC, Crown, and LabGruppen. Any other brand/model must be approved by AV Consultant.

### 2.3. LOUDSPEAKERS

2.3.1. Acceptable loudspeaker brands are: QSC, Community, JBL and Electrovoice/Bosch. Submit all other speaker proposals for AV Consultant approval.

### 3. Execution

#### 3.1. AUDIO SYSTEM TESTING AND CALIBRATION

3.1.1. Optimize the digital signal processors, amplifiers, loudspeakers, speaker power taps, phasing, and speaker aiming as required to achieve the system's optimal performance with reference to the intent of the design and the performance criteria defined in the specifications.

3.1.2. The system is intended to provide (without clipping) an average program level of at least 85 dBa at 1.5m above the floor.

- .1 Using pink noise (with range of 250 Hz to 8 kHz), measure the sound pressure level at one randomly chosen position in each zone.
- .2 Adjust signal so the variation in sound pressure level within in each area shall approach +/- 3dB or better, measured in 1/3 octave bandwidth across a frequency range of 250 Hz to 8 kHz)

3.1.3. The AV Contractor shall have as a minimum the following test equipment available on site during testing and performance acceptance:

- .1 Sound-level meter (peak and average reading) c/w calibrated microphone
- .2 Phase checker generator/receiver set
- .3 Include all necessary cables and specialty adapters

3.1.4. All testing of loudspeakers to be installed overhead should be tested thoroughly prior to installation. It is important that all rigging systems are inspected for structural integrity and all fasteners are secured. Once installed, the speakers shall need to be tested for proper polarity.

3.1.5. The system shall be free of hum, clicks, RF pickup, thumps or other audible distortions in all configurations and phases of operation. Correct all deficiencies.

#### 3.2. DIGITAL SIGNAL PROCESSORS

3.2.1. Where the DSP is used in conjunction with table microphones and audio/video conferencing, the DSP shall be configured for mix-minus operation to ensure maximum gain before feedback. Ensure room speakers are individually home run back to equipment rack. Provide enough DSP outputs and amplifier channels to support mix-minus operation.

3.2.2. DSP shall be programmed and commissioned by programmers and technicians certified on specified platform. Provide all certifications at time of bid.

3.2.3. Upon completion of the project, AV Contractor shall provide all custom programmed code to Owner on USB media or Owner identified preferred media format.

3.2.4. Provide all programming and end to end calibration to align the DSP with interconnected devices.

3.2.5. Provide all GUI's and interface control programming as required. Provide user manuals for custom GUIs.

3.2.6. Provide all software applications and tools to configure and maintain the DSP systems.

3.2.7. Provide system presets to capture and store signal routing and processing paths for table configurations.

- 3.2.8. Configure the software to allow full processing of all signal paths.
- 3.2.9. Where interfaced with a third party control system, control system shall hang up any open calls on system shutdown routines.
- 3.2.10. Microphone signal paths to include:
  - .1 High pass filter
  - .2 Compression
  - .3 3 band parametric EQ
  - .4 Gain control on each input Level metering on each input
- 3.2.11. Line signal paths to include:
  - .1 High pass filter
  - .2 Levelling
  - .3 3 band parametric EQ , Gain control on each input & Level metering on each input
- 3.2.12. Microphone mixing includes:
  - .1 Automatic gain sharing mixing (organised into groups)
  - .2 Individual and group master levels which can be controlled in real time.
  - .3 Full metering of microphone input
- 3.2.13. Mixing and routing to include:
  - .1 Matrix router to assign any combination of inputs to outs (some signals may be combined to reduce matrix size depending on facility operation)
  - .2 Microphones to be grouped and processed by gain sharing auto mixers
- 3.2.14. Loudspeaker signal paths to include:
  - .1 High pass filter
  - .2 6 band parametric EQ
  - .3 Limiting and compression with side chain
  - .4 Up to 100ms Delay
  - .5 Low pass filter
  - .6 Level control on each output & Metering on each output
- 3.3. DISTRIBUTED AUDIO SYSTEMS
  - 3.3.1. Remove distributed audio line from the output of the distribution amplifiers.
  - 3.3.2. Connect an impedance meter to the distributed loudspeaker line.
  - 3.3.3. Use the meter to verify the total load on the distributed line. The line load shall not exceed the intended design limits.
  - 3.3.4. System Contractor shall include test results in the system manual.
- 3.4. DIGITAL AUDIO SIGNAL SYSTEMS
  - 3.4.1. Test digital audio signals for proper operation between devices. Ensure no additional noise is introduced into the analogue audio and digital signal paths when all devices are interconnected for normal operation.
  - 3.4.2. Ensure all signals throughout the digital audio path are functioning at designed levels.

3.5. HEARING ASSISTANCE SYSTEMS

- 3.5.1. Verify Hearing Assistance systems are free of drop out and interference in the intended areas of operation. Change frequencies and/or relocate transmitters/antennas if necessary to correct such problems. Verify operation of all headsets and receivers.

END OF SECTION

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27 41 16.11 Displays

1. General

1.1. FLAT PANEL DISPLAYS

- 1.1.1. All sources to flat panel display shall be scaled so display sees its native resolution. Scale input signal as required to ensure correct resolution and aspect ratio.
- 1.1.2. All displays must be bi-directional RS-232 or network controllable.
- 1.1.3. All efforts to provide an Energy Star / Green certified display model to be provided whenever possible.
- 1.1.4. When used in conjunction with audio-video transmission systems, the AV Contractor shall ensure display does not over scan the video signal when full-pixel sources are routed.
- 1.1.5. If consumer grade displays are specified, verify that the manufacturer warranty is not void if used in business applications. Bidders to notify the AV Contractor at time of bid if no such displays can be sourced. A minimum one year warranty for consumer grade displays shall be provided.

1.2. WALL MOUNTS FOR DISPLAYS

- 1.2.1. Displays shall be mounted as shown on architectural drawings.
- 1.2.2. The AV Contractor shall provide wall-mount that allows accessibility to infrastructure located behind the display.
- 1.2.3. The AV Contractor shall select mounts to match blocking requirements shown on audiovisual and/or architectural drawings.

1.3. DIGITAL SIGNAGE DISPLAYS

- 1.3.1. All displays used for digital signage applications shall be commercial grade and designed to run 24/7 operation.
- 1.3.2. All digital signage displays shall have on-board scheduling systems for system power on and off.
- 1.3.3. Digital signage displays shall have a minimum three-year warranty.
- 1.3.4. Provide all necessary mounting accessories to professionally mount digital signage players behind the display. Velcro or zip ties are not acceptable.

1.4. VIDEOWALL DISPLAYS

- 1.4.1. All displays used for videowall applications shall be commercial grade and designed to run 24/7 operation.
- 1.4.2. All videowall displays shall have on-board scheduling systems for system power on and off.
- 1.4.3. Videowall displays shall have the connectivity to allow a video input to be passed-through natively to a video output.
- 1.4.4. Videowall display screens shall have a haze value between 25%-50%.
- 1.4.5. Videowall displays shall have a minimum three-year warranty.
- 1.4.6. All displays must be bi-directional RS-232 or network controllable.
- 1.4.7. Provide all necessary mounting accessories to properly align all display, as well as prevent the displays from coming out of alignment over time.

2. Products

2.1. FLAT PANEL DISPLAYS

2.1.1. Acceptable brands are: NEC/Sharp, Planar, Sony, Samsung and LG. Any other brand/model must be approved by AV Consultant.

2.2. WALL MOUNTS FOR FLAT PANEL DISPLAYS

2.2.1. Acceptable brands are Chief, Premier Mounts and Peerless. Any other model must be approved by the AV Consultant.

3. Execution

3.1. DISPLAYS

3.1.1. Provide all necessary mounting hardware to mount the displays to structural and route cabling concealed from view.

3.1.2. Displays to be wall mounted or ceiling mounted as per manufacturer's instruction.

3.1.3. Provide all necessary accessories and hardware for a fixed installation of the display system.

3.1.4. Locking display mounts shall contain the same locking mechanisms / keys on all mounts (unless specified otherwise).

3.1.5. The AV Contractor to confirm all required wall blocking, power and conduit required at display locations is adequate and properly installed prior to display installation.

3.2. VIDEOWALL DISPLAYS

3.2.1. Provide all necessary mounting hardware to mount the displays to structural and route cabling concealed from view.

3.2.2. Displays to be wall mounted or ceiling mounted as per manufacturer's instruction.

3.2.3. Provide all necessary accessories and hardware for a fixed installation of the display system.

3.2.4. All displays shall be calibrated to display uniform:

.1 Colour

.1 Including edge-to-edge in corners

.2 Brightness

.3 Contrast

3.2.5. Videowall displays shall be physically aligned on X, Y and Z-axis of all edges and corners to within 2mm tolerance.

3.2.6. The AV Contractor to confirm all required wall blocking, power and conduit required at display locations is adequate and properly installed prior to display installation.

END OF SECTION

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27 41 16.15 Control Systems

1. General

1.1. DESCRIPTION

- 1.1.1. The control system provides a central microprocessor for control and automation of project audiovisual systems and equipment, and interfaces for user interaction with all devices.
- 1.1.2. Control processors shall be rackmount based. Provide all rackmount accessories to properly mount and house processor.
- 1.1.3. Provide all networking components required to provide an audiovisual control network. Coordinate with Owner's IT officers to arrange an IP subnet range as required.
- 1.1.4. Supply, install and program all expansion modules to provide functionality and control as outlined in the Specification.
- 1.1.5. Where devices are under the control of the AV system controller, connections and hardware shall support bi-directional communications with the AV systems controller.
- 1.1.6. Coordinate with the Owner and/or appointed representative to provide a user intuitive and functional control methodology for all room uses, configurations and user skill sets.
- 1.1.7. System programming shall meet with all specified requirements for a complete control solution.
- 1.1.8. All control system program files shall be created by the AV Contractor. Reuse of old programming code on existing systems is not acceptable without approval of the Owner and AV Consultant.
- 1.1.9. Upon completion of the project, all control system software files shall be submitted in complied and uncompiled formats. Executable files that mimic the graphical control interfaces shall also be provided to the Owner to be used on designated computers.

2. Products

2.1. CONTROL SYSTEM

- 2.1.1. Acceptable control system products are: Crestron, QSC and AMX. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. CONTROL SYSTEM PROGRAMMING AND INSTALLATION STANDARDS

- 3.1.1. All control system programmers and field commissioning technicians must possess manufacturer specific programming certifications.
- 3.1.2. Where Touch Panels or button panels are used to control AV systems, the AV Contractor shall work with the AV Consultant and Owner to develop user interfaces that are intuitive for the Owner and system users to operate. This practice should occur in as far advance as possible prior to project deployment.

- 3.1.3. Where Touch Panels or button panels are used to control AV systems, the AV Contractor shall coordinate a minimum of two (2) development workshops, each being a minimum of four (4) hours in length, with the AV Consultant and Owner to develop user interfaces that are intuitive for the Owner and system users to operate. This practice should occur in as far advance as possible prior to project deployment.
- 3.1.4. Prior to commissioning, submit all software programming files to AV Consultant for review. All software submissions must be accompanied by documentation indicating the intent of the program, table of presets, flow diagrams, revision date and any omissions to overall functionality.
- 3.1.5. All hardware used to control and interface with the computer system shall be tested and fully functional prior to installation on site.
- 3.1.6. Control system shall manage all system devices and provide full feature control of the following devices using the protocols indicated in brackets.:
- .1 Audiovisual Matrix Switchers (RS-232 or Ethernet)
  - .2 Flat panel displays (RS-232 or Ethernet)
  - .3 Projector/display lifts (Relay or contact closure)
  - .4 Video conference codec (RS-232 or Ethernet)
  - .5 Audio DSP (RS-232 or Ethernet)
  - .6 Document camera (RS-232 or Ethernet)
  - .7 Lighting (Ethernet or RS-232; Interface at AV rack location by others)
  - .8 Blinds and shades (Ethernet, Relay or RS-232; Interface at AV rack location by others)
  - .9 Projection screen low-voltage controller (Relay)
  - .10 Partition status and activation where applicable
- 3.1.7. In addition to typical device control, the AV Contractor programming is to include the following functionality within the control software and touch panel page design:
- .1 Provide pop window to indicate "System initializing" upon system start when projection systems are utilized.
  - .2 Provide pop-up window to indicate "System shutting down":
    - .1 Include countdown timer, or bar graph indication of time remaining
      - .1 Confirm timer setting during workshop
    - .2 Provide menu to cancel shutdown request.
    - .3 Upon timer expiration, the system shall automatically shutdown without user action.
  - .3 Automatic system shut down with timing to be confirmed with Owner. Provide 15 minute prompt screen pop-up
  - .4 Room program audio and voice reinforcement level and mute controls. Include master fader and mute control as required
  - .5 Password protected start up page (to be confirmed during workshop)
  - .6 Dynamic and speed dial facilities for audio conferencing
  - .7 Dynamic and speed dial facilities for video conferencing.
  - .8 Automated system on/off when a user connects a presentation device to the system such as a laptop/tablet to a input presentation cable.
  - .9 All other programming features deemed appropriate by the Owner and/or appointed representative to provide an intuitive and easy to understand user interface.

- 3.1.8. Where the project contains graphical user interfaces from multiple manufacturers, provide a consistent graphical user experience regardless of manufacturer. For example, if a project contains both Cisco and Crestron Touch panels, ensure the custom Crestron interfaces match the Cisco user interface/user experience as closely as possible. Provide mock-ups of interfaces for Owner/AV Consultant approval prior to the completion of development of custom software and the deployment of custom software to touch panel hardware on site.
- 3.1.9. All control programming with custom graphical user interfaces shall be controllable through the Owner's computers, mobile devices or tablets. Provide executable files of the control system program graphical user interface and deploy on computers as directed by the Owner. Submit executables as part of the as built documentation. Provide a method (eg. QR code) to allow the user to transfer the interface to their own device (mobile or tablet). Confirm with Owner/consulting preferred operating system and network configuration requirements

END OF SECTION

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27 41 16.16 Audio Video Transmission Systems

1. General

1.1. MULTI-SIGNAL MATRIX SWITCHING AND TRANSMISSION SYSTEMS

1.1.1. Audio video transmission systems shall transcode multiple types of AV signals to a single signal type for distribution. The system shall support the following AV signal inputs:

- .1 HDMI 2.0 (High Definition Multimedia Interface)
- .2 DVI 1.1 (Digital Visual Interface)
- .3 DisplayPort Multimode 1.1
- .4 Analog RGB
- .5 YPbPr
- .6 Component video
- .7 Analog Stereo Audio

1.1.2. The AV distribution system shall use multimode fiber or shielded twisted pairs for AV signal distribution.

1.1.3. The twisted pair structured cabling used to carry the AV signals shall be shielded.

1.1.4. The AV Contractor shall verify the data rate supported by each shielded twisted pair cable used for AV distribution.

1.1.5. The AV distribution system shall route AV signals from any input to any output with less than 1ms of latency.

1.1.6. The AV switching system shall allow configuration of the EDID presented to sources on each AV input.

1.1.7. The AV switching system shall allow the user to enter each input's EDID video timings individually.

1.1.8. The AV distribution system shall allow all source and sink transmitters and receivers to be monitors through PC based software.

1.1.9. The AV distribution system shall transmit the following control signals for AV sources and sinks using the same cabling infrastructure:

- .1 RS-232
- .2 Infrared
- .3 Ethernet
- .4 Contact closure

1.2. HIGH BANDWIDTH DIGITAL CONTENT PROTECTION (HDCP) MANAGEMENT

1.2.1. The AV switching system shall support HDCP 1.1 or greater.

1.2.2. The AV switching system shall detect the number of KSVs supported by each source, and not send a source more Key Selection Vectors (KSVs) than it supports.

1.2.3. The AV switching system shall authenticate all cached KSVs with each source up to the source's KSV limit, so that authentication does not need to be re-started each time content is routed to a new output.

1.2.4. The AV Contractor shall notify AV Consultant if a particular AV source cannot provide enough KSVs to route to all sink destinations simultaneously.

- 1.3. HDBASET AUDIO VIDEO TRANSMISSION SYSTEM TRANSPORT
- 1.3.1. The audio video transmission system transport shall be an advanced signal extender capable of extending multiple AV signals from source to sink location using a single STP or fibre optic cable.
- 1.3.2. The system shall support the following features:
- .1 Signal transmission up to 330 feet via STP cable
  - .2 Signal transmission up to 3000 feet via fiber
  - .3 Video resolutions up to 4096x2160 (4K DCI) or 3840 x 2160 (UHD)
  - .4 IR and RS-232 control
  - .5 Advanced video detection on every video type, including resolution, frame rate and color depth.
- 1.3.3. Cabling for all 4K DCI and UHD systems shall be shielded.
- 1.3.4. HDBaseT Audio video transmitters shall be able to extend HDMI (including digital audio), DVI-I, RGBHV, RGBS, RGsB, YPbPr, and Analog 2-channel audio.
- 1.3.5. HDBaseT Audio video receivers shall receive and decode any signal sent from a cabling transmitter or from matrix switch. All video and audio signals shall be output via the HDMI connector. HID data shall be carried via the USB connector. Scaling receivers are mandatory.
- 1.4. IP AUDIO VIDEO DISTRIBUTION SYSTEM TRANSPORT
- 1.4.1. The audio video distribution system shall be a Gigabit IP network based advanced signal distribution system capable of extending multiple AV signals from source to sink location(s) using a single UTP or fibre optic cable to each end device.
- 1.4.2. The system shall support the following features:
- .1 Signal distribution up to 330 feet via STP cable
  - .2 Signal distribution up to 3000 feet via fiber
  - .3 Video resolutions up to 4096x2160 (4K DCI) or 3840 x 2160 (UHD)
  - .4 IR and RS-232 control
  - .5 Advanced video detection on every video type, including resolution, frame rate and color depth.
  - .6 USB HID
- 1.4.3. UTP cabling for all 4K DCI and UHD systems shall be rated for Gigabit speed or higher.
- 1.4.4. IP Audio Video encoder shall be able to ingest HDMI (including digital audio).
- 1.4.5. IP Audio Video decoder shall receive and decode any signal available from an encoder. All video and audio signals shall be output via the HDMI connector. HID data shall be carried via the USB connector. Scaling decoders are mandatory.
- 1.5. MATRIX SWITCHER
- 1.5.1. The matrix switcher shall consist of a card-cage type unit, capable of accepting different input and output cards while fulfilling the functionality described in sections 1.1, 1.2 and 1.3.
- 1.5.2. Any input shall be routable to any output. Matrix shall provide almost instantaneous HDMI switching for sources with HDCP. Breakaway audio, video, and USB switching shall also be available.
- 1.5.3. Configure switcher system to accommodate all inputs and outputs as indicating on project functional drawings. Provide two additional "spare" inputs, two additional "spare" DVI-I inputs and at least one spare output as part of each switcher configuration.

- 1.5.4. Provide fast HDMI switching with switch timings less than three seconds.
- 1.6. PRESENTATION SWITCHERS
- 1.6.1. The presentation switcher is a single central switching and control unit that integrates audio-video switching, audio mixing and amplification, and a complete system controller.
- .1 The presentation system shall be a single central switching and control unit integrating the following functions:
- .1 Audio matrix switching.
  - .2 Microphone pre-amplification.
  - .3 Acoustic echo cancellation where audio conferencing is specified.
  - .4 Microphone and program audio mixing.
  - .5 Audio amplification.
  - .6 Digital multi-channel audio router.
  - .7 Analog to digital video transcoding.
  - .8 Video matrix switching.
  - .9 Single Cable Signal Transmission.
  - .10 System control processing.
- 1.6.2. Ensure presentation switcher accepts and routes all signal types shown on functional drawings.
2. Products
- 2.1. AUDIO VIDEO TRANSMISSION SYSTEMS (HDBASE-T)
- 2.1.1. Acceptable products are: Crestron Digital Media and Extron XTP. Any other brand/model must be approved by AV Consultant.
- 2.2. AUDIO VIDEO TRANSMISSION SYSTEMS (AV-OVER-IP)
- 2.2.1. Acceptable products are: Crestron Digital Media NVX, Extron NAV, Visionary Solutions and Aurora Multimedia. Any other brand/model must be approved by AV Consultant.
3. Execution
- 3.1. COMMISSIONING
- 3.1.1. All field commissioning technicians must possess manufacturer specific certifications. The AV Contractor shall supply to AV Consultant all required system certifications at time of bid.
- 3.1.2. All infrastructure wiring should be tested before connecting any active equipment.
- 3.2. SHIELDED TWISTED PAIR (STP) CABLE
- 3.2.1. The installed twisted-pair horizontal links shall be tested from terminated end point to terminated end point for compliance with the “*Permanent Link*” performance specification as defined in the Category ANSI/TIA-568-C Standard.

- 3.2.2. Field structured cables should be tested for the following, in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard".
- 3.2.3. Test Result Documentation
- .1 An electronic or paper copy of the test results shall be provided if requested that lists all the links that have been tested with the standard summary testing results.
- 3.3. FIBER
- 3.3.1. Each fiber end should be inspected with a 100x-200x microscope and cleaned if necessary before testing. Each fiber should be tested for optical loss using the 'IEC 61280-4-1 single reference cable method' or 'TIA 526-14 OFSTP-14 Method B' with the acceptable link attenuation (insertion loss) on each fiber end-to-end link of <4dB @ 850nm and <4dB @ 1300nm.
- 3.3.2. Test Result Documentation
- .1 An electronic or paper copy of the test results shall be provided if requested that lists all the links that have been tested with the standard summary testing results.
- 3.3.3.
- 3.4. SYSTEM TESTING AND COMMISSIONING
- 3.4.1. Testing
- .1 A Manufacturer Certified Engineer shall perform the AV Contractor verification tests.
- .2 The AV Contractor shall verify that all components of the system are installed according to manufacturer's specifications and are compliant with Division 27 specifications.
- 3.4.2. Commissioning
- .1 A Manufacturer Certified Engineer shall perform acceptance testing and commissioning.
- .2 The AV Contractor shall provide a copy of the system commissioning Test Report in electronic format upon request.
- .1 All reported information shall be generated by the matrix unit and the configuration software and cable testing device.
- .3 Commissioning engineer shall run all available tests and include all installed system components.
- .4 Commissioning Test Report shall include the following:
- .1 Tests Failures and Notices
- .1 Sink Device EDID Test – Open items or failures shall not be accepted.
- .2 Cable Length Test - Open items or failures shall not be accepted.
- .3 HDCP KSV Limitations – Limitations shall not be accepted.
- .4 Cable Limitations – Limitations shall not be accepted.
- .5 EDID Limitations – Limitations shall not be accepted.
- .6 Cable Length Limits exceeded – Failing cables shall not be accepted.
- .2 Device Model Number, Serial Number, and Firmware Version for main chassis and each input and output card.
- .3 Device Model Number, Serial Number, and Firmware Version for connected transmitter and receiver devices.
- .4 EDID – Input Resolution and 3D support status for each input.

- .5 EDID – Supported Output Resolution and 3D support status for devices connected to each output.
- .6 EDID – Supported Audio formats for each input.

END OF SECTION

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27 41 23.10 Audiovisual Cabinets, Racks, Frames and Enclosures

1. General

1.1. FIXED INSTALLED RACKS

1.1.1. All equipment racks must conform to the following standards:

- .1 EIA RS-310-C, Racks, Panels and Associated Equipment
- .2 AVIXA F502.01:2018 – Rack Building for Audiovisual Systems
- .3 IEC 60297-3-100 – Mechanical Structures for Electronic Equipment

1.1.2. Provide openings top and bottom as required for cabling.

1.1.3. Provide rack elevations as part of shop drawing submissions.

1.1.4. Racks to be Black unless otherwise specified.

1.1.5. All racks to be of a professional quality, all steel welded construction, baked enamel finish, removable side panels, sliding front and rear equipment mounting rails, formed dress panels and a bottom dress panel.

1.2. PORTABLE RACKS

1.2.1. Provide portable steel equipment racks with dress panels and removable sides as required for a completed look and finish. Top panel should be solid or vented depending on cooling requirements and rear doors with flush key locks are required. Doors should be perforated unless solid doors are required in cooling scheme.

1.2.2. Top and bottom planes should incorporate a recess on the rear edge to allow for the passage of cables when the cabinet is located against a surface to the rear.

1.2.3. Provide approval drawing of this equipment for review by the AV Consultant prior to construction.

1.3. WALL MOUNT RACK REQUIREMENTS

1.3.1. For wall mounted racks, provide swing-out style steel racks with locking front doors and vented side panels. Ensure the rack has appropriate ventilation requirements.

1.4. RACK ACCESSORIES

1.4.1. Supply cable tie bars for all horizontal cable transitions and vertical lacing bars.

1.4.2. Supply vent panels at the top and bottom of all 44RU equipment racks.

1.4.3. Supply blank panels (blank or vent) to fill all empty rack spaces. Panels can be 1, 2 or 3 RU.

1.4.4. Provide one 3 RU steel pull out drawer in each rack that is greater than 27RU in capacity.

1.4.5. Provide a multi-duplex AC outlet plug strip in each rack, one outlet for each 3 RU.

1.4.6. Provide a permanent work light with switch, mounted at the rear top of the rack to assist with service.

1.4.7. Provide adjustable front and rear mounted rails tapped with #10-32 mounting holes.

1.4.8. Provide all mounting hardware and rack screws with nylon washers.

1.4.9. Where isolated ground systems are specified provide copper ground buss bar with tapped holes. Provide copper cable clamps (“Burndy”) for connection to equipment. Provide 12 AWG stranded copper strap between buss bar and each rack mount component.

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- 1.5. AUDIO AND VIDEO RACK PATCH PANELS
    - 1.5.1. For audio and video cable interconnectivity, provide custom rack patch panels with the following requirements:
    - 1.5.2. Nominal panel dimensions to be 19" wide and 1.75" (1RU), 3.5" (2RU), 5.25" (3RU) or 7" (4RU) high as required. Refer to EIA Standard RS-310-C for allowable tolerances.
    - 1.5.3. Panels shall be made of #16 C.R.S. folded back ½" top and bottom.
    - 1.5.4. Panel shall have integrated "tie-bar" to support cables at rear of panel of sufficient depth not to impede connector wiring.
    - 1.5.5. All connector cut-outs shall be sized to accommodate Neutrik D-format or equivalent connectors.
    - 1.5.6. All rack panel mount audio connectors shall be XLR-type, premium quality with metallic shells, universal Neutrik D-format, gold contacts.
    - 1.5.7. All panel mount video connectors shall be coaxial 75 ohm BNC, isolated ground, suited for bandwidth and signal type.
    - 1.5.8. All jack panel designations shall be silk-screened.
    - 1.5.9. Data patch panels with the following requirements:
      - .1 Data patch panels shall be rack-mountable
      - .2 Data patch panels shall be 24-port CAT6 RJ45, 1RU
      - .3 Data patch panels shall have labelling strip to allow three lines of text
    - 1.5.10. Data patch panels shall be Blackbox, Panduit or approved equal.
  - 1.6. UNINTERRUPTIBLE POWER SUPPLY (UPS)
    - 1.6.1. Provide a series mode UPS for all equipment racks that house microprocessor devices such as control systems and DSP.
  - 1.7. WORK INCLUDED
    - 1.7.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.
  - 2. Products
    - 2.1. FIXED INSTALLED RACKS AND ACCESSORIES
      - 2.1.1. Acceptable brands are: Middle Atlantic. Any other brand/model must be approved by AV Consultant.
    - 2.2. PORTABLE RACKS
      - 2.2.1. Acceptable brands are: Engineered Case Manufacturer. Any other brand/model must be approved by AV Consultant.
    - 2.3. UNINTERRUPTIBLE POWER SUPPLY (UPS)
      - 2.3.1. Acceptable brands are: Middle Atlantic, SurgeX, Eaton and APC. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. FIXED INSTALLED RACKS

3.1.1. Amplifiers should be mounted at the bottom rail of the equipment rack to maintain balance and stability. Support the weight of the amplifier with angle brackets attached to the side rails of the equipment rack or with the rear support flanges included with some amplifiers. Attach a label to the faceplate of each amplifier to indicate function.

3.2. EQUIPMENT RACKS IN MILLWORK

3.2.1. Racks in millwork must have a minimum of 2" clear space behind the racks and rear of the cabinet.

3.2.2. Millwork should be cut to allow access to electrical, data and AV wall boxes.

3.2.3. Millwork and credenza must have ventilation slots provided to allow for proper cooling of the audiovisual equipment.

3.3. VENTILATION

3.3.1. Provide vent panels at the top and bottom of all 44RU equipment racks.

3.3.2. Provide blank or perforated metal panels as required to provide adequate cooling. If rack is convection cooled, install a 1RU panel above and below each power amplifier.

3.3.3. Internal equipment rack temperature should not exceed 85°F. Provide passive or active thermal management solutions to maintain an internal temperature lower than stated.

3.3.4. For equipment racks mounted in credenzas, ensure adequate cutouts are provided to dissipate heat. Cutouts should be provided at the bottom and top (or rear) of all millwork for ventilation. Provide active thermal management if required to the millwork. Coordinate with millwork Contractor.

3.3.5. Avoid locating racks directly under supply ductwork. The flow of hot air rising from the top of the rack should have no impediments on its way back to the return air intake duct.

3.4. PORTABLE RACKS

3.4.1. Provide four high-quality locking casters, 4" wheel diameter for cabinets taller than 21". wall mount RACK REQUIREMENTS

3.5. UNINTERRUPTIBLE POWER SUPPLY (UPS)

3.5.1. All connected equipment shall be considered critical use devices.

3.5.2. Ensure all power cords connected are properly labelled with destination device name.

END OF SECTION

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27 41 23.11 Audiovisual Cabling

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.
    - 1.1.2. Supply and install cabling as detailed in Contract Documents. The AV Contractor shall provide all required pathways to distribute the cables throughout the facility where the pathway has not been provided by Division 26. Where cables leave the pathways, the AV Contractor shall supply and install cable slings and/or j-hooks to support cabling up to point of termination. Comply with the following section - *27 05 28.00 Pathways for Communication Systems*.
    - 1.1.3. Supply and install conductors and cables as detailed in Contract Documents and as required and as recommended by the manufacturer to ensure proper operation of all systems. The AV Contractor shall use pathways (by Division 26) to distribute the cables throughout the facility. Where the cables leave the pathways and extend to the termination point the AV Contractor shall ensure cable have appropriate infrastructure to support and secure the cables.
    - 1.1.4. Avoid scraping, denting, or otherwise damaging cables, before, during or after installation. The AV Contractor without any additional compensation shall replace damaged cables.
    - 1.1.5. Ensure that all cable lengths are sufficient to allow for slack, vertical runs, wastage, connectorization and future moves.
  - 1.2. CABLE ROUTING
    - 1.2.1. Make any necessary changes or additions to routing of cables, pathways to accommodate structural, mechanical, electrical and architectural conditions. Where pathways or cables are shown diagrammatically run them parallel to building columns. If it is necessary to run cables otherwise to accommodate acceptable cable lengths, written permission must be obtained from the Audiovisual Engineer's Representative prior to installation.
    - 1.2.2. For all schemes of cable routing, no point in the path shall be subjected to a bend radius of less than eight times the cable diameter or minimum cable bend radius specified by the manufacturer.
  - 1.3. CABLE PROPERTIES
    - 1.3.1. Conductors and cables shall be CMR where installed completely in conduit and/or where installed in non-plenum rated areas. Conductors and cables shall be CMP where not completely installed in conduit and/or installed in plenum rated areas. All cable shall conform to the recommendations of the manufacturers of the audiovisual systems.
    - 1.3.2. Conductors and cables shall be outdoor rated where installed outdoor and /or installed in locations where exposed to weather elements.
    - 1.3.3. Provide and install shielded cables where required and or recommended by the manufacturer of the audiovisual systems.
    - 1.3.4. Wiring shown is for typical systems. All wiring shall be as required and recommended by the manufacture of the audiovisual systems.
    - 1.3.5. All wiring shall be of proper gauge, type and quantity of conductors as required and as recommended by the manufacturer to ensure proper operation of audiovisual systems and peripheral devices.

- 1.3.6. Multi-conductor cables shall have color-coded conductors.
- 1.3.7. All conductors and cables shall be CSA approved and must bare stamping by the manufacturer. .
- 1.3.8. Consult drawings and provide FT-6 rated cable where cables are outside of conduit systems

1.4. CABLE DISTRIBUTION

- 1.4.1. Utilise all indicated and available cable pathways such as conduits, communications cable tray, ducts, surface raceways and furniture system channels except where otherwise noted.
- 1.4.2. Wires and cables shall be segregated according to signal type. In addition, audio cable shall be subdivided into three classes: microphone level circuits, analog line level circuits and speaker level circuits.
- 1.4.3. Microphone level audio circuits shall be kept at least 75mm (3") away from any other type of parallel signal circuits and at least 150mm (6") away from any parallel AC power circuits.
- 1.4.4. Speaker level audio circuits shall be kept a minimum of 75mm (3") from line level audio and AC power circuits. All other signal circuits shall be kept at least 75mm (3") away from any parallel AC power circuits. Where conditions allow, high impedance and low impedance (8 ohm) speaker levels shall be separated by minimum of 75mm (3").
- 1.4.5. Where circuits of different types must cross, they shall do so at right angles and then return to the above required separations in as short a distance as possible.
- 1.4.6. Inside buildings minimise any possibilities of disruption by maintaining the following minimum clearances from electrical and heat sources when routing cables.

<b>Item</b>	<b>Minimum Clearance</b>
Motors	1.20 m (4'-0")
Transformers	1.20 m (4'-0")
Conduit and cables used for electrical distribution less than 1kVA	0.30 m (1'-0")
Conduit and cables used for electrical distribution greater than 1kVA	1.00 m (3'-0")
Fluorescent Luminaries	12 cm (0'-5")
Pipes (gas, oil, water, etc.)	30 cm (1'-0")
HVAC (equipment, ducts, etc.)	15 cm (0'-6")

1.5. FIRE STOPPING

- 1.5.1. General
  - .1 Provide seals in all Fire Rated Separations and Firewalls to form tight barriers to retard the passage of flame and smoke.
  - .2 The installed seals shall provide and maintain the fire resistance rating of the adjacent floor, wall or other fire separation assembly to the Code Requirements.
  - .3 Moisture seals as well as fire and smoke seals shall be required for all floor penetrations in Laboratories and Operating Rooms in Hospitals, Universities and Schools.
  - .4 The Communications Contractor shall establish/re-establish the integrity of all fire-rated structures and assemblies that they have created or disturbed, or that were created by others for use by the Communications Contractor.
  - .5 Supply and install Fire Stop pillows for existing cable tray penetrations through firewalls.
  - .6 For the purposes of this specification, the only acceptable Fire Stop Systems shall be those that have been tested to the CAN/ULC S115 Standard.

- .7 Supply and install non-permanent CSA approved Fire Stop systems that are dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with the appropriate damming or backer materials (where required).
- .8 All fire stopping shall maintain a minimum one hour rating and shall meet applicable Federal, Provincial and Local building codes.
- .9 All Fire Stop Systems shall be listed and tested by an SCC and accredited Third Party Testing Agency in accordance with the Standards.
- .10 Fire resistance ratings of installed Fire Stop Systems shall not be less than the fire resistance rating of the surrounding Fire Separation or Firewall.
- .11 All Smoke Seals selected for use shall comply with Standards.
- .12 Where moisture seals are required for floor penetrations in Operating Rooms, Morgues, and Laboratories in Hospitals, Universities and Schools, the Fire Stop Materials selected shall be compatible with Formalin.
- .13 All Fire Stop Materials and Smoke Seals shall have elastomeric characteristics to allow for building settling and seismic movement. All Fire Stop Materials and Smoke Seals shall be free of asbestos.

#### 1.5.2. Quality Assurance

- .1 Provide fire stopping systems that comply with the following requirements following:
  - .1 Fire stopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for fire stop system acceptable to authorities having jurisdiction.
  - .2 Fire stopping products bear the classification marking of qualified testing and inspection agency.
- .2 Provide the work of this Section using competent installers, experienced in the application of the materials and systems being used, approved and trained by the material or system manufacturer.
- .3 Fire Stop Systems shall conform to the fire (F), hose (H) and temperature (T) ratings of Codes.
- .4 Fire Stop Materials and Smoke Seal materials shall have a flame spread rating of 25 or less, National Fire Protection Association (NFPA Class "A").
- .5 For the purposes of this specification the only acceptable Fire Stop Systems are those that have been tested to the CAN/ULC S115 Standard.

#### 1.5.3. Performance

- .1 Fire rated pathway devices shall be the preferred product and shall be installed in all locations where frequent cable moves, add-ons and changes shall occur.
- .2 Where non- mechanical products are utilized, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction.
- .3 Where it is not practical to use a mechanical device, openings within floors and walls designed to accommodate telecommunications and data cabling shall be provided with re-enterable products that do not cure or dry.
- .4 Openings for cable trays shall be sealed using re-enterable fire stopping pillows.

#### 1.5.4. Project Conditions

- .1 Do not install fire stopping products when ambient or substrate temperatures are outside limitations recommended by manufacturer

- .2 Do not install fire stopping products when substrates are wet due to rain, frost, condensation, or other causes.
- .3 Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- .4 Do not use materials that contain flammable solvents.
- .5 Coordinate construction of openings and penetrating items to ensure that through-penetration fire stop systems are installed according to specified requirements.
- .6 Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems.
- .7 Schedule installation of fire stopping after completion of penetrating item installation but prior to covering or concealing of openings.

## 2. Products

### 2.1. MIC/LINE LEVEL ANALOG AUDIO CABLE (TYPE MLA)

- 2.1.1. The mic/line cable is an installation grade cable intended for permanent analog microphone and line level installations.
- 2.1.2. Mic/line level cable shall be minimum 22 AWG stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.
- 2.1.3. Mic/line cable shall have 100% foil shield with 22 AWG drain wire.
- 2.1.4. Mic/line cable shall have a voltage rating of 300 V RMS.
- 2.1.5. Mic/line cable shall be Belden 9451 (FT-4), 9451P (FT-6) or approved equivalent.

### 2.2. MIC/LINE LEVEL DIGITAL AUDIO CABLE (TYPE MLD)

- 2.2.1. The mic/line level digital audio cable is an installation grade cable intended for digital audio (AES/EBU signals).
- 2.2.2. Mic/Line Level digital audio cable shall be minimum 24 AWG stranded shielded twisted pair copper with propylene or equivalent insulated conductors and PVC outer jacket.
- 2.2.3. Mic/Line Level digital audio cable shall have minimum 95% braided shield and bare copper 26 AWG drain wire.
- 2.2.4. Mic/Line Level digital audio cable shall have a voltage rating of minimum 300 V RMS.
- 2.2.5. Mic/Line Level digital audio cable shall have a nominal impedance of 110 ohms.
- 2.2.6. Mic/Line Level digital audio cable shall be Belden 1800B (FT-4), 1801B (FT-6) or approved equivalent.

### 2.3. SPEAKER CABLE HIGH IMPEDANCE (TYPE LS16 AND TYPE LS14)

- 2.3.1. The speaker cable –high impedance is an installation grade cable intended for permanent 70-volt speaker system installations.
- 2.3.2. Speaker cable – high impedance shall be unshielded stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.
- 2.3.3. Speaker cable – high impedance shall be minimum 16 AWG for low power (under 200 watt loads) to a maximum of 500ft – 152m.

- 2.3.4. For higher than 200 watt loads or cable runs longer than 200ft, utilize a 14 AWG unless otherwise specified. See "Speaker Cable – Low Impedance".
- 2.3.5. Speaker cable – high impedance shall have a voltage rating of 300 V RMS.
- 2.3.6. Speaker cable – high impedance shall be Belden 6200UE (16AWG FT-6), 5200UH (16AWG FT-4), 6100UE (14 AWG FT-6), 5100UH (14 AWG FT-4) or approved equivalent.
- 2.4. SPEAKER CABLE LOW IMPEDANCE (TYPE LS14 AND LS12)
- 2.4.1. Speaker cable – low impedance is an installation grade cable intended for permanent performance audio system installations.
- 2.4.2. Speaker cable – low impedance shall be unshielded stranded twisted pair copper with propylene insulated conductors and PVC outer jacket.
- 2.4.3. Speaker cable – low impedance shall be minimum 14 AWG for runs that are not longer than 75ft (23 metres).
- 2.4.4. Speaker cable – low impedance shall be minimum 12 AWG for runs that are longer than 75ft (23 metres) to a maximum of 200ft (63 metres).
- 2.4.5. Cabling for speaker cable runs longer than 200ft (63 metres) to be coordinated with the AV Consultant.
- 2.4.6. Speaker cable – low impedance shall be Belden 6100UE (14 AWG FT-6), 5100UH (14 AWG FT-4), 6000UE (12 AWG FT-6), 5000UH (12 AWG, FT-4) or approved equivalent.
- AUDIOVISUAL STRUCTURED CABLING (TYPE D)
- 2.5.1. Audiovisual structured cabling is an installation grade cable used for IP control, video-over-IP solutions or audio-over-ethernet solutions (eg. Dante, AES67).
- 2.5.2. Cabling used for IP-based audiovisual solutions such as AES67 or H.264 shall comply with ANSI/EIA/TIA standards (minimum Category 6) and manufacturer specific networking requirements.
- 2.5.3. Comply with the following specifications:
- .1 27 13 13.00 Communications Copper Backbone Cabling
  - .2 27 13 23.00 Communications Optical Fibre Backbone Cabling
  - .3 27 15 00.19 Data Communications Horizontal Cabling
  - .4 27 15 33.00 Communications Coaxial Horizontal Cabling
- 2.5.4. Refer to division of responsibility between AV Contractor and communications Contractor on AV drawings and scope of work specification (27 41 00.00) for project specific audiovisual structured cabling requirements.
- 2.6. ANTENNA CABLE UHF (TYPE ANT-U)
- 2.6.1. The antenna cable is an installation grade cable intended for permanent wireless microphone system antennas and assistive listening system transmitters (IR radiators and antennas) operating in the UHF frequency bands.
- 2.6.2. Antenna cable shall be RG-8X type with 10AWG solid copper conductor.
- 2.6.3. Antenna cable shall have minimum braided shield and over foil shield.
- 2.6.4. Antenna cable shall have a nominal impedance of 50 ohms.

- 2.6.5. Antenna cable shall be Belden 9913 (FT-4), 89913 (FT-6) or approved equivalent.
- 2.7. ANTENNA CABLE DECT (TYPE ANT-D)
- 2.7.1. The antenna cable is an installation grade cable intended for digital wireless systems operating the DECT frequency bands (above 1GHz).
- 2.7.2. Antenna cable shall have a frequency range of 30MHZ to 8000MHZ.
- 2.7.3. Antenna cable shall have minimum braided shield and over foil shield.
- 2.7.4. Antenna cable shall have a nominal impedance of 50 ohms.
- 2.7.5. Antenna cable shall be Times Microwave LMR-400-LLPX or approved equivalent.
- 2.8. 12 GHZ SERIAL DIGITAL INTERFACE COAXIAL VIDEO CABLE (TYPE SDI)
- 2.8.1. The 12G-SDI digital video cable is intended for permanent installations requiring transmission of uncompressed UHD and 4K-DCI video signals requiring an approximate 12 Gb/s data rate.
- 2.8.2. 12G-SDI Digital Video Cable shall be minimum 18 AWG bare silver-plated copper insulated conductor, shielded and PVC outer jacket.
- 2.8.3. 12G-SDI Digital Video Cable shall have a minimum 95% braided shield and 100% foil shield.
- 2.8.4. 12G-SDI Digital Video Cable shall have a nominal impedance of 75 ohms.
- 2.8.5. 12G-SDI Digital Video Cable shall adhere to SMPTE 2082-1 specifications.
- 2.8.6. 12G-SDI Digital Video Cable shall be Belden 4794R or approved equivalent.
- 2.9. HDBASE-T CABLE (TYPE HDBT)
- 2.9.1. Refer to 27 41 16.16 Audio Video Transmission Systems for projects with HDBase-T solutions.
- 2.10. FIRE STOP
- 2.10.1. Products manufactured by Hilti Corporation (or approved equivalent) are acceptable.
- 2.10.2. Obtain fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.
3. Execution
- 3.1. CABLE INSTALLATION
- 3.1.1. Exercise caution when pulling cables in pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.
- 3.1.2. All cables and components shall be installed and terminated in accordance with applicable Codes, Standards and Regulations.
- 3.1.3. Supply and install all wiring as required for the proper operating of each audiovisual system and each peripheral device.
- 3.1.4. After installation, and before termination, all wiring and cabling shall be checked and tested to insure there are no grounds, opens, or shorts on any conductors or shields.

- 3.1.5. Visually inspect wire and cable for faulty insulation prior to installation. Protect cable ends at all times with acceptable end caps except during actual termination.
- 3.1.6. Protect wire and cable from kinks.
- 3.1.7. Provide grommets and strain relief where required.
- 3.1.8. Comply with controller and peripheral device manufactures installation and termination recommendation.
- 3.1.9. Where more than two cables shall terminate at the output of a device a terminal block with identification must be provided near the device to gather the cables together so only one cable actually terminates on the device. Provide terminal blocks, marking and mounting systems.
- 3.1.10. Provide brush plates or scoop wall plates to cover all mudrings and backboxes used for cable passthrough.
- 3.2. CABLE SUPPORT
  - 3.2.1. Hangers shall be installed at 4' intervals (maximum). Cables shall be run such that sag between supports does not exceed 4". Secure all cables to J-hooks/supports with Velcro tie-wraps. Cables shall be combed and dressed for all visible portions of the install. The above noted conditions shall be strictly checked and the AV Contractor shall be required to comb and redress any cables that are unsatisfactory at no additional cost.
  - 3.2.2. Attaching to T-bar support rods is not acceptable. Anchors for hangers must not be drilled into post tensioned beams under any circumstances. The AV Contractor shall not use Hilti Pneumatic hammers. All anchors must be drilled into slab.
  - 3.2.3. The AV Contractor must minimize the disturbance or removal of 'fire spray' insulation during installation of cable supports.
- 3.3. NON-CONTINUOUS CABLE SUPPORT
  - 3.3.1. The AV Contractor shall supply and install cable support for the distribution of horizontal and backbone cables where conduit or ladder tray has not been provided.
  - 3.3.2. The size of J-hooks/support shall suit quantity of cables in runs used for distribution.
  - 3.3.3. Include any other miscellaneous hardware (angled hanger bracket, hammer/screw on clamps) required to support horizontal and backbone cabling.
- 3.4. GROUNDING WIRE
  - 3.4.1. Supply and install #6 AWG green grounding wire for all metallic components that shall be grounded and Code Conductor Two Hole Long Barrel with Window Lug to bond the conductor to the ground bus.
- 3.5. VELCRO TIE-WRAPS
  - 3.5.1. Velcro tie-wraps shall be used to neatly dress cables; they shall be placed at a maximum of 4' intervals for horizontal distribution (centre points between cable supports).
- 3.6. CABLE DISTRIBUTION
  - 3.6.1. Do not exceed the copper cables maximum tensile rating during installation. Monitor tension of the cable during installation. Use a dynamometer to record installation tension. Use a tension limiting device to prevent the exceeding of maximum pulling tension specifications during installation. The tension limit shall be set at or below the manufacturer's limit. The cable shall be taken up at intermediate pulling points with an intermediate take-up device as approved by the Audiovisual Engineer's Representative, to prevent over tension on the cable.

- 3.6.2. Minimum bend radius shall be as per manufacturer's recommendations.
- 3.6.3. Make cable pulls continuous and steady between pull points. Do not interrupt the pull unless necessitated by excessive tension on the cable.
- 3.6.4. Protect exposed cable ends from moisture ingress.

### 3.7. DUCT AND CONDUIT

- 3.7.1. Clean out each section of duct or conduit by pulling a steel wire brush and mandrel of the correct size through the duct or conduit before pulling cables. Bush, ream and remove any sharp projections on all conduits prior to installation of cables. When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Audiovisual Engineer's Representative of the problems encountered.
- 3.7.2. Apply manufacturer's recommended lubricant to cables to reduce friction between the cable and the conduit. Cable grip shall be attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip shall have a ball bearing swivel to prevent the cable from twisting during pulling.

### 3.8. TESTING

#### 3.8.1. Coaxial Cable Testing

- .1 All horizontal CATV Coaxial cables shall be swept tested to industry standards using a Time Domain Reflectometer (TDR).
- .2 All horizontal CATV Coaxial cables shall be sweep tested after installation for opens, shorts, and kinks. Damaged cables shall be replaced by installing a new cable. Indicate on the floor plans the actual length of each cable section as installed.
- .3 The AV Contractor shall provide soft and hard copy of cable test result for each CATV cable. Cable test results shall identify cable numbers and associated test results.

#### 3.8.2. Copper Cabling Test Requirements

- .1 Every cabling link in the installation shall be tested (as required by the Cabling specified) in accordance with the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA-568-B.1.
- .2 The installed twisted-pair horizontal links shall be tested from the Telecom Room to the workstation against the "Permanent Link" performance limits Specification as defined in ANSI/TIA/EIA-568-B.1.
- .3 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate, as proof thereof shall execute the tests. Appropriate training programs include installation certification programs provided by BICSI or the ACP (Association of Cabling Professionals) and Vendor supplied certifications for their product.
- .4 The test equipment shall comply with or exceed the accuracy requirements for enhanced level II and/or level III field testers (according to Cabling specified) as defined in TIA-568-B; Annex I: Section I.4. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table I.4 of Annex I of TIA/EIA-568-B.2.
- .5 The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The AV Contractor shall provide proof that the interface has been calibrated within the period recommended by the

Vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

- .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail\* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass\*.
- .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (\*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. (Reference TIA-568-B; Annex I: Section I.2.2).

### 3.8.3. Optical Fibre Cabling Test Requirements

- .1 Every optical fibre cabling link in the installation shall be tested in accordance with the field test Specifications defined by the Telecommunications Industry Association (TIA) Standard ANSI/TIA/EIA- 568-C (or by the appropriate network application Standard(s) whichever is more demanding).
- .2 ANSI/TIA/EIA-568-B, defines the passive cabling network, to include cable, connectors, and splices (if present), between two optical fibre patch panels (connecting hardware). A typical horizontal link segment is from the telecommunications outlet/connector to the horizontal cross-connect. This TIA document describes three typical backbone link segments: (1) main cross-connect to intermediate cross-connect, (2) main cross-connect to horizontal cross-connect, or (3) intermediate cross-connect to horizontal cross-connect. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.
- .3 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate, as proof thereof shall execute the tests. These certificates may have been issued by any of the following organisations or an equivalent organisation:
  - .1 The manufacturer of the optical fibre cable and/or the optical fibre connectors
  - .2 The manufacturer of the test equipment used for the field certification
  - .3 Training organisations authorised by BICSI (Building Industry Consulting Services International) or by the ACP (Association of Cabling Professionals™).
  - .4 Vendor supplied certifications for their product.
- .4 Field test instruments for multimode fibre cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B; Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source. Field test instruments for singlemode fibre cabling shall meet the requirements of ANSI/EIA/TIA-526-7.
- .5 The optical fibre launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
- .6 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests as detailed below.
- .7 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.

### 3.8.4. Optical Fibre Cabling Performance Test Parameters

- .1 ANSI/TIA/EIA Standard 568-C3 prescribes that the single performance parameter for field testing of optical fibre links is link attenuation when installing components compliant with this Standard.
- .2 The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA 568-B:

.3 Link Attenuation =		.4 Cable_Attn + Connector_Attn + Splice_Attn	
.5 Cable_Attn (dB) =		.6 Attenuation_Coefficient (dB/km) * Length (Km)	
.7 Connector_Attn (dB) =		.8 Number_of_connector_pairs * connector_loss (dB)	
		.9 (Maximum allowable connector_loss = 0.75 dB)	
.10 Splice_Attn (dB) =		.11 Number of splices (S) * splice_loss (dB)	
		.12 (Maximum allowable splice_loss = 0.3 dB)	

- .13 The values for the Attenuation\_Coefficient are listed in the table below:

Type of Optical Fibre	Wavelength (nm)	Attenuation Coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5
	1300	1.5
Multimode 50/125 µm	850	3.5
	1300	1.5
Single-mode (Inside plant)	1310	1.0
	1550	1.0
Single-mode (Outside plant)	1310	0.5
	1550	0.5

- .14 Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- .15 The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these Standards or application notes to accurately conduct performance testing.
- .16 The Horizontal Link (multimode): acceptable link attenuation for a multimode horizontal optical fibre Cabling Solution is based on the maximum 90 m (295 ft) distance. The horizontal optical fibre cabling link segments need to be tested at only one (1) wavelength. Because of the short length of cabling [90 m (295 ft) or less], attenuation deltas due to wavelength are insignificant. The horizontal link should be tested at 850 nm or 1300 nm in one direction in accordance with ANSI/EIA/TIA-526-14A, Method B, and One Reference Jumper. The horizontal link may be tested using a fixed upper limit for attenuation of 2.0 dB. This value is based on the loss of two (2) connector pairs, one (1) pair at the telecommunications outlet/connector and one (1) pair at the horizontal cross-connect, plus 90 m (295 ft) of optical fibre cable.
- .17 The Backbone Link (multimode) shall be tested in one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.

- .18 Multimode Backbone Links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.
  - .19 Singlemode Backbone Links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, and One Reference Jumper. All singlemode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm (See Note below).
  - .20 Notes:
    - .1 Link attenuation has been based upon the use of a light source categorised by a Coupled Power Ratio (CPR) of Category 2, Underfilled, per Annex B of ANSI/EIA/TIA-526-14A. The use of a light source categorised as Category 1, Overfilled, may provide results higher than the 2.0 dB limit. A field test tool based on LED (light emitting diode) light sources is a Category 1 device and typically yields high attenuation results.
    - .2 Links destined to be used with network applications that use laser light sources (underfilled launch conditions) shall be tested with test equipment based on laser light sources. This rule should be followed for Cabling Solutions to support Gigabit Ethernet. Gigabit Ethernet only specifies laser light sources.
    - .3 For Gigabit Ethernet compliant certification (IEEE STD 802.3z application), use test equipment which uses a VCSEL (Vertical cavity surface emitting laser) at 850 nm (compliant with 1000BASE-SX) and a FP laser at 1310 nm (compliant with 1000BASE-LX).
  - .21 Each optical fibre link terminated with an optical adapter system which does not impose a transmission direction because the adapters are not or cannot be ganged should be tested and documented in both direction since the direction of the signal transmission cannot be predicted at the time of installation.
- 3.8.5. Test each strand of fibre with an Optical Time Domain Reflectometer for length and attenuation. Performance test must be below the total return loss budget for the cable connectors/balun. Provide comprehensive optical time domain reflectometry (OTDR) testing for all fibre runs. Include a hard copy chart recording with the test documentation.
- 3.9. FIRE STOPPING
- 3.9.1. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of fire stopping in accordance with manufacturer's installation instructions and technical information
  - 3.9.2. Examine sizes and conditions of voids to be filled to establish correct thickness and installation of Fire Stop Materials.
  - 3.9.3. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion
  - 3.9.4. Prepare surfaces in contact with Fire Stop Systems and Smoke Seals to manufacturer's instructions. Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.
  - 3.9.5. The Communications Contractor shall install/replace sound barrier/fire stopping materials as soon as cables have been pulled through the opening.
  - 3.9.6. In all Fire Stop Systems that require mineral wool or ceramic fibre backer or filler materials, these materials shall be dry and free of other contaminants before, during and after installation of sealant Fire Stop Materials. Alkaline water contamination of the backer or filler materials may cause corrosion of metallic penetrating items.

- 3.9.7. Apply Fire Stop Systems and Smoke Seals in strict accordance with manufacturer's instructions to prevent the passage of fire and smoke, and where required and / or specifically designated, the passage of fluids.
- 3.9.8. Provide temporary forming and packing as required. Tool or trowel all exposed surfaces to smooth, neat and tidy finish.
- 3.9.9. Fire Stop and smoke seal gaps and holes in all Fire Separation and Firewall construction through which cables pass as a result of work in this document.
- 3.9.10. In Combustible Construction (membrane GWB type) where the framing members are wood or where paper faced insulation is incorporated within the separation, a Fire and Temperature rise "FT" rating is required equal to that of the rating of the Fire Separation. Include openings which have been formed and sleeved.
- 3.9.11. Where the bottom of a Fire Stop System is exposed, seal bottom side of the assembly with a fire rated elastomeric Fire Stop sealant.

END OF SECTION

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27 41 23.12 Grounding and Bonding for Audiovisual Systems

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform to Section 27 40 10 – GENERAL INSTRUCTIONS FOR AUDIOVISUAL SYSTEM INSTALLATION.
  - 1.2. APPLICABLE CODES & STANDARDS
    - 1.2.1. Provide grounding & bonding in accordance with good industry practices and in accordance with the following codes and standards:
      - .1 CSA Standard C22.2 No.41-M1987 – Grounding & Bonding Equipment
      - .2 CSA Standard T527 (ANSI/TIA/EIA-607)
      - .3 Provincial Hydro Electrical Safety Code
      - .4 Provincial Building Code
      - .5 Local Codes & Bylaws
      - .6 BICSI requirements
      - .7 AVIXA/Infocomm AV Installation Handbook, latest edition
  - 1.3. GROUNDING PRACTICES
    - 1.3.1. It is the responsibility of the AV Contractor to follow good engineering practices to minimize crosstalk and maximize signal-to-noise ratios in audiovisual systems.
    - 1.3.2. The AV Contractor shall take care to consider ground references within each device and ground factors on site.
2. Products
  - 2.1. RACK ACCESSORIES
    - 2.1.1. Provide rack isolation kits to maintain galvanic isolation between the equipment rack and semi-conductive flooring.
3. Execution
  - 3.1. GENERAL REQUIREMENTS
    - 3.1.1. Ensure ganged equipment racks are bonded. Scrape paint off adjacent racks and utilize a stranded bonding jumper with a lug to connect racks to the same ground reference. Bolting racks together is an insufficient bonding method.
    - 3.1.2. The AV Contractor shall ensure that there is complete metal-to-metal contact is made when grounding to painted or powder coated metal surfaces.
    - 3.1.3. Grounding & bonding installed by the AV Contractor shall not interfere with the existing grounding practices within the customer premises.
    - 3.1.4. The AV Contractor shall utilize thread-forming screws, bonding screws & any other hardware necessary to complete the ground system.

END OF SECTION

27 51 26.10 Assistive Listening Systems - RF

1. General

1.1. GENERAL

- 1.1.1. Furnish and install a RF based wireless assistive listening system for use by the hearing-impaired.
- 1.1.2. Provide sufficient receivers and hearing aid compatible receivers in accordance with National Building Code 3.8.3.7.
- 1.1.3. For all buildings of assembly occupancy greater than 100 m<sup>2</sup>, provide an assistive listening system that encompasses the entire seating area.
- 1.1.4. The assistive listening system (ALS) shall be capable of broadcasting on multiple channels and be frequency agile.
- 1.1.5. The ALS system shall have 80dB signal to noise ratio or greater, end-to-end.
- 1.1.6. Receivers shall be frequency agile and frequency set with a "seek" button. The receiver shall incorporate a stereo headset jack that allows the user to plug in either a mono or stereo headset and listen to audio normally.
- 1.1.7. Provide sufficient receivers and hearing aid compatible receivers in accordance with table 219.3 of the 2010 ADA Standards for Accessible Design.
- 1.1.8. Interface with the public address system to transmit all audio from the public address system over the assistive listening system.
- 1.1.9. Provide strategically located signage informing about the availability of assistive listening system at the Facility that includes the International Symbol of Access for Hearing Loss at public entrances/circulation, and at each ticket office and help point.
- 1.1.10. Provide "T-coil" compatible devices to adapt receivers to hearing aid devices.

1.2. ADA COMPLIANCE

- 1.2.1. The Americans with Disabilities Act (ADA) 2010 ADA Standards requires public facilities to provide auditory assistance devices.
- 1.2.2. <http://www.ada.gov/regs2010/2010ADAStandards/2010ADAStandards.pdf>
- 1.2.3. Provide compliance with the following requirements:

Capacity of Seating in Assembly Area	Minimum Number of Required Receivers	Minimum Number of Required Receivers Required to be Hearing-aid Compatible
50 or less	2	2
51 to 200	2, plus 1 per 25 seats over 50 seats*	2
201 to 500	2, plus 1 per 25 seats over 50 seats*	1 per 4 receivers*
501 to 1000	20, plus 1 per 33 seats over 500 seats*	1 per 4 receivers*
1001 to 2000	35, plus 1 per 50 seats over 1000 seats*	1 per 4 receivers*
2001 and over	55 plus 1 per 100 seats over 2000 seats*	1 per 4 receivers*

\*Or fraction thereof

1.3. ASSISTIVE LISTENING SYSTEM

1.3.1. Furnish and install the following:

.1 BASE FM TRANSMITTER

- .1 Base FM Transmitter shall have a frequency response of 50 Hz-15 kHz (+/- 3dB) at 72 MHz or 216 MHz.
- .2 Base FM Transmitter shall be capable of broadcast on 17 wide band channels and 40 narrow band channels and be frequency agile.
- .3 Base FM Transmitter shall have a signal-to-noise ratio of -80 dB or greater, end-to-end.
- .4 Base FM Transmitter shall be rack mountable.

.2 UNIVERSAL ANTENNA

- .1 Universal Antenna shall be weather proof for various environments including high wind.
- .2 Universal Antenna shall be able to be pole or conduit mount.
- .3 Universal Antenna shall have a frequency range of 216.0125 to 216.9875 MHz.
- .4 Universal Antenna shall have a maximum of 57 (19 wide band, 38 narrow band) channels.
- .5 Universal Antenna shall have a unity gain of 0 dB.
- .6 Universal Antenna shall have a beam width of 360°

.3 PORTABLE DISPLAY RECEIVER (QUANTITIES PER 1.2.3)

- .1 Portable Display Receiver shall utilize 17 most common wide band channels.
- .2 Portable Display Receiver shall have a signal-to-noise ratio of -80 dB.
- .3 Portable Display Receiver shall have an audio frequency response of 50 Hz - 15 kHz (+/- 3 dB) at 72 MHz.
- .4 Portable Display Receiver shall have a stereo earphone jack that allows the user to plug in either a mono or stereo earphone(s).
- .5 Portable Display Receiver shall have rechargeable battery and compatible with standard alkaline or nickel-metal hydride (NiMH) batteries.

.4 EAR SPEAKERS

- .1 Ear Speakers shall be an over the ear speakers.
- .2 Ear Speakers shall have a frequency response of 20 Hz to 20 kHz with an impedance of 32 ohm +/- 15% @ 1 kHz.
- .3 Ear Speakers shall have a rating of power input of 50 mW, with a maximum power input of 100 mW.
- .4 Ear Speakers shall use a 3.5mm stereo head phone jack.
- .5 Ear Speakers shall comply with RoHS.

.5 NECK LOOP (QUANTITIES PER 1.2.3)

- .1 Neck Loop shall be able to use with any hearing aid equipped with a "T" coil.
- .2 Neck Loop shall have a frequency response of 20 Hz to 20kHz with an impedance of 12 ohm +/- 15% @ 1 kHz.
- .3 Neck Loop shall have a rating of power input of 75mW with a maximum power input of 2 watts.
- .4 Ear Speakers shall use a 3.5mm stereo head phone jack.
- .5 Ear Speakers shall comply with RoHS.

- .6 UNIT CHARGER – CARRYING CASE
  - .1 Unit Charger shall store up to 16 receivers with earphone storage pocket.
  - .2 Unit Charger shall support a power input of 100-240V, 50-60 Hz, 1200 mA with power supply output of 7.5V, 4A, 30W.
- .7 ADA SIGNAGE - ACCESS/COMPLIANCE SIGNAGE KIT
  - .1 ADA Signage shall have maximum dimension of 6 in. (151 mm) x 8 in. (202 mm)  
Soft Cling: 6 in. (151 mm) x 7.85 in. (199 mm).

2. Products

2.1. ASSISTIVE LISTENING SYSTEM

- 2.1.1. Acceptable products are: Listen Technologies. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. GENERAL PERFORMANCE

- 3.1.1. Verify Hearing Assistance systems are free of drop out and interference in the intended areas of operation. Change frequencies and/or relocate transmitters/antennas if necessary to correct such problems. Verify operation of all headsets and receivers.

END OF SECTION

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27 51 50.00 Audiovisual Networking

1. General
  - 1.1. WORK INCLUDED
    - 1.1.1. Conform with Section 27 40 10.00 – General Instructions for Audiovisual Systems
  - 1.2. CODES, STANDARDS AND CERTIFICATION
    - 1.2.1. Data communication network shall be in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A, and TBITS 6.9.
    - 1.2.2. Equipment shall meet all applicable FCC/CRTC Regulations.
  - 1.3. DEFINITIONS
    - 1.3.1. Cyber Assets: Systems (including hardware, software, and data) and communication networks (including hardware, software, and data).
    - 1.3.2. Critical Cyber Assets: Those cyber assets that perform critical system functions. The loss or compromise of these cyber assets would adversely affect the operational reliability of the system.
    - 1.3.3. Cyber Attack: The use of electronic means to interrupt, manipulate, destroy, or gain unauthorized access to a computer system, network, or device.
    - 1.3.4. Cybercrime: to be any crime where cyber – the internet and information technologies, such as software, firmware, computers, tablets, personal digital assistants or mobile devices – has a substantial role in the commission of a criminal offence.
    - 1.3.5. Cyber Hygiene: is a reference to the practices and steps that users of computers and other devices take to maintain system health and improve online security. These practices are often part of a routine to ensure the safety of identity and other details that could be stolen or corrupted.
    - 1.3.6. Cyber Incident: Any unauthorized attempt, whether successful or not, to gain access to, modify, destroy, delete, or render unavailable any computer network or system resource.
    - 1.3.7. Cyber Security: refers to the body of technologies, processes and practices designed to protect networks, devices, programs, and data from attack, damage, or unauthorized access.
    - 1.3.8. Cyber Threat or Cyber Security Threat: is a malicious act that seeks to damage data, steal data, or disrupt digital life in general. Cyber threats include computer viruses, data breaches, Denial of Service (DDoS/DoS) attacks and other attack vectors.
    - 1.3.9. Cyber Threat Actors: is a broad term for any states, groups, or individuals who, with malicious intent, aim to take advantage of vulnerabilities, low cyber Security awareness, and technological developments to gain unauthorized access to information systems in order to access or otherwise affect victims' data, devices, systems and networks.
    - 1.3.10. Network Certificates: are also known as a Digital Certificates, which are an electronic "password" that allows a person, organization to exchange data securely over the internet using the public key infrastructure (PKI). Digital Certificates are also known as a public key certificate or identity certificate. There are 3 Main types of certificates:
      - 1.3.11. Secure Socket Layer Certificate (SSL) Digi-SSL
      - 1.3.12. Software Signing (Code Signing Certificate) Digi-Code
      - 1.3.13. Client Certificate (Digital ID) Digi-ID

- 1.3.14. Social Engineering: are exploitation methods that target human vulnerabilities, such as carelessness and trust.
- 1.3.15. Technical Vulnerabilities: are weaknesses or flaws in the design, implementation, operation, or management of an information technology system, device, or service.
- 1.3.16. Power-Over-Ethernet (POE)
- 1.3.17. Next Generation Firewall (NGFW)
- 1.3.18. Transport Layer Security (TLS)
  
- 1.4. DESCRIPTION
  - 1.4.1. Network Switch
    - .1 Network Switch shall support Layer-3 Gigabit Ethernet switching.
    - .2 Network Switch shall provide Power Over Ethernet (PoE) on all ports and to provide wattage as required for the project.
    - .3 Network Switch shall be managed.
    - .4 Network Switch shall allow for a minimum of ten (10) configurable VLANs.
    - .5 Network Switch shall support 10Base-T/100Base-TX/1000Base-T Ethernet with network standards of IEEE 802.3, 802.3u, 802.3ab, 802.3x, & 802.3af.
    - .6 Network Switch shall have sufficient host ports to accommodate all system AV devices, with an additional 4-ports for expansion.
    - .7 Network Switches that have more than eight (8) host ports shall be network stackable using a single IP management and have uplink ports.
    - .8 Network Switch with uplink ports shall have a minimum of four (4) uplink ports that support 1000BaseSX, 1000BaseLX, 10GBase-SR and 10GBase-LR.
    - .9 Network Switch shall be compatible with all digital audio and video multicast protocols and products required as part of the project. Refer to Scope of Work 27 41 00.
    - .10 Network Switch shall be allow for proper bandwidth traffic to traverse across switches as required.
    - .11 Network Switch shall be rackmountable.
  - 1.4.2. Firewall
    - .1 Firewall shall have a minimum NGFW throughput of 3.5 Gbps.
    - .2 Firewall shall have a minimum Threat Protection throughput of 3 Gbps.
    - .3 Firewall shall have a SSL inspection throughput of 4 Gbps.
    - .4 Firewall shall have a maximum latency of 5 microseconds.
    - .5 Firewall shall support a minimum of 100 VLANs.
    - .6 Firewall shall support a minimum of 20 concurrent users.
  - 1.4.3. PoE Injector
    - .1 PoE injector shall feature two RJ45 connections.
    - .2 PoE Injector shall support IEEE 802.3af Class 0 PoE Power Sourcing Equipment.
  
- 1.5. COORDINATION
  - 1.5.1. IP Addressing
    - .1 Do not use default IP addresses for configuration, all systems shall be configured based on the Owner's preferred method of either assigned static IP addressing or DHCP

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reservation scheme. In cases that the network shall be standalone, assigned static IP addressing shall be used.

1.5.2. Cyber Security

- .1 Coordinate with Owner's Information Technology representatives, obtain a copy of Owner's cyber security policy and provide all applicable cyber security configurations.

2. Products

2.1. NETWORK SWITCHES

- 2.1.1. Acceptable manufacturers are Cisco, HP Aruba, Extreme Networks and NetGear. Any other brand/model must be approved by AV Consultant.

2.2. FIREWALLS

- 2.2.1. Acceptable manufacturers are Fortigate and Palo Alto. Any other brand/model must be approved by AV Consultant.

3. Execution

3.1. INSTALLATION

- 3.1.1. Install equipment and components in accordance with applicable standards and manufacturer's recommendations.
- 3.1.2. Install components securely, properly aligned, and in locations as shown on drawings or as determined by site conditions.
- 3.1.3. Enable authentication and encryption TLS 1.2 (128kbit) technology for all network attached equipment.
- 3.1.4. Employ network security best practices when programming and configuring network equipment:
  - .1 Configure dedicated VLAN's for each protocol such as control, digital audio, digital video, etc.
  - .2 Restrict access on network switch ports to assigned device addresses.
- 3.1.5. Employ network security best practices when programming and configuring workstations:
  - .1 Restrict the use of external memory.
  - .2 Set up all security features on client software including passwords, user profiles, and operator action logging.
  - .3 Enable password change on scheduled interval.
  - .4 Enable auto-logoff timer.
  - .5 Enable and configure anti-virus software.
- 3.1.6. Setup a domain for all audiovisual systems on the network. Coordinate with Owner if the network shall be part of the Owner's corporate network.
- 3.1.7. Provide certification of vulnerable-free devices for all active equipment.
- 3.1.8. Provide end-of-life information, including an anticipated timeline of ending security support for active equipment.

3.1.9. Provide notice of a security incident within 24 hours of becoming aware of any incident as it relates to the active equipment supplied.

### 3.2. DOCUMENTATION

3.2.1. Provide a full design architecture design during the shop drawings process.

3.2.2. Provide a full device schedule for the entire network listing each device, including but not limited to:

- .1 Device manufacturer and model
- .2 Device ID
- .3 Device Host Name
- .4 Device IP
  - .1 Provide multicast address if applicable
- .5 Device serial number
- .6 Device MAC address
- .7 Device VLAN assignment (name and number)
- .8 Last firmware version number running
- .9 Device location, including room or rack number
- .10 Connected switch number/name and port
- .11 Port Required
- .12 Device Username and Password
- .13 Any additional notes to provide better support

### 3.3. CYBER SECURITY

3.3.1. Cyber Security Measures

- .1 The following multi-layered Cyber Security measures shall be implemented at minimum to limit and or reduce the Owner's potential risk from a cyber threat event; Such as a Cyber Security data breach or Cyber Security attack.
- .2 Password Management
  - .1 Employ password management best practices such as:
    - .1 All device access and configuration passwords for devices shall be changed from default to a custom password.
    - .2 Use strong and unique passwords for all applications. Where there is no password policy inherent in the software use a minimum of 8 characters; use a mixture of uppercase and lowercase letters, numbers, and include at least one special character (! @ # ? ]).
    - .3 Reset passwords at regular intervals.
    - .4 Configure two-factor authentication for all accounts where possible in the system software.
    - .5 Do not use System Admin logins for simple tasks, Create separate User accounts with rights levels appropriate for the job function. These user accounts can be defined and created in many ways such as Role based, Individual logins or assigned roles.
    - .6 Use different passwords for every account
    - .7 Enforce secure password policies within the business environment.

- .8 Have interface lock after a predefined # of failed login attempts for a pre determined time interval.
- .3 Port and Interface Management
  - .1 Employ Port Management techniques such as:
    - .1 Restrict access on network switch ports to assigned devices addresses.
    - .2 Be sure to lock down all open, unused and unsecure ports on the networking devices such as switches, routers, and firewalls.
    - .3 Shut off all unused communication services and hardware interfaces.
    - .4 The use of 3rd party port security monitoring such as Solarwinds should be investigated and is highly recommended.
- .4 Physical and Virtual Networks
  - .1 Where a dedicated LAN has not been provided a dedicated VLAN for the audiovisual system is required.
- .5 Encryption
  - .1 Minimum TLS 1.2 should be used and where available use most current version of TLS encryption for all network attached equipment.
- .6 Network Certificates
  - .1 Make sure Network Certificates are up to date and not expired for all equipment and systems.
- .7 Firmware & Software Update Management
  - .1 Be sure to have the latest stable Firmware / Software version on all devices/ equipment/ as well as implement a Firmware/Software Update management process and procedure.
- .8 Manufacturer's System Hardening Guides
  - .1 Be sure to have the Manufacturers System hardening guides provided for the equipment being installed and implement as many recommendations/features as practical to do so.
- .9 External Memory
  - .1 Restrict the use of external memory. The use of devices such as external USB Thumb drives should be restricted or not used at all unless expressly allowed by the Owner's Information Technology representatives.
- .10 Log Off
  - .1 Enable auto-logoff timer. Be sure to have the local Workstation being used to access the equipment has an auto-logoff timer set with a reasonable timer in the case that the employee leaves it unattended for any amount of time.
- .11 Anti-Virus Software
  - .1 Enable and configure anti-virus software on PC endpoints in accordance with the Owner's Information Technology requirements, unless it is to be installed and configured by the Owner.
- .12 Filtering Techniques
  - .1 There are many types of filtering techniques and filters that can be applied and should be investigated for specific project requirements. Some of these filtering techniques are:
    - .2 Web Filtering: A Web filter adds another layer to your anti-phishing defences by blocking the web based component of phishing and malware attacks.

- .3 Multicast Message Filtering: Filters the packets sent to multicast groups they are not subscribed to.
- .4 Content Filtering: is the use of a program to screen and or exclude access to web pages or email deemed objectionable. A content filter shall then block access to this content
- .13 Back up Regularly
  - .1 Provide backup schedule in the closeout submittals and configure system for automatic backups wherever possible. Regularly back up important files either manually or through a scheduled backup procedure. This helps to protect against many types of data loss, especially if a Cyber Threat Actor gains access.
- 3.3.2. IT Devices and Systems
  - .1 The above listed Cyber security measures can be applied in part or in full to a wide range of Information Technology (IT) Devices. A list of some of these device types are:
    - .1 Firewalls
    - .2 Routers
    - .3 Network switches (Core and Edge Devices)
    - .4 Servers and databases
    - .5 Workstation computers
    - .6 Network connected system devices and controllers
    - .7 Wireless Access Points and wireless controllers
    - .8 Mobile phones and tablets
    - .9 Any IT System or endpoint connected to the network can have some form of Cyber security measure applied to it.
- 3.3.3. OT Devices and Systems
  - .1 These Cyber security measures can also be applied in part or in full to a wide range of Operational Technology (OT) Network devices.
    - .1 AV Control System Processors and Touch Panels
    - .2 Digital Signal Processors
    - .3 Digital Signage Players
    - .4 Collaboration/conferencing codecs
    - .5 Industrial Control Systems such as:
      - .1 (PLC's) Programmable Logic Controllers are an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices.
      - .2 (SCADA) Supervisory Control and Data Acquisition is a control system architecture comprising of computers, networked data communications and graphical user interfaces (GUI) for high level process supervisory management.
      - .3 (DCS) Distributed Control System is a computerized control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system.
- 3.3.4. Report Cybercrime
  - .1 When performing any work on a network connected system advise the Owner and or their representatives of any indication of a Cyber Incident of a criminal nature.
- 3.3.5. Cyber Security Report Letter

- .1 When implementing any and or all of the Cyber Security Measures mentioned in this Specification, be sure to include a Report letter in the closeout documents to the client stating which Cyber Security measures have been implemented.

END OF SECTION

00 00 00.00 Attachment A Audio Visual Tender Form

**AUDIOVISUAL TENDER FORM  
 FOR  
 University of Toronto  
 Robarts MDL  
 08086.008.AV.001**

SUBMITTED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

1. Having carefully examined and understood the site and all the Bid Documents, and having complied with all the conditions of the Instructions to Bidders including those issued prior to this date, we hereby offer to furnish all materials, equipment, plant and labour necessary for the proper completion of the Audiovisual work, and enter into a Lump Sum Contract for the execution of the aforementioned work, in accordance with the Contract Documents, for the stipulated sum of:

\_\_\_\_\_ Dollars in lawful money of Canada \$ \_\_\_\_\_

The Stipulated Sum excludes all applicable taxes. H.S.T. shall be identified below.

Harmonized Sales Tax excluded in total Stipulated Sum \$ \_\_\_\_\_

2. Breakdown of work shall be provided as follows and sum shall equal previously Stipulated Sum, excluding taxes.

SYSTEM (ROOM TYPE)	ROOM QTY	LABOUR (UNIT)	EQUIPMENT/ MATERIALS (UNIT)	TOTAL [(LABOUR + EQUIPMENT) xQTY]
TYPE 1A		\$	\$	\$
TYPE 1B		\$	\$	\$
TYPE 2		\$	\$	\$
TYPE 3		\$	\$	\$
TYPE 4		\$	\$	\$

<b>TYPE 5</b>		\$	\$	\$
<b>TOTAL \$</b>				\$

3. We will hold our tender open for acceptance for a period of sixty (60) days from the date of this tender.
4. The Tenderer acknowledges that the Owner shall have the right to reject any and all tenders for any reason or to accept any tender which the Owner in its sole unrestricted discretion deems most advantageous to itself. The Tenderer acknowledges that the Owner may rely upon criteria which the Owner deems relevant even though such criteria have not been disclosed to the Tenderer. By submitting a tender, the Tenderer acknowledges the Owner's rights under this clause and absolutely waives any right of action against the Owner and its consultants for the Owner's failure to accept the Tenderer's tender whether such right of action arises in contract, negligence, bad faith, or any other cause of action.

5. ALTERNATIVE PRICES

We submit the following Alternative Prices for items as defined:

	DEDUCT FROM BID PRICE	ADD TO BID PRICE
5.1 _____	_____	_____
5.2 _____	_____	_____
5.3 _____	_____	_____

6. Acceptance to this agreement is to accept confirmation of completion date as noted. Expected equipment delays shall be identified and specifically noted on Tender documentation. Failure to comply to this delivery may be subject to penalty as negotiated prior to Tender Award

7. AUDIOVISUAL TENDER DOCUMENTS

We further confirm that we have received the following documents:

- a. Audiovisual Tender Form
- b. Audiovisual Instructions to Bidders
- c. Audiovisual Specifications as described on Index 27 00 00.00
- d. Audiovisual Drawings consisting of those listed on drawing number AV-000
- e. Audiovisual Addenda listed below:

ADDENDUM NO.	DATE	PAGES
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8. ACCEPTANCE

If we are notified of the acceptance of our Tender within the time stipulated as mentioned above, we will:

- a. Execute a contract on Document CCDC-2 (latest edition) subcontract, Canadian Standard Construction Subcontract stipulated Price or as identified by the General Contractor.
- b. Commence work immediately with approval or letter of intent
- c. Substantially perform the work within the construction schedule agreed upon above and with the project team recognising that time will be of the essence of the Contract. We understand that regardless of the time period we have indicated for substantial performance of the entire work (the 'Work' of the Contract), certain parts of the work included in the Contract have specified completion dates to enable use, occupancy and access by the Owner, and we accept and will meet those requirements.

9. BID SUBMITTED BY

\_\_\_\_\_  
(Company)

\_\_\_\_\_  
(Address)

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_  
(Date)

\_\_\_\_\_

SIGNING OFFICER:

\_\_\_\_\_  
(Printed Name)

\_\_\_\_\_  
(Signature)

WITNESS:

\_\_\_\_\_  
(Printed Name)

\_\_\_\_\_  
(Signature)

END OF SECTION