

**1. General**

**1.1 RELATED WORK**

- .1 Testing, Adjusting and Balancing of Electrical Equipment and Systems      Section 26 01 26
- .2 Electrical Equipment and Systems Demonstration and Instruction      Section 25 05 83

**1.2 COORDINATION**

- .1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:
  - .1 Electrical equipment and systems specified in Division 26.
  - .2 Mechanical equipment and systems specified in Division 23.
  - .3 Other equipment and systems specified in other Divisions.
- .2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

**2. Products**

- .1 Not Used

**3. Execution**

**3.1 ENERGIZING MAIN ELECTRICAL SYSTEM**

- .1 Prior to energizing main electrical system:
  - .1 Verify supply authority voltage and phase rotation.
  - .2 Close and open all devices to ensure proper mechanical operation.

**3.2 STARTING MOTORS**

- .1 Prior to starting motors:
  - .1 Verify phase rotation at motor control centres.
  - .2 Confirm motor nameplate data with motor starter heater overloads.

**3.3 ENERGIZING EQUIPMENT**

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the Owner.
- .2 Confirm equipment nameplate data with characteristics of power supply.

**END OF SECTION**

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**1. General**

**1.1 INTENT**

- .1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.
- .2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.
- .3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.
- .4 All tests shall be witnessed by persons designated by the Owner, who shall also sign the test documentation.
- .5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

**1.2 RELATED REQUIREMENTS**

- .1 Electrical Operation and Maintenance Data Section 26 05 01
- .2 Starting of Electrical Systems and Equipment Section 26 01 25

**1.3 MANUFACTURER'S PRODUCTION TEST RECORDS**

- .1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

**1.4 SITE TESTING REPORTS**

- .1 Log and tabulate test results on appropriate test report forms.
- .2 Submit forms to Owner for approval prior to use.
- .3 Submit completed test report forms as specified, immediately after tests are performed. Final test report to be included in electrical O&M Manuals.

**1.5 REFERENCE DOCUMENTS**

- .1 Perform tests in accordance with:
  - .1 The Contract Documents
  - .2 Requirements of authorities having jurisdiction
  - .3 Manufacturer's published instructions
  - .4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards
- .2 If requirements of any of the foregoing conflict, notify A/E before proceeding with test and obtain clarification.

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**1.6 MANUFACTURER'S SITE SERVICES**

- .1 Arrange and pay for the site services of appropriately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

- .1 Specified, or
- .2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

**1.7 SEQUENCING AND SCHEDULING**

- .1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.
- .2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

**2. Products**

**2.1 TEST EQUIPMENT**

- .1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

**3. Execution**

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### **3.2 TESTING OF WIRING AND WIRING DEVICES**

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.
- .2 Test service grounding conductors for ground resistance.
- .3 Test all wiring devices for correct operation.
- .4 Test all receptacles for proper polarity and circuitry.

### **3.3 LOAD BALANCE TESTING**

- .1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.
- .2 Turn on all possible loads.
- .3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.
- .4 If load balance exceeds 15%, reconnect circuits to balance loads, update as built.

### **3.4 VOLTAGE TESTING AND ADJUSTING**

- .1 Test voltage at all panelboards.
- .2 Test voltage at motor control centre.
- .3 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by A/E.
- .4 Confirm phase rotation and colour coding of conductors at the main switchboard, all panelboards and motor control centres.

**END OF SECTION**

**1. General**

**1.1 WORK INCLUDED**

- .1 Complete and operational electrical system as required by the drawings and as herein specified.

**1.2 RELATED WORK**

- |    |                      |                  |
|----|----------------------|------------------|
| .1 | General Requirements | Section 01 00 00 |
| .2 | Site Work            | Section 31 00 00 |
| .3 | Concrete             | Section 03 00 00 |
| .4 | Doors and Windows    | Section 08 00 00 |
| .5 | Finishes             | Section 09 00 00 |
| .6 | Specialties          | Section 10 00 00 |
| .7 | Equipment            | Section 11 00 00 |
| .8 | Mechanical           | Section 23 00 00 |

**1.3 DRAWINGS AND SPECIFICATIONS**

- .1 The General Conditions, Supplementary Conditions and Division 1 are a part of this specification and shall apply to this Division.
- .2 The intent of the drawings and specifications is to include all labour, products and services necessary for complete work, tested and ready for operation.
- .3 Mention herein or indication on the drawings, of articles, materials, operations or methods requires that all such items shall be supplied in the quality and quantity required, and that the operations shall be performed according to the methods prescribed, complete with all necessary labour and incidentals.
- .4 These specifications and the drawings and specifications of all other divisions shall be considered as an integral part of the accompanying drawings. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided. Also refer to 3.2 (this section) coordination with other divisions.
- .5 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.
- .6 If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, advise the Owner for clarification before submitting tender.
- .7 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

## **1.4 QUALITY ASSURANCES**

- .1 Codes, Rules, Permits & Fees
  - .1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.
  - .2 Comply with all rules of the Electrical Protection Act of BC, CSA Standards and Canadian Underwriters Laboratories and the applicable building codes, whether specifically shown on drawings or not.
  - .3 Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.
  - .4 Immediately after award of contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.
  - .5 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.
  - .6 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Owner.
- .2 Standards of Workmanship
  - .1 Execute all work in a competent manner and to present an acceptable appearance when completed.
  - .2 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.
  - .3 Arrange and install products to fit properly into designated building spaces.
  - .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

## **1.5 SUBMITTALS**

- .1 Refer to architectural specifications.

## **1.6 RECORD DRAWINGS**

- .1 Maintain on site a complete set of as-built drawings as listed in General Conditions and as follows. Before commencing work, obtain a set of white prints of all drawings pertinent to the work. Keep record drawings on site and continuously update to accurately record in coloured pencil all items such as change orders, alterations or Facility's, runs of conduit, numbers and location of outlets, motors, panels and luminaires that may occur during the progress of the work.
- .2 Before substantial performance is granted to this Contractor, neatly transpose this information onto a set of full size white paper set of drawings in red and coloured ink. All conduit runs and junction boxes larger than 150 mm square must be shown on the Record Drawings, complete with size and wire count. Provide one (1) complete printed set and colour scanned version.
- .3 Before requesting final certificate, make any necessary final corrections, sign each print as a certification of accuracy and deliver all sets to the Owner.

## **1.7 OPERATIONS AND MAINTENANCE MANUALS**

- .1 Before requesting final certificates, submit two complete sets of the operating/maintenance manuals, as specified in the General Conditions. Refer to Section 01781.
- .2 Binders: Extension type catalogue binders bound with heavy fabric, hot stamped in gold lettering front and spine, sized for 216 mm (8 ½") x 279 mm (11") paper. Binders must not exceed 76 mm (3") thick or be more than 2/3 full. Binder colour to be yellow with the lettering on the front spine to read:
  - Project Title
  - Date Submitted
  - Project Location
  - Manual Title
  - Volume Number
  - Project Number
- .3 Each manual shall contain:
  - Table of contents. Arrange contents sequentially by systems under section numbers. Label tabs of dividers between each to match section numbers in table of contents.
  - Tabs are to be celluloid covered fastened to hard paper dividing sheets.
  - List the electrical engineering firm and electrical contractor with names, addresses and telephone numbers of contacts.
  - Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.
  - Descriptive and technical data to follow the general layout of the specifications.
  - Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)
  - Lubricating and servicing intervals recommended.
  - A copy of all wiring diagrams complete with wire coding.
  - List of spare parts of all electrical equipment complete with names, addresses, and telephone numbers of sales, service representatives and suppliers.
  - Copy of test data
  - A motor list showing each motor number, name, horsepower, nameplate, current rating, heater size and type, and current being drawn, on the form specified in Section 26 05 82.
  - Include type and accuracy of instruments used.
  - Copy of final inspection certificate.
  - Set of final reviewed Shop Drawings.
- .4 Electrical Operation and Maintenance Manuals are to be organized.

## **1.8 PRODUCT HANDLING**

- .1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the Owner and to the approval of the Owner.
- .3 Remove advertising labels from fixtures, conduit, panelboards, etc. Do not remove identification or CSA labels.

- .4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces.

## **1.9 ALTERNATE AND SEPARATE PRICES**

- .1 In accordance with the Instructions to Bidders, state on the Tender Form in the space provided, the amount to be deducted from the base bid tender amount for the use and installation of equipment as an alternate to those specified and the requested separate prices.

## **1.10 GUARANTEE**

- .1 Furnish a written guarantee to the Owner prior to final contract payment, which will be in effect for one year from the date of final acceptance of the complete work. Replace or repair at no cost to the Owner any defective material or workmanship except where, in the opinion of the Owner, such defects are due to the misuse or neglect by the Owner.
- .2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees which cover a greater length of time.

## **1.11 PROGRESS CLAIMS**

- .1 Within thirty (30) days after award of contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the Owner format. Subsequent requests for payment shall be documented accordingly.

## **1.12 WORK SCHEDULE**

- .1 Install work to facilitate installation and servicing of indicated future work.
- .2 Work shall be done in phases as described in Architectural.
- .3 Layout electrical work to allow for phasing of work. Refer to architectural for breakdown of phases and for construction schedule regarding phasing.

## **1.13 FOR ENGINEERS SERVICES**

- .1 Division 26 to include, for all costs to provide construction related engineering services specified herein.
- .2 These services include, but are not limited to:
  - .1 All costs for additional engineering services during construction as a result of the following:
    - .1 Re-inspection due to incomplete or defective work.
    - .2 Contractor caused delays during normal testing and inspection procedures.

## **2. Products**

### **2.1 SELECTED PRODUCTS AND EQUIVALENTS**

- .1 Products and materials provided shall be new and free from all defects. Related materials shall be of the same manufacturer throughout the project.



- .2 Products and materials called for on the drawings or in the specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.
- .3 The design has been based on the use of the first named product.

## **2.2 ALTERNATIVE PRODUCTS**

- .1 Alternative products and materials to those specified shall only be considered if they are shown in the Tender as a material variation with an appropriate price adjustment. The Owner reserves the right to accept or reject any alternative without explanation.
- .2 Submission shall provide sufficient information to enable the Owner to determine acceptability of such products. Submission to be submitted seven (7) days before close of tender.
- .3 Provide complete information on required revisions to other work and products to accommodate each alternate product, and the amount of Facility or reduction from tender amount, including required revisions, for each alternate product.
- .4 Assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the contractor.
- .5 Unless a proposal for an alternative product is submitted in this manner and later accepted, provide the product specified.
- .6 Materials or equipment rejected by the Owner shall be immediately removed from the project and suitable materials shall be provided.
- .7 Prior approval to submit a proposal for an alternative product with the Tender is not required.

## **2.3 REVIEW OF PRODUCTS**

- .1 Immediately after notification of award of contract, review with the Owner a list of products proposed, including any alternatives submitted with tender.
- .2 After agreement on product list, no subsequent changes will be permitted except as specified hereafter.

## **2.4 SUBSTITUTION OF PRODUCTS AFTER CONTRACT AWARD**

- .1 After acceptance of the list of products, no substitution of any item will be permitted unless the approved item cannot be delivered in time to comply with the work schedule.
- .2 To receive acceptance, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the drawings.
- .3 Provide to the Owner documentary proof of equality, difference in price (if any) and delivery dates, in the form of certified quotations from suppliers of both specified items and proposed substitutions.
- .4 Include costs for any required revisions to other structures and products to accommodate such substitutions.

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**2.5 QUALITY OF PRODUCTS**

- .1 All products provided shall be CSA Approved, Canadian Underwriters' Laboratory approved where applicable, and new, unless otherwise specified.
- .2 If products specified are not CSA approved, obtain approval of provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Owner.

**2.6 UNIFORMITY OF MANUFACTURE**

- .1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

**2.7 PRODUCT FINISHES**

- .1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in ANSI 61 grey enamel unless otherwise specified.
- .2 Apply primer on all items which are to be finished on the job.
- .3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Owner, completely repaint damaged surface.

**2.8 USE OF PRODUCTS DURING CONSTRUCTION**

- .1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.
- .2 The warranty period shall not begin until the date of substantial performance of the work.

**3. Execution**

**3.1 SITE EXAMINATION**

- .1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.
- .2 No additional compensation will be given for extra work due to existing conditions which such examination should have disclosed.
- .3 Report to the Owner any unsatisfactory conditions which may adversely affect the proper completion of this work.

**3.2 COORDINATION WITH OTHER DIVISIONS**

- .1 Examine the drawings and specifications of all divisions and become fully familiar with their work. Before commencing work, obtain a ruling from the Owner if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments. Also refer to item 1.3.4 this section.
- .2 Fully understand the functions of the systems specified and have no doubts with regard to the extent of the Contract.

- .3 Coordinate with all Divisions installing equipment and services, and ensure that there are no conflicts.
- .4 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.
- .5 Lay out the work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.
- .6 Do not cut structural members without approval of the Owner.

### **3.3 LOCATION OF OUTLETS AND LUMINAIRES**

- .1 Electrical drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural drawings.
- .2 Outlet and equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the Owner, provided that installation has not been completed.
- .3 Maintain luminaire locations wherever possible. Notify the Owner of conflicts with other services.
- .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

### **3.4 SEPARATION OF SERVICES**

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.
- .2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.
- .3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Owner and the ceiling installer, and approved clips or hangers are used.

### **3.5 IDENTIFICATION**

- .1 Clearly mark all exposed conduit, junction boxes, etc., to indicate the nature of service.
- .2 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.
- .3 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.
- .4 All exposed feeder conduits for all systems and all control conduits shall be clearly identified at all pull box locations.

- .5 Conductor s:
- Equipment Grounding - Green
- Neutral Conductor - White
- | <u>120/208 Volt System</u> | <u>347/600 Volt System</u> |
|----------------------------|----------------------------|
| Phase A - Red              | Phase A - Orange           |
| Phase B - Black            | Phase B - Brown            |
| Phase C - Blue             | Phase C - Yellow           |
- .6 Low Voltage Wiring: per manufacturer's standard, i.e. PDM low voltage relay switching system.
- .7 All colours referred to in the above paragraphs shall be as follows:
- |        |   |
|--------|---|
| Grey   | Canadian General Standards Board #501-107 Grey        |
| Green  | Canadian General Standards Board #503-211 Apple Green |
| Blue   | Canadian General Standards Board #202-101 Dark Blue   |
| Red    | Canadian General Standards Board #509-102 Red         |
| Bronze | Canadian General Standards Board #514-101 Bronze      |
| Brown  | Canadian General Standards Board #504-104 Brown       |
- .8 Submit paint chips for approval for all colours referred to in the above paragraphs prior to manufacture of equipment.
- .9 Pull Boxes and Conduit:
- Conduit as indicated previously and one conduit entering or leaving a pull box shall be identified as follows:
- 120/208V: Red background with black letters "120/208V"
- Telephone System: Green background with black letter "T"
- Low Voltage Control Circuits: Black background with black letters "TV"
- Television Distribution: Green background with black letters "TV"
- Use Brady self-sticking identification tape, or approved equal. The use of "Dymo" tape identification is not acceptable.

### **3.6 WIRING TO EQUIPMENT SUPPLIED BY OTHERS**

- .1 Equipment supplied by the Owner or under other Division will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.
- .2 It is the responsibility of this Division to ensure that all wiring, connectors, branch circuit breakers, etc. are sized to and match the equipment provided.

### **3.7 TESTING**

- .1 Refer To Section 26 01 26

### **3.8 SINGLE LINE DIAGRAM**

- .1 Provide and mount a framed as-built single line diagram at the main electrical equipment. Use a clear plexiglass cover. The diagram shall be 914 mm x 600 mm minimum, with all lettering Leroyed.

### **3.9 INSTRUCTIONS TO OWNER'S PERSONNEL**

- .1 Refer To Section 26 05 83

### **3.10 ACCESS PANELS**

- .1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Owner.
- .2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Owner.

### **3.11 MOUNTING HEIGHTS**

- .1 Unless a conflict exists, use the following as mounting heights from finished floors:

Data Receptacles	787 mm to centre of outlet
Data Outlets	787 mm to centre of outlet
Receptacles in Mechanical Rooms	1,070 mm to centre
Receptacles & Telephone Outlets	1070 mm to centre
Light Switches	1,220 mm to centre
Clocks	2,300 mm
Panels and Starters to top of cover	1,870 mm
End of Line Resistors (maximum)	1525 mm (maximum 1800mm)
Receptacles & Telephone Outlets above counters	150 mm above countertop or 150 mm above splash bar
Emergency Lighting Remote Heads	2,300 mm or 2,800 mm in high ceiling areas or as indicated on drawings
Power Receptacle supporting data outlet	460 mm to bottom of outlets
Classroom Telephones	1500 mm to centre

### **3.12 SEALING OF WALLS AND FLOOR OPENINGS**

- .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.
- .2 Openings shall be sealed when all wiring entries shown on the drawings have been completed.
- .3 Sealing material shall be fire resistant and shall not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed in accordance with Section 26 05 01.

### **3.13 FIRE PROTECTION OF ELECTRICAL CONDUCTORS**

- .1 Fire rated access panels shall be provided in the enclosures where required.

- .2 The fire rated enclosures required by this Division shall, unless otherwise noted, be by this Division and shall be in accordance with the sections of the specification detailing the fire rated enclosures requirements.
- .3 Advise the extent of the fire rated enclosures required and supply all information and details as to size and locations within thirty days after the award of the contract.
- .4 Failure to comply with the above requirements shall be remedied at this Division's expense.
- .5 Where fire rated cables that comply with the requirements of the Authorities having jurisdiction are provided, it shall not be required that they be installed in fire rated enclosures.

### **3.14 HOUSEKEEPING PADS**

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which shall, unless otherwise noted, be by this Division.
- .2 Advise the extent of the housekeeping pads required and supply all information and details as to size and locations within thirty days after the award of the Contract.
- .3 Failure to comply with the above requirements shall be remedied at this Division's expense.

### **3.15 SLEEVES**

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.
- .3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate and position sleeves exactly prior to construction of walls, floors.
- .5 Failure to comply with the above requirements shall be remedied at this Division's expense.

### **3.16 PRICEBREAKDOWN**

- .1 The successful bidder shall, following award of contract, give a breakdown of the tender price as follows:
  - .1 Electrical distribution equipment and feeders.
  - .2 Emergency distribution system including emergency and exit lights.
  - .3 Lighting, branch circuit wiring and controls.
  - .4 Mechanical equipment, power and control wiring.
  - .5 Miscellaneous power and branch circuit wiring (indicate items included).
  - .6 Telephone/Data raceway and wiring system.
  - .7 Intercommunication/Security Conduit Systems

**3.17 EQUIPMENT STORAGE AND PROTECTIONS**

- .1 Deliver equipment in original wrapping or containers, with manufacturer's label and seals intact.
- .2 Handle and store equipment in accordance with manufacturer's recommendations and prevent damage, inclusion of foreign matter, rusting, staining and defects which will affect performance and appearance.
- .3 Equipment containing components such as open bussing, contacts and solid state devices to be adequately and continuously protected in an enclosed, dry and dust-free environment while in transit, during installation and until completion of the Contract. The Owner may not accept repair of defective equipment if the above is not observed.

**3.18 WORKMANSHIP**

- .1 Workmanship to be of a high standard throughout.
- .2 Exposed conduit runs to be perpendicular or parallel to the building lines as necessary. Panels, boxes, covers, etc. shall be mounted in a similar manner. These conditions to be determined using spirit levels.
- .3 Bolts or nuts in a "stripped" or "cross threaded" condition to be replaced immediately.

**3.19 COST BREAKDOWN**

- .1 Submit to the Owner at time of award of Tenders a cost breakdown of the contract amount for the items described on sheet provided.

**3.20 CLEANING**

- .1 Do final cleaning in accordance with Division 01 requirements.
- .2 At time of final cleaning, lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt shall be cleaning using soft clothes and approved cleansers.
- .3 Vacuum out all panelboard, cabinet and enclosure tubs and clean all equipment surfaces so they are free of construction dirt and paint.

**3.21 YEAR COMPLIANCE**

- .1 All products and equipment utilized on this project shall be designed and able to manage dates of more than one century, providing correct dates and times into the 21<sup>st</sup> century and beyond, including correct leap year calculations.
- .2 The Contractor shall provide testing protocols to confirm their equipment is fully Y2K and Y2K38 (Year 2038) compatible and other potential year with known computing issues (e.g., 2070).
- .3 The Contractor shall agree to repair, replace, or upgrade at not cost to the Owner any failure to comply with these warranties and to reimburse and indemnify the Owner against liabilities or losses it may suffer as a result of such failure.

**3.23 PROGRESS BREAKDOWN**

DESCRIPTION	CONTRACT AMOUNT	COMPLETED TO DATE	% COMPLETE	PREVIOUS COMPLETE	AMOUNT THIS CLAIM
Intrusion Alarm System					
Electrical Distribution					
Emergency Distribution					
Lighting Fixtures					
MCC Equipment					
Misc. Power & Branch Circuit					
Telephone, Computer, CATV Wiring & Raceways					
Miscellaneous					
<b>TOTAL</b>					

**END OF SECTION**



**1. General**

**1.1 WORK INCLUDED**

- .1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

**1.2 SPECIAL CODES**

- .1 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

**2. Products**

**2.1 WIRE**

- .1 Conductors outdoors or in wet areas. X-Link: 98% conductivity copper conductors sized as indicated with 600 volt insulation of chemically cross-linked thermosetting polyethylene material, rated RW90 and RWU-90.
- .2 Conductors indoors. X-Link: 98% conductivity copper conductors sized as indicated with 600 volt insulation of chemically cross-linked thermosetting polyethylene material, rated RW90 and RWU-90. Or nylon jacketed thermoplastic insulation type T90 Nylon rated at 600V.
- .3 Luminaire Wire: Copper conductors, #12 A.W.G. with thermoplastic and asbestos insulation type TEW, flame retardant, heat and moisture resistant, rated 600 volts, 105°C.
- .4 Thermoplastic: Copper conductors, #12 AWG with thermoplastic insulation types X-Link, rated at 600 volts.
- .5 Conductors: Stranded for # 8 AWG or larger.

**2.2 WIRE CONNECTORS**

- .1 Use 3M "Scotchlock," or ideal self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.
- .2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten - 32 x 3/8" machine bolts.
- .3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.
- .4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.
- .5 Wiring device connections, follow the "good installation practice" of pigtail both the "hot" and the neutral conductors of electrical devices, such as receptacles, so that removal of a device (while lines are hot) cannot result in the disconnection of downstream devices from power nor expose the electrical working to line-to-line voltages that would result from a neutral disconnection.

**2.3            ARMoured CABLE**

- .1        Conductors: Insulated copper size as indicated, Armour: Interlocking fabricate from aluminum strip.
- .2        Type: AC90

**2.4            COMMUNICATION CABLES:**

- .1        Structured Communication Cabling to section 27 10 00
- .2        Security Intrusion and Access Control to section 28 16 00

**3.            Execution**

**3.1           GENERAL**

- .1        X-Link: for all wiring except as specified below. All conductors to be rated RW90 copper unless otherwise shown.
- .2        RW90 for branch circuit conductors, #12 AWG or larger. Use #10 AWG for 120 volt home runs over 30 meters.
- .3        Minimum #14 AWG flexible stranded copper for controls and #12 AWG solid copper for branch circuit power and lighting.
- .4        Luminaire Wire: run wires from outlet boxes through luminaire raceways, splice and connect in raceways. Connect continuous rows of luminaires to circuit without breaking conductors.
- .5        Insulation is to be rated for a minimum of 600VAC unless specified otherwise. Conduit sizes are based on 600V insulation. Adjust conduit size as required for insulation greater than 600VAC.
- .6        Use copper conductors for all feeders. Panel, motor control centres and distribution board feeders may be aluminum alloy if 100 amps or larger.

**3.2           WIRECONNECTORS**

- .1        Select hand twist connectors for wire size and install tightly on conductors.
- .2        Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the manufacturer.
- .3        Install compression connectors using methods and tools recommended by manufacturer.
- .4        Do not install stranded conductors under screw terminals unless compression lugs are installed.

### **3.3 WORKMANSHIP**

- .1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.
- .2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with Table 24 of the C.E.C., Part 1. Submit data sheet with values measured.
- .3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for P.A. wiring, etc.
- .4 Provide sizes of conductors as shown on drawings. Voltage drop from branch panels to farthest outlet must not exceed 3% at full load in any case. Advise Owner if problem is foreseen. Voltage drop for conductors from main distribution to branch circuit panelboards shall not exceed 2% under full load conditions.
- .5 Exercise care in stripping insulation from wire. Do not nick conductors.

### **3.4 IDENTIFICATION, CODING AND BALANCING**

- .1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 26 05 01.3.5, Identification.
- .2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.
- .3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.
- .4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.
- .5 For direct current wiring use red for positive and black for negative.

### **3.5 INSTALLATION OF ARMOURED CABLE:**

- .1 Minimum wire size shall be AWG# 12.
- .2 Armoured cable may be used for:
  - .1 Final connection to luminaires not exceeding 1.5 m in length.
  - .2 Connection of wiring devices located in millwork.
  - .3 Runs contained in metal or wood stud containing only one or two circuits. Power must be brought first to a junction box within an individual room in conduit. Up to two circuits can be taken from that junction box with in that room using armoured cable.

**3.6 TESTING**

- .1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.
- .2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Owner.

**END OF SECTION**

**1. General**

**1.1 DESCRIPTION**

- .1 Supply and install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest C.E.C. Section 10 and the local Electrical Inspection Branch.
- .2 The system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.
- .3 All ground conductors shall be run in conduit.

**2. Products**

- .1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.
- .2 All ground wires to be stranded copper R-90 complete with a green jacket unless otherwise shown.
- .3 Ground Grid:
  - .1 Ground rods shall be 20 mm x 3650 mm copper flashed or galvanized for first 400 mm.
  - .2 No 3/0 AWG bare copper interconnected conductors.
  - .3 No 3/0 bare copper to main electrical room ground bus.
- .4 Cable to pipe connectors to be made with Burndy GAR connectors.
- .5 In the main electrical room, provide a copper ground bar complete with lugs suitable to terminate all ground cables. See grounding detail on drawing.
- .6 Utility Padmount Transformers Grounding: Provide ground grid in accordance with utility requirements. Confirm supply of transformer grounding with Utility.

**3. Execution**

**3.1 GROUNDING - GENERAL**

- .1 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.
- .2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the C.E.C. The ground wire shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Ground wire to be green R-90.
- .3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the C.E.C.

- .4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.
- .5 All bolted connections must be accessible.
- .6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.
- .7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, C.E.C.
- .8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per C.E.C.
- .9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium" or approved equal hardware.
- .10 Connect all transformer neutrals to the main building ground wire, using compression terminations.
- .11 Install rigid conduit sleeves where ground wires pass through concrete slabs.
- .12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.
- .13 Ground all utility services to the electrical system ground.
- .14 Provide ground wires for main telephone/computer rooms as required and shown on drawings.
- .15 Provide #6 AWG bonding conductor in all cable tray bond at each section and as per inspection authority requirements. Ground to main electrical system ground.
- .16 Bond all conduits supplying cabling for systems that uses the cable tray.
- .17 Sound, Fire, and other communications cabinets minimum #12 to each panel or cabinet location.

**END OF SECTION**

**1. General**

**1.1 WORK INCLUDED**

- .1 Supply and install all hangers, supports and inserts for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

**2. Products**

**2.1 FRAMING AND SUPPORT SYSTEM**

- .1 Materials:
  - .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.
  - .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.
  - .3 Finishes:
    - .1 Outdoors, wet locations: Hot dipped galvanized.
    - .2 Indoors, dry locations: Galvanized when available, prime painted if not available.
    - .3 Nuts, bolts, machine screws: Cadmium plated.
  - .4 Unistrut:
    - .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

**2.2 CONCRETE AND MASONRY ANCHORS**

- .1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.
- .2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
- .3 Manufacturer: Hilti (Canada) Limited or approved equal.

**2.3 NON-METALLIC ANCHORS**

- .1 Material: Plastic anchors for sheet metal screws.
- .2 Manufacturer: Fischer

**2.4 CONDUIT SUPPORTS**

- .1 General: Malleable iron one-hole conduit straps where exposed to weather or indoors for conduit smaller than 50 mm. Stamped steel two-hole straps indoors for conduits 50 mm and larger.

- .2 Structural Steel: Crouse-Hinds "Wedgetite" supports or equivalent manufactured by Appleton.
- .3 Masonry, concrete, stone, etc: Lead Anchors.
- .4 Title: Toggle bolts.
- .5 Metal studs, ceiling hangers, etc.: "Caddy-Clips".
- .6 Unistrut: Unistrut conduit clamps.
- .7 Non-metallic not allowed

## **2.5 CABLE SUPPORTS AND CLAMPS**

- .1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

## **3. Execution**

### **3.1 GENERAL**

- .1 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.
- .2 Do not cut or drill beams, joists or structural steel unless written permission of the A/E is obtained.
- .3 Distance between conduit or cable supports not to exceed code requirements.
- .4 Supports to be suitable for the real loads imposed by equipment.
- .5 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.
- .6 Use metal anchors for all other loads.
- .7 Shot driven pins may only be used with written approval of the structural engineer.
- .8 Use round or pan head screws for fastening straps, boxes, etc.
- .9 Do not support heavy loads from the bottom chord of open web steel joists.
- .10 Install channels in telephone/communication rooms.
- .11 Rack multiple parallel conduit runs on Unistrut support system. Maintain recommended separation between conduits of different systems, e.g. power and low voltage systems.
- .12 Nylon anchors may not be used.
- .13 Fasten exposed conduit to building structure using straps or to exposed beams using beam clamps.



- .14      Suspended support system: Support individual suspended conduits with 6 mm threaded rod and spring clips. Support two or more conduits with on channels supported by min 6 mm threaded rod where direct fastened to building construction id impractical.

**END OF SECTION**

**1. General**

**1.1 WORK INCLUDED**

- .1 Provide a complete system of boxes for the installation of wiring and equipment.

**2. Products**

**2.1 OUTLET BOXES FOR METAL CONDUIT**

- .1 Materials:
  - .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.
  - .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.
  - .3 Iberville or approved equal.
- .2 Components:
  - .1 Ceiling outlets, surface mounting, concealed:
  - .2 101 mm square, depth 54 mm, Iberville 52171 series
  - .3 119 mm square, depth 54 mm, Iberville 72171 series
  - .4 Ceiling outlets, concealed mounting in concrete:
  - .5 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.
  - .6 Extension ring to change from recessed conduit to exposed conduit, 101 mm octagonal, 38 mm deep square Iberville (type for all) 53151-1/2 or 38 mm deep octagonal Iberville 51151C or 54 mm deep, Iberville (type for all) 55171C.
  - .7 Wall boxes, concealed in concrete or masonry: for one and two gang applications shall be 101 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.
  - .8 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or special boxes as required).
  - .9 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, condulet.
  - .10 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

**2.2 OUTLET BOXES FOR RIGID PVC CONDUIT**

- .1 Materials:
  - .1 Rigid PVC boxes and fittings: Unplasticized PVC.
- .2 Components:
  - .1 Floor boxes: Round with threaded hubs for threaded female connectors.

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### **2.3 JUNCTION BOXES AND PULL BOXES, WEATHERPROOF**

- .1 Materials:
  - .1 Cast steel, Crouse Hinds, WBJ Series.

### **2.4 JUNCTION AND PULL BOXES, INDOOR DRY LOCATIONS**

- .1 Materials:
  - .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.
- .2 Components:
  - .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.
  - .2 Use rolled edges for surface boxes.
- .3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

### **2.5 JUNCTION BOXES, SURFACE POWER OUTLETS**

- .1 Materials
  - .1 Cast aluminum.
- .2 Components:
  - .1 Single gang, 1/2" hubs for 120V duplex receptacle equal to Iberville C-143 or Commander Perfect Line T11 type.
  - .2 Double gang, 1/2" hubs for quad (double duplex) receptacles equal to Commander Perfect Line LT11 type.

### **2.6 JUNCTION BOXES AND PULL BOXES FOR COMMUNICATION SYSTEM**

- .1 Refer to Section 27 05 28.

### **2.7 CABINETS**

- .1 Materials
  - .1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.
  - .2 Locks: to match panelboards.
  - .3 Backboards: 20 mm GIS fir plywood, one piece per cabinet, covering entire cabinet interior.
- .2 Components:
  - .1 Type E: With hinged door and return flange overlapping sides, with handle for surface mounting, size as indicated or to suit.
  - .2 Type T: Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

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## **2.8 COMPUTER OUTLET BOXES**

- .1 Recessed 4" square box complete with two gang plaster ring are to be used for all computer outlets shown on drawings. All wall enclosures are to be white and be complete with barrier, standard duplex outlet covers, blank covers or designated covers as shown on details on drawings.

## **2.9 MASONRY BOXES:**

- .1 Electro galvanized steel masonry boxes single and multiple gang for devices flush mounted in exposed block walls.

## **2.10 CONCRETE BOXES:**

- .1 Electro galvanized steel concrete boxes single and multiple gang for devices flush mounted in concrete walls with extension rings and plaster rings as required to suite application.

## **3. Execution**

### **3.1 INSTALLATION**

- .1 For flush installation s mount outlet box to allow finish wall to come within 6mm of opening.
- .2 Relocate outlet boxes as directed on site at no extra cost or credit provided that change occurs prior to installation and distance does not exceed, 3.0 m.
- .3 Review the drawings and work of other trades and disciplines to determine best location for electrical outlets and equipment that best uses the available space.
- .4 Prior to roughing in outlets with in a space review the architectural drawings, mill work fitments and elevations to determine the outlet locations Review discrepancies with the owner prior to proceeding.
- .5 Do not install outlet boxes back to back but allow min 150 mm horizontal clearance between boxes.
- .6 Mounting height are from finished grade (AFG) of Above Finished Floor (AFF) unless otherwise noted. If mounting height for a device is not shown confirm height before proceeding. Outlet boxes in masonry should line up with mason course.
- .7 Outlet Boxes:
  - .1 Install all outlets flush and surface mounted as required for the installation.
  - .2 Surface mount above suspended ceilings, or in unfinished areas.
  - .3 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.
  - .4 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.
  - .5 Use plaster rings to correct depth. Use 30 mm on concrete block.
  - .6 Do not use sectional boxes.
  - .7 Provide boxes sized as required by the C.E.C.
  - .8 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.
  - .9 Outlets installed in party walls to be offset by a minimum of one stud space.

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- .10 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.
  - .11 Support outlet boxes independently of supporting conduit.
  - .12 Fill boxes with paper, foam to prevent entry of foreign material. Remove upon completion of work.
- .8 Junction Boxes and Pull Boxes:
- .1 Supply all pull boxes and junction boxes shown on the drawings or required for with system name and circuit designation as applicable.
  - .2 Size in accordance with the Canadian Electrical Code, as a minimum.
  - .3 support independently of supporting conduit.
- .9 Cabinets:
- .1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

**END OF SECTION**

**1. General**

**1.1 WORK INCLUDED**

- .1 Provide a complete system of conduit and fittings for installation of wiring.
- .2 Contractor may install sub-distribution conduit for panel feeders in slab on grade. No panel feeder conduit is to be run in structural slabs. All other conduit work is to be done above ground in ceiling space.

**2. Products**

**2.1 RIGID STEEL CONDUIT**

- .1 Galvanized with threaded joints and connections.
- .2 Connections in dry locations: steel or malleable iron locknuts outside enclosures. Insulated bushings Thomas & Betts Type 222 or approved alternate.
- .3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series.
- .4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketed covers in damp locations.
- .5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

**2.2 E.M.T. CONDUIT**

- .1 Fittings in dry locations: steel set-screw type, coupling and connectors with insulated throats or non-metallic bushings, Thomas & Betts Ltd. Series 5031.

**2.3 RIGID P.V.C. CONDUIT**

- .1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride C.G.E. "Sceptre" Schedule 40.
- .2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.
- .3 Solvent: as recommended by conduit manufacturer.

**2.4 FLEXIBLE CONDUIT**

- .1 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

**2.5 LIQUID -TIGHT FLEXIBLE CONDUIT**

- .1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquidseal".
- .2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000). Liquid tite connectors for liquid tight conduit.

### **3. Execution**

#### **3.1 RIGID STEEL CONDUIT**

- .1 Use as raceways for following applications:
  - .1 In all areas exposed to weather.
  - .2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 metre.

#### **3.2 E.M.T. CONDUIT**

- .1 Use as raceways for following applications:
  - .1 In surface and concealed areas or in poured concrete above ground level.
- .2 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

#### **3.3 RIGID P.V.C. CONDUIT**

- .1 Use as raceways for following applications:
  - .1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.
  - .2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.
  - .3 Rigid PVC conduit shall not be surface mounted.
- .2 Use strictly in accordance with the C.E.C. Do not use in return air plenums and for exit and fire escape lights.
- .3 Provide insulated ground wire in all rigid PVC conduits in accordance with the C.E.C.
- .4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.
- .5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

#### **3.4 FLEXIBLE CONDUIT AND BX**

- .1 Use as raceways for following applications:
  - .1 Flexible connections to luminaires and ceiling mounted devices in suspended ceilings and T-bar.
  - .2 Armoured cable "BX" connections to recessed and/or hanging luminaires. (BX shall not be used to loop between fixtures.)
  - .3 Maximum length of BX to be 1.5 meters from Junction Box.
- .2 Provide a separate insulated ground wire in all flexible conduits.
- .3 Within new drywall partitions to interconnect electrical devices on the same wall, except that the connection from the junction box above the suspended ceiling down to the first electrical device in the drywall shall be wired in EMT conduit.

### **3.5 RIGID PVC DUCT**

- .1 Provide a separate green insulated copper ground wire in all ducts as required by the Code.
- .2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the drawings.
- .3 Support duct bank on plastic spacers 35 mm between ducts. Foundation spacers to maintain at least 76 mm clearance between ducts and exterior coverage.
- .4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.
- .5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.
- .6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.
- .7 Cap ends of unused ducts with plug ends of same material as ducts.
- .8 Seal all joints in ducts with solvent cement.

### **3.6 LIQUID -TIGHT FLEXIBLE CONDUIT**

- .1 Use as raceways for following applications:
  - .1 At all motors, transformers, pipe mounted control devices, and other devices subject to movement or water.
  - .2 At all CTS equipment and kitchen equipment.
- .2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.
- .3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.
- .4 Liquid tight connections required on all liquid tight flex.

### **3.7 WORKMANSHIP**

- .1 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.
- .2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.
- .3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.
- .4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.



- .5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.
- .6 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.
- .7 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.
- .8 At all recessed panels cap 2 - 25 mm and 4 - 19 mm empty conduits from panel into ceiling above and below for future use.
- .9 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be red, 150 mm wide, catalogue no. 91296.
- .10 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 meter length of conduit extending from the structure to be Polykin wrapped rigid steel.
- .11 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.
- .12 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per C.E.C.
- .13 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.
- .14 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt or moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.
- .15 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.
- .16 Use insulated non-metallic bushings on all conduit terminations.
- .17 Ensure electrical continuity in all conduit systems.
- .18 All conduit shown exposed in finished areas is to be free of labels and trade marks.
- .19 Install a 90 lb. test line in all conduits left empty by this contractor including those which others will pull cables, wires, etc.
- .20 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or FRE.

- .21 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant.
- .22 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Departmental Representative.
- .23 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.
- .24 Where conduit finish is damaged, repair or replace.
- .25 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.
- .26 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter.
- .27 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.
- .28 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.
- .29 Conduit shall not impede service access to mechanical and electrical equipment. I.e. VAV or filter access on HVAC units.

### **3.8 CONDUIT IN SLAB**

- .1 All conduit with the exception of main shall be installed above finished floor level and shall not be installed in floor slab or underground and are not to penetrate attic space except where specifically indicated.

### **3.9 CONDUIT UNDER STRUCTURAL SLABS**

- .1 All conduits installed below structural slabs are to hung with a minimum 6.3 mm threaded rod and approved conduit clamps at intervals as required by the CEC. Contractor is to examine structural drawings to determine extent of the structural slab.

### **3.10 CONDUIT BENDS**

- .1 For communications conduit system a maximum of 180° bend is permitted between pull boxes. Refer to Section 27 05 28 for additional information.

**END OF SECTION**

**1. General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.2 No. 126-2009, Cable Tray Systems

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 01 00 10 – Shop Drawings, Product Data, Samples and Mock-ups.
- .2 Identify types of cable tray used.
- .3 Show actual cable tray installation details and suspension system.

**2. Products**

**2.1 CABLE TRAY**

- .1 Cable tray and fittings: to CAN/CSA C22.1.
- .2 Continuous, rigid, welded steel wire mesh cable management system.
- .3 Trays: galvanized steel mesh system, welded at all intersections with safety edge T-welded wire lip. Carbon steel wire 4.5mm dia, to ASTM A510 grade 1008.
- .4 Fittings: use only manufacturer recommended fittings.
- .5 Only low voltage systems are to be installed in the cable tray.
- .6 Approved manufacturers are Thomas & Betts Express Tray, Cablofil EZ Tray and Cope Cat-Tray

**2.2 SUPPORTS**

- .1 Provide supports as required and recommended by the manufacturer at a minimum of 1500mm apart and 600mm from ends.

**3. Execution**

**3.1 INSTALLATION**

- .1 Install complete cable tray system.
- .2 Support cable tray on both sides.
- .3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.
- .4 Bond all sections of the cable tray system to the main communication ground bar using a #6 AWG copper wire.
- .5 Dimensions: Mesh – 50x100mm nominal, straight section lengths – 3 meters, cable tray width 300mm, cable trays depth to be 100mm.

- .6 Communication conduits installed to within 400 mm of cable tray and are longer than 7.5m (from outlet to tray) are to be bonded to the cable tray.

### **3.2 CABLES IN CABLE TRAY**

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 Secure cables in cable tray at 6m centres, with milk-tie wraps.
- .4 Identify cables every 30m with size 2 nameplates in accordance with Section 16040.
- .5 Lighting or power cables shall not be installed in the cable tray.
- .6 Cable tray fill shall not exceed forty percent (40%).

### **3.3 FIRE BARRIERS**

- .1 Cable tray to run to within 450mm of Fire Rated Walls. Conduits (minimum 6-53mm conduits) to run between cable trays on either side of fire rated walls. Provide fire stopping at wall penetrations. Arrange and make good-fire rating of walls after conduits have been installed.
- .2 Or run cable tray to within 100 mm of wall and install fire rated cable pass through for full capacity of the tray. As STI EZ -Path series 33 pass through.

**END OF SECTION**

**1. General**

**1.1. SCOPE**

- .1 The work under this section includes underground cast-in-place concrete ductbanks for electrical power and signal system distribution. The term "signal" is used thorough this specification as a generic term to include communications, control, security and other low voltage systems. Included are the following topics:

**1.2. RELATED WORK**

- .1 Applicable provisions of Division 1 govern work under this Section
- .2 Section 26 05 44 – Manholes
- .3 Section 26 08 00 - Commissioning of Electrical
- .4 Section 01 91 01 or 01 91 02 – Commissioning Process

**1.3. SUBMITTALS**

- .1 Indicate material specifications, and provide product data on conduit, spacers, terminators, reinforcing steel and related components.

**2. Products**

**2.1. CONDUIT**

- .1 Size: 5" nominal for voltages above 600V, and 4" nominal for 600V or lower and communication system applications.
- .2 Material: Rigid polyvinyl chloride (PVC) marked at uniform intervals to indicate the kind of material; type Schedule 40 heavy wall, type EB-20 (TC-6), or type EB-35 (TC-8). Type EB conduit is rated for use only in concrete encased applications.

**2.2. ELBOWS**

- .1 Material to match conduit; minimum bend radius of 36 inches (915 mm).

**2.3. SPACERS**

- .1 Plastic, to maintain 3" minimum between conduits.

**2.4. CONDUIT TERMINATION IN MANHOLES AND BUILDINGS**

- .1 Bell Ends: Manufactured bell ends of appropriate sizes at each end of conduit. When entering a new building or a new manhole a pre-manufactured PVC bell end system (as manufactured by Formex or similar) with conduit seals, provisions for roughing into the concrete and water stops is allowed.
- .2 Seals: When entering an existing building or manhole below grade, the concrete shall be core drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly of modular rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.
- .3 Bushings: Steel grounding bushings shall be used on all metal conduits entering a building or manhole.

**2.5. PLUGS**

- .1 Expandable pipe plug, gas and water tight, for sealing empty conduit. Plug shall be high impact plastic with an outer rubber gasket expandable by hand tightening a wing nut on a central spindle.
- .2

**2.6. PULL TAPE**

- .1 Polyester pull tape, 1/2" width, tensile strength of 1,250 lbs. with sequential footage markings along the entire length of the tape as manufactured by Greenlee, Carlon, Garvin Industries, or Neptco (Muletape). Install pull tape in each empty conduit.

**2.7. GROUNDING**

- .1 Steel grounding bushings shall be grounded to manhole or junction box ground.

**2.8. DRAINAGE ASSEMBLY**

- .1 All ducts shall drain to an open end - preferably a manhole.

**2.9. CONCRETE ENCASEMENT**

- .1 Concrete used throughout shall be ready mixed concrete furnished by an approved mixing plant. The plant shall comply with the requirements of National Ready Mixed Concrete Association certification plan.
- .2 The concrete mix used with type Schedule 40 heavy wall conduit shall be 3000 psi minimum, 3/4" aggregate.
- .3 The concrete mix used with type EB-20 (TC-6), or type EB-35 (TC-8) thin wall conduit shall be 2500 psi minimum, 3/8" pea gravel aggregate.
- .4 The slump shall be just enough to allow the mix to flow to the bottom of the formation and yet not be so wet as to cause the ducts to float.
- .5 Encase duct with 3 in. minimum of concrete on top, bottom, and sides with top of duct bank troweled to a smooth crown to prevent pooling of water.

**2.10. REINFORCING STEEL**

- .1 Provide reinforcing steel the entire length of the duct system, four - #4 bars - one in each corner, minimum, or as shown on the drawings. Tie or dowel the reinforcement steel into the connecting walls of manholes, vaults and buildings, etc. to protect against vertical shearing.

**2.11. UNDERGROUND WARNING TAPE**

- .1 Detectable underground warning tape, 2" wide minimum, 5 mil thickness, containing a foil core as manufactured by Presco, Seton, or similar.
- .2 Tape color and labeling shall be as follows:
  - .1 Electrical Power Systems: Red color and labeled with the words "CAUTION-BURIED ELECTRIC LINE BELOW" or similar.
  - .2 Communication Systems: Orange color and labeled with the words "CAUTION-BURIED COMMUNICATION LINE BELOW" or similar.

**3. Execution**

**3.1. EXCAVATIONS**

- .1 Excavate trenches for ductbank to adequate width, depth, and proper slope as specified.
- .2 Install forms on sides of ductbank if trench is not of proper firmness to prevent cave-in.
- .3 The trench sidewall shall be less than 6 inches from the edge of the conduit being installed. Install forms if needed to limit the trench width.

- .4 Bottom of trench shall be undisturbed earth. If trench bottom is too low for proper grade, fill to proper level with sand and mechanically compact it.
- .5 Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

### **3.2. PLACEMENT OF CONDUIT**

- .1 Install flush bell ends on duct at manholes and buildings. When entering a new building or a new manhole, a pre-manufacture end bell system (by Formex or similar) with conduit seals is allowed.
- .2 When entering an existing building or manhole, core drill existing walls and waterproof using a mechanical seal of assembled rubber links properly sized for the pipe and tighten in place, in accordance with the manufacturer's instruction, after the new conduit is installed.
- .3 Install spacers as recommended by conduit manufacturer and requirements stated above, but not to exceed a maximum of 6 ft-0 in. on center for PVC conduit and 8 ft-0 in. on center for steel conduit. Bottom spacers shall rest on 8" X 16" X 2" concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 in. minimum horizontally.
- .4 Tie the conduit assembly down at regular intervals so it does float up in the concrete during the pour.
- .5 Pitch conduit properly for drainage to manhole and to prevent low pockets or irregular dips between conduit ends. Pitch conduit away from building and toward manhole. Minimum pitch to be 4 inches per 100 feet.
- .6 Install not more than one 90 degree bend or equivalent between manholes for primary conduit and two 90 degree bends or equivalent for signal conduit.
- .7 In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct.
- .8 Install insulated grounding bushings on steel duct ends.
- .9 Install closure plugs in all empty conduits at manhole and building entrances and at terminations in equipment pedestals to prevent the entrance of water, sediment and vapors.

### **3.3. PLACEMENT OF REINFORCING BARS**

- .1 At new building and manhole walls, tie duct bank and wall reinforcing steel together to provide a permanent connection.
- .2 At existing building and manhole walls, dowel reinforcement bar into the wall to provide protection against vertical shearing. Use epoxy adhesive to secure the dowels.
- .3 Install the bars - one in each corner, minimum or as shown on the drawings, overlap the joints 12" and tie into the connecting walls of manholes, vaults, and buildings, etc.

### **3.4. PLACEMENT OF CONCRETE**

- .1 After ducts are in place and before the concrete is poured, the installation shall be inspected by the DFD Construction Representative. Notify the Construction Representative at least two days before the time of inspection.
- .2 The Contractor shall supervise the placement of concrete in the ductbank.
- .3 Complete entire section of conduit from manhole to manhole or from manhole to building before encasement by concrete.
- .4 Top of concrete envelopes shall be not less than 24 inches below grade.

- .5 In placing concrete around the conduit, adjust delivery chute so the fall of the concrete into the trench is minimal.
- .6 Vibrating is not allowed as it tends to cause the conduit to float up in the concrete.
- .7 Provide minimum of 3" (76 mm) of concrete cover over conduit at the top, bottom and sides with top of duct bank troweled to a smooth crown to prevent pooling of water.
- .8 Place concrete continuously from manhole to manhole to building without interruption.
- .9 Extend concrete envelope to finish floor grade or interior wall surface in buildings and finish pad grade at equipment. Maintain moisture seal.

**3.5. BACKFILL**

- .1 Compact backfill around ductbank.
- .2 Install warning tape 12" below finish grade over all ductbanks. For ductbanks more than 24" wide, install multiple runs of warning tape no farther than 18" apart. The warning tape shall not be farther than 12" from the ductbank edge.

**3.6. RESTORATION**

- .1 After completion of ductbank installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, plantings, etc.

**3.7. ACCESSORY INSTALLATION**

- .1 Pull a mandrel/swab (diameter 1/4 in. smaller than conduit) through each conduit in completed ductbank to insure adequate opening of duct run.
- .2 Install pull tape with measurement markings in each empty duct.
- .3 Install closure plugs in all empty conduits at manhole and building entrances and at terminations in equipment pedestals to prevent the entrance of water, sediment and vapors.
- .4 Ground all steel bushings to manhole or junction box ground.

**3.8. CONSTRUCTION VERIFICATION**

- .1 Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

**END OF SECTION**



**1. General**

**1.1 RELATED REQUIREMENTS**

- .1 Electrical General Requirements Section 26 05 01

**1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS**

- .1 Conduit Section 26 05 33

**2. Products**

**2.1 COMPONENTS**

- .1 Conduit: Type Rigid PVC Duct, DB2 otherwise.
- .2 Concrete: 20 MPa with additive to give permanent red colour - 20 mm maximum aggregate size.
- .3 Markers: Markers shall be square with 25 mm letters.
- .4 Conductors: Refer to Section 26 05 19
- .5 Cable Lugs: Suitable for the application and use as required by the Canadian Electrical Code, approved by the electrical inspection authority and acceptable to the local supply authority.

**3. Execution**

**3.1 INSTALLATION**

- .1 Installation shall be on undisturbed soil or on well compacted granular fill, 150mm thick.
- .2 Install at minimum of 1 meter below finished grade.
- .3 Install rigid PVC conduit in configuration indicated. Spacers installed at maximum intervals of 1.5 meters.
- .4 Clean conduits before laying. Cap ends during construction and after installation to prevent entrance of foreign materials.
- .5 Route of conduit runs shall be marked with marking tape, Brady Identoline, laid in trench approximately 300mm below grade.
- .6 Check all conduits for clear bore before backfilling. Install fish wires in all conduits.
- .7 Coordinate routing and depth of all conduits with General Contractor.
- .8 Conduits shall be encased in concrete where run below parking or vehicle traffic areas.

**3.2 DUCT BANK INSTALLATION**

- .1 Provide reinforcing rods and band ties over entire length as detailed.
- .2 Ensure that concrete fills all voids around ducts.

- .3 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with minimum 75 mm thick concrete cover on all sides.
- .4 Slope ductbanks 150 mm per 30 m minimum to drainage point. Adjust final slopes on site to coordinate with existing utilities. Slope away from building.
- .5 Provide drain holes not less than 12 mm in diameter in each conduit and provide a fabricated 50 mm drain assembly with saddle cutouts for each conduit fitting over the drain line. Tape drain assembly to each conduit to prevent entrance of concrete. Band drain assembly with 12 mm stainless steel straps to conduit assembly to prevent mechanical displacement.
- .6 Install on undisturbed soil where possible. Backfill required to be compacted pit run gravel and sand, 200 mm lifts maximum.
- .7 Clean and swab all ducts. Install galvanized iron pullwires in spare ducts. Cap spare ducts.

### **3.3 SERVICE INSTALLATION**

- .1 General routing to follow that indicated on drawings.
- .2 Contractor to provide required trenching backfill etc. to install primary & secondary feeders, Telus, Cable TV and Supernet underground in coming conduits. Coordinate with Utility.

**END OF SECTION**

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**1. General**

**1.1 SUMMARY**

- .1 All electrical fittings, supports, hanger rods, pull boxes, channel frames, conduit racks, outlet boxes, brackets, clamps, etc. to have galvanized finish or enamel paint finish over corrosion-resistant primer.
- .2 All panelboards, distribution centres, motor control centres, transformers, etc. to be factory finished in alkyd high gloss enamel applied over corrosion-resistant primer. Matte or flat type finish paint not acceptable. Factory finished units that are scratched or marked during installation or shipping to be touched up with matching spray-on air dry lacquer or, if required to provide a satisfactory job, completely refinished.
- .3 All panelboards, distribution centres, transformers, motor control centres, low voltage cabinets, pull boxes and raceways to be colour coded as follows. The exact colour to be approved by the architect prior to manufacture.
- .4 All 120/208 volt equipment including pull boxes and raceways to be finished in grey.
- .5 Transformer enclosures to be finished in accordance with primary voltage colour as outlined above.
- .6 Low voltage switching terminal cabinets and pull boxes to be finished in black.
- .7 Telephone terminal panels and junction boxes to be finished in green.
- .8 Public address terminal panels and junction boxes to be finished in yellow.
- .9 Security terminal panels and junction boxes to be finished in orange.
- .10 R.F. television and satellite system pull boxes and junction boxes to be finished in ivory.

**1.2 NAMEPLATES**

- .1 Clearly identify all major electrical equipment including main distribution centres, sub-distribution panels, power panels, lighting panels, disconnect switches, starters, contactors, motor control centres, terminal cabinets and panels, pushbuttons and selector switches, etc. by permanent labels described below.
- .2 Provide nameplates of lamicoid plastic with black back showing 10 mm white letters mounted in conspicuous location on the surfaces of the equipment, except in finished areas locate nameplates in flush panels mounted on panel front inside enclosure.
- .3 Nameplates to be black/white/black giving white letters on black background for all normal power equipment. Nameplates to be red/white/red giving white letters on red background for all emergency power equipment.
- .4 All nameplates to include equipment name and designation number as shown on drawings, and voltage rating. All nametags to be attached to the outside of panel doors and equipment enclosures.

- .5 In terminal cabinets for control wiring, low voltage relays, intercommunication, telephone, clock, etc. Identify terminal strips, etc. utilizing 9.5 millimetre roll adhesive back embossed type nametags.
- .6 Transformers: identify as shown on drawings showing capacity and primary and secondary voltages.
- .7 Disconnect switches, starters and contactors indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 On/Off switches: indicate equipment being served.
- .10 Distribution centres: identify distribution centres as indicated on drawings and main voltage or voltages if more than one.
- .11 Motor control centres: identify as shown on drawings and show main voltage or voltages if more than one.
- .12 Surface raceway normal and emergency receptacles: identify panel and circuit number.
- .13 All receptacles: identify panel and circuit number. Special receptacles to be identified by architect. Confirm identification method with PCA Departmental Representative.
- .14 Receptacles and light switches: use Kroy label showing panel and circuit numbers.
- .15 Ceiling mounted junction boxes: use permanent marker showing panel and circuit numbers on junction boxes or on slab beside junction boxes.
- .16 Emergency lighting remote heads to be with lamacoid with battery pack designation on the base.
- .17 Battery packs to be labelled with lamacoid with battery pack designation.

### **1.3 CABLES**

- .1 Clearly label all ends of low voltage system cables to conform with EIA/TIA 606 standards. Use wire sleeves equal to Brady LS2000 series. The label shall not be handwritten and shall be affixed to the cable jacket.

**END OF SECTION**

**1. General**

**1.1. SCOPE**

- .1 The electrical contractor shall retain the services of an independent third party firm, or the equipment manufacturer's technical services group, to perform a short circuit/coordination study and arc flash risk assessment as described herein.
- .2 Preliminary studies shall be submitted to the A/E prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture to ensure the characteristics and ratings of the proposed overcurrent devices will be satisfactory. The final submittal shall capture any changes in circuit lengths, wire sizes, Additionalloads, etc. that may occur during the construction project.
- .3 The studies shall include all portions of the electrical distribution system from the normal power source or sources, and emergency/standby sources, down to and including the smallest circuit breaker in the distribution system (for short circuit calculations). Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study.
- .4 The firm should be currently involved in medium- and low-voltage power system evaluation. The study shall be performed, stamped and signed by a registered professional engineer in the State of Wisconsin. Credentials of the individual(s) performing the study and background of the firm shall be submitted to the A/E for approval prior to start of the work.
- .5 The firm performing the study should demonstrate capability and experience to provide assistance during start up as required.
- .6 The study and assessment shall be performed on SKM Dapper, Capter and PowerTool software or EasyPower product suite software.

**1.2. RELATED WORK**

- .1 Applicable provisions of Division 1 govern work under this section
- .2 Section 26 14 13 – Switchboards
- .3 Section 26 24 16 – Panelboards
- .4 Section 01 91 01 or 01 91 02 – Commissioning Process

**1.3. REFERENCE STANDARDS**

- .1 Standards listed in the IEEE "Buff Book", latest edition
- .2 National Fire Protection Association (NFPA) 70E, latest Facility
- .3 IEEE 1584 – Guide for Performing Arc Flash Calculations

**1.4. DATA COLLECTION FOR THE STUDY**

- .1 The contractor shall provide the required data for preparation of the studies. The engineer performing the system studies shall furnish the contractor with a listing of the required data immediately after award of the contract.
- .2 The contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to release of the equipment for manufacture.

**1.5. SUBMITTALS**

- .1 THIRD PARTY QUALIFICATIONS: Submit qualifications of individual(s) who will perform the work to the A/E for approval prior to commencement of the studies.
- .2 PRELIMINARY REPORT: Submit a draft of the studies to the A/E for review prior to delivery of the final study to the Owner. Make all Facility's or changes as required by the reviewer.
- .3 FINAL STUDY REPORT: Provide studies in conjunction with equipment submittals to verify equipment ratings required.
- .4 The results of the power system studies shall be summarized in a final report and provided in the following formats. Provide (2) bound hard copies of the final report. Provide (2) electronic copies (on CD) of the final report and one-line diagrams in PDF format. Provide (2) electronic copies (on CD) of the final report in MS Word format and the one-line diagrams in CAD format.
- .5 Also provide (2) electronic copies (on CD) of all files generated by the SKM or EasyPower software for all scenarios evaluated in the studies. The files shall permit the studies to be opened, reviewed or updated by any user of the analysis software used for the studies.
- .6 The report shall typically include the following sections:
  - I. Overview
  - II. Short Circuit Study
    - SC-1 Purpose
    - SC-2 Explanation of Data
    - SC-3 Assumptions
    - SC-4 Analysis of Results
    - SC-5 Recommendations
    - SC-6 Fault Analysis Input Report from Software Program
    - SC-7 Fault Contribution Report
  - III. Protective Device Coordination Study
    - PDC-1 Purpose
    - PDC-2 Explanation of Data
    - PDC-3 Assumptions
    - PDC-4 Analysis of Results
    - PDC-5 Recommendations (Including NEC 700-27 Requirement)
    - PDC-6 Results from Software Program
    - PDC-7 Example Drawings
  - IV. Arc Flash Study
    - ARC-1 Purpose
    - ARC-2 Explanation of Data
    - ARC-3 Assumptions
    - ARC-4 Analysis of Results
    - ARC-5 Recommendations
    - ARC-6 Arc Flash Evaluation Report from Software Program
  - V. Prioritized Recommendations and Conclusions
  - VI. Appendices
    - APP-1 One-line Diagrams from Software Program
    - APP-2 AutoCAD One-line Diagrams
    - APP-3 Protective Device Summaries from Software Program
    - APP-4 Reference Data
    - APP-5 Sample Work Permit Form
    - APP-6 Copy of Warning Labels, including study date
- .7 The above sections shall include the following items in detail:
  - Obtain available fault current from the local utility company.
  - Short circuit studies shall evaluate the available fault current at each bus (each change of impedance), including all three-phase motors.

- Coordination study recommendations for relay settings, breaker settings, and motor protection settings.
- Recommendations for improving the coordination and/or load distribution, as well as ground fault requirements.
- Worst case Arc Flash values (highest incident energy) for project specific scenarios (low short circuit and high short circuit for each possible power supply source).
- Arc flash values for two maintenance cases, which define the arc flash values available at the equipment that would be available if the instantaneous trip of the upstream circuit breaker is set at a minimum value. This is recommended if someone has to work on live equipment.
- IEEE standard one-line diagram with equipment evaluation and circuit breaker settings that clearly define the system data and are easy to interpret. The diagrams should include the bus names and references used in the studies.
- Recommendations to reduce the arc flash incident energy in all areas that are subject to 8 calories per square centimeter or greater of available incident energy.
- Condition of Maintenance information for any existing equipment included in the study.
- Prioritized report summarizing all recommendations from this study. This shall include observed NEC code violations and their corrective action.
- The contractor shall provide a one-line diagram that meets IEEE/ANSI standard 141, mounted on 24" x 36" (minimum) Styrofoam backboard. This one-line diagram shall be mounted in each electrical room.

## **2. Products**

### **2.1. Not used.**

## **3. Execution**

### **3.1. SHORT CIRCUIT AND COORDINATION STUDY**

- .1 The short circuit, coordination, and arc flash hazard studies shall be performed using SKM Dapper, Captor and PowerTool for Windows software or EasyPower product suite Windows based software packages. In the short circuit study, provide calculation methods and assumptions, the base per unit quantities selected, one-line diagrams, source impedance data including power company system characteristics, typical calculations, and recommendations. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed 3-phase bolted fault at each supply switchgear lineup, unit substation primary and secondary terminals, low voltage switchgear lineup, switchboard, motor control center, distribution panelboard, pertinent branch circuit panelboard, and other significant locations throughout the system. Provide a ground fault current study for the same system areas, including the associated zero sequence impedance data. Include in tabulations fault impedance, X to R ratios, asymmetry factors, motor contribution, short circuit KVA, and symmetrical and asymmetrical fault currents.
- .2 In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, centered on conventional, full-size, log-log forms. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.

- .3 Include on the curve sheets power company relay and fuse characteristics, system medium-voltage equipment relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent transformer characteristics, pertinent motor and generator characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center, and main breaker in branch panelboards.
- .4 Include all adjustable settings for ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. Show transformer full load and 150, 400, or 600 percent currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and significant symmetrical and asymmetrical fault currents. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.
- .5 Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium-voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.
- .6 Include complete fault calculations as specified herein for each proposed and ultimate source combination. Note that source combinations may include present and future supply circuits, large motors, or generators as noted on drawing one-lines.
- .7 Utilize equipment load data for the study obtained by the Contractor from contract documents, including contract addendums issued prior to bid openings.
- .8 Include fault contribution of all motors in the study. Notify the Engineer in writing of circuit protective devices not properly rated for fault conditions.
- .9 Provide settings for the chiller motor starters or obtain from the mechanical contractor, include in the study package, and comment.
- .10 When an emergency generator is provided, include phase and ground coordination of the generator protective devices, to meet NEC 700.27 requirements. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices. Obtain the information from the generator manufacturer and include the generator actual impedance value, time constants and current boost data in the study. Do not use typical values for the generator.
- .11 Evaluate proper operation of the ground relays in 4-wire distributions with more than one main service circuit breaker, or when generators are provided, and discuss the neutral grounds and ground fault current flows during a neutral to ground fault.
- .12 For motor control circuits, show the MCC full-load current plus symmetrical and asymmetrical of the largest motor starting current to ensure protective devices will not trip major or group operation.

### 3.2.

#### FIELD SETTINGS

- .1 The Contractor shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study, protective device coordination study and arc flash risk



assessment.

- .2 Necessary field settings and adjustments of devices and minor modifications to equipment to accomplish conformance with the approved short circuit and protective device coordination study shall be carried out by the Contractor at no additional cost to the owner.

### **3.3. ARC FLASH RISK ASSESSMENT**

- .1 As part of the short circuit and coordination study, arc flash risk assessment shall be included. The study shall include the following:
  - .1 Determine and document all possible utility and generator/emergency sources that are capable of being connected to each piece of electrical gear. Calculations shall be based on highest possible source connection.
  - .2 Calculations to conform to National Fire Protection Association (NFPA) 70E recognized means of calculation standards. All incident energy units shall be calculated in calories per square centimeter.
  - .3 Provide recommended boundary zones and personal protective equipment (PPE) based on the calculated incident energy and requirements of NFPA 70E for each piece of electrical gear.
  - .4 Electrical Contractor shall provide warning labels as required by OSHA based upon the results of the arc flash risk assessment. At a minimum, the labeling shall contain the following information: nominal system voltage, arc flash boundary, limited approach boundary, restricted approach boundary, available incident energy and the corresponding working distance or the arc flash PPE category, minimum arc rating of clothing, and study date. Label shall also include the name or logo and the phone number of the company performing the study.
  - .5 Arc flash warning labels shall be affixed to all electrical equipment that is likely to require examination, adjustment, servicing or maintenance while energized. This includes, but is not limited to, medium-voltage switchgear, transformers, switchboards, panel boards, three-phase disconnect switches, transfer switches, motor control centers, motor controllers, and three-phase motor disconnect switches.

**END OF SECTION**

**1. General**

**1.1 RELATED WORK**

- |    |                                     |                  |
|----|-------------------------------------|------------------|
| .1 | Motor Starters                      | Section 26 24 19 |
| .2 | Connections to Mechanical Equipment | Section 25 30 01 |

**2. Products**

**2.1 NAMEPLATES**

- .1 Lamacoid, white with black lettering except for equipment connected to the emergency supply for which orange nameplates with black letters are to be used.

**3. Execution**

**3.1 IDENTIFICATION**

- .1 Label every motor to show the motor number, the motor name and power source.  
Example:

"MOTOR #3-51, EMERGENCY EXHAUST, CCT. EAA2-4"

Label every starter to show motor it controls. Coordinate with all Divisions, equipment names and numbers to be identical.

**3.2 NAMEPLATES**

- .1 Permanently fasten the nameplates to the equipment, so as to be clearly visible.

**3.3 MOTOR SURVEY AND CONTROL WIRING DIAGRAMS**

- .1 Make a complete survey of all electric motors. For every motor and starter, fill in the Motor Survey sheets illustrated herein. List each motor on a separate page. Attach a control wiring diagram neatly drawing in ladder form for each motor. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the Operating/Maintenance Manuals. Include motor overload selection charts for each type and application of overload relay.
- .2 Instruments used shall be digital with an accuracy of  $\pm 2\%$ .

**END OF SECTION**

**1. General**

**1.1 INTENT**

- .1 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.
- .2 Submit system sign off sheets for each system listed after substantial completion.
- .3 Complete a motor survey sheet for each motor and submit after substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.
- .4 All sign off and survey sheets shall be typewritten.

**1.2 MANUFACTURER'S SITE SERVICES**

- .1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

**1.3 CONTRACTOR/OWNER COORDINATION**

- .1 Owner will chair demonstration and instruction sessions.
- .2 Establish agendas for demonstration, commissioning and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner and PCA Departmental Representative.

**2. Products**

- .1 NotApplicable

**3. Execution**

**3.1 SYSTEMS DEMONSTRATION**

- .1 Demonstrate operation of following systems:
  - .1 120/208 and 347/600 Volt System Emergency and Normal
  - .2 Pump Protection Panels
  - .3 Mechanical Equipment Connections and Controls
  - .4 Grounding System
  - .5 Intercom System
  - .6 Lighting
  - .7 Lighting Controls
  - .8 Future Connection Points and Conduit Stubs

---

**MOTOR SURVEY SHEET**

Motor Name & Number \_\_\_\_\_

Manufacturer \_\_\_\_\_

H.P. \_\_\_\_\_ Max. Ambient \_\_\_\_\_ °C

R.P.M. \_\_\_\_\_ Service Factor \_\_\_\_\_

Volts \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ Insulation Class \_\_\_\_\_

AMPS \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ EEMAC Design \_\_\_\_\_

PHASE \_\_\_\_\_ Time Rating \_\_\_\_\_

Frame \_\_\_\_\_ Type \_\_\_\_\_

Serial # \_\_\_\_\_

Model # \_\_\_\_\_

Starter \_\_\_\_\_ Type \_\_\_\_\_

Full Load Operating Amps \_\_\_\_\_ A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_

Capacitor Operating Amps \_\_\_\_\_ A \_\_\_\_\_ B \_\_\_\_\_ C \_\_\_\_\_

Full Load Operating Voltage \_\_\_\_\_ A-B \_\_\_\_\_ B-C \_\_\_\_\_ C-A \_\_\_\_\_

at Motor

Power Factor \_\_\_\_\_

Overload Relay Installed \_\_\_\_\_ Adjustable Setting \_\_\_\_\_ %

M.C.P. AMPS \_\_\_\_\_ Adjustable Setting \_\_\_\_\_

Acceleration Time (If over 7 seconds) \_\_\_\_\_

Reduced Voltage Starter Transition Time Setting \_\_\_\_\_

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.)

---

**SYSTEM COMPLETION AND COMMISSIONING**

**SYSTEM:** \_\_\_\_\_

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

**Electrical Contractor**

Signed by: \_\_\_\_\_ Dated: \_\_\_\_\_

**General Contractor**

Signed by: \_\_\_\_\_ Dated: \_\_\_\_\_

Deficiencies Attached

This system has been reviewed by:

**The Owner**

Signed by: \_\_\_\_\_ Dated \_\_\_\_\_

The Owner's personnel have been instructed in the operation and maintenance of the above system:

**The Owner**

Signed by: \_\_\_\_\_ Dated \_\_\_\_\_

The above does not constitute a waiver of any of the requirements of the Contract Documents.

ELECTRICAL  
CONTRACTOR

GENERAL  
CONTRACTOR

Address: \_\_\_\_\_

Phone: \_\_\_\_\_

**END OF SECTION**

**1. General**

**1.1 RELATED WORK**

- |    |                      |                  |
|----|----------------------|------------------|
| .1 | Motor Starters       | Section 26 24 19 |
| .2 | Motor Identification | Section 25 05 82 |
| .3 | Mechanical           | Section 23 00 00 |

**1.2 REQUIREMENTS**

- .1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.
- .2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.
- .3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.
- .4 Unless specifically noted otherwise, provide all line voltage equipment such as, but not limited to, pushbuttons, relays, thermal overload protection, starters, conduit and wire, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.
- .5 Do not operate motors and controls until approval is obtained from the trade providing equipment.
- .6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.
- .7 Assist in placing in operation all mechanical equipment having electrical connections.
- .8 Provide three phase starters with fused 120 volt control transformers and overload relays.
- .9 Provide all power wiring for all motors and control wiring as indicated on the drawings.
- .10 In general, wiring for freeze stats, fire stats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCC's for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.
- .11 Refer to Motor Control Equipment Schedule.

.12 Some specific definitions of equipment wiring responsibilities are as follows:

.1 Fans

.1 Provide all 120V and 208V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 23.

.2 Pumps for Domestic Water, Plumbing & Drainage Systems

.1 Provide all 208V and 120V wiring as shown on drawings. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under division 23.

.3 Unit Heaters

.1 Provide power wiring and starter for unit heater fans. Install and wire line voltage thermostats supplied by others. Where thermostats are low voltage or pneumatic, control wiring is under Division 23.

.4 Forced Flow Convectors

.1 Provide 120V power supply to the convectors. Starters, speed controllers and temperature controllers will be supplied and wired by Division 23.

**2. Products**

**2.1 3 PHASE MOTOR DISCONNECT SWITCHES**

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

**2.2 120 VOLT, 1 PHASE DISCONNECT SWITCHED**

.1 Manual starter without overload relay.

**2.3 600 VOLT, 1 PHASE MOTOR DISCONNECT SWITCHES**

.1 Manual starter without overload relay.

**3. Execution**

**3.1 INSTALLATION**

.1 Provide disconnect switches adjacent to all motors.

- .2 Provide all wiring between all force flow and unit heaters and their line voltage thermostats. Install wiring between all flow switches and valve monitors.
- .3 Do control wiring as indicated on the drawings and the motor control schedules.
- .4 Connection to motors and ancillary control equipment shall utilize liquid tight flexible metal conduit with adequately sized bonding conductor.
- .5 Division 26 shall wire up all controls where controls switch power lines directly, such as a line voltage thermostat.
- .6 Check phase rotation before energizing.
- .7 Connect up all motorized dampers and backdraft dampers as indicated on mechanical drawings or specified in mechanical specifications.
- .8 Provide relay / contactors as required, operated by built-in motor thermal protection devices (thermistors), for motors incorporating this type of overload protection.
- .9 Provide disconnects for boiler modules (one disconnect per module), and wire up low water cutoffs. Confirm horsepower of boiler burners with mechanical contractor.
- .10 Provide control power supply outlets and data outlets as required by Honeywell for operation of control panels and similar equipment. Allow for a separate circuit for each control panel unless otherwise indicated. Coordinate with Honeywell.
- .11 Provide power to sump pumps and associated control panel. Installation to meet requirements of CEC Section 22 and Inspection Authority.
- .12 Provide 120V connection to infrared sink, urinals & toilets controls. Provide and install GFCI receptacles for multi-station Bradley lavatories in the student washrooms.
- .13 Provide 120V, 15A, single phase circuit to each refrigerated drinking fountain. Coordinate exact location, and whether hard-wired or plug-in, with mechanical contractor.
- .14 Provide a 120V, 15A, single phase circuit for the interior lights on main ventilation unit.
- .15 Provide a 120V, 15A, single phase circuit to each flammable storage cabinet for power vent. Coordinate on site regarding exact location of cabinets and vent fan.
- .16 Provide single connection to dust collector control panel. From control panel wire up dust collector motor and shaker motor individually as per dust collector shop drawings. Interlock to the makeup air unit supply air into the CTS room. Control panel comes complete with necessary starters and control transformers.
- .17 Provide an empty conduit stub from every thermostat and sensor location shown on mechanical drawings, up to ceiling space. Coordinate with Honeywell.
- .18 Coordinate requirements for the foregoing with the mechanical trade.
- .19 Provide a 120V, 15A, single phase circuit to each Kiln Venting system.
- .20 Provide single phase circuit for internal lights on ventilation units.

### **3.2 VARIABLE FREQUENCY DRIVES**

- .1 Loose variable frequency drives (VFDs) will be supplied by Div. 23, to control mechanical equipment requiring speed control. Electrical Contractor shall install VFDs, including all necessary line voltage wiring connections.
- .2 Packed VFDs on pumps will be supplied by the pump supplier.
- .3 VFDs are to be mounted as close the motor as possible.
- .4 Identify mounting requirements and include all materials and labour, including unistrut frames and plywood backboards, as per of this tender, as required to support VFDs if wall space is inadequate. Plywood used on unistrut frames to be minimum 19 mm thick, painted both sides with fire retardant intumescent paint.



- .5 Electrical Contractor should allow for line and load side connections to each VFD, as well as the supply and installation of a disconnect for each motor.

### **3.3            MOTORIZED ROLLER SHADES**

- .1 Motorized roller shades are to be installed complete with controls and limit switches by Section 12 24 13. Run power to a junction box adjacent to each shade and connect up complete with recessed conduit. Install and connect up remote rocker switches. Each shade requires a 120V, 15A, single phase circuit.

### **3.4            Not used**

- .1

### **3.5            BARRIER FREE DOOR OPERATORS.**

- .1 Provide power and control rough in and wiring for motorized doors for barrier free doors.
- .2 Barrier Free door push buttons shall be cabled with 2 pair 22 AWG – Decacom 40-101 (solid wire) or approved equivalent and the exterior door push button station shall be cabled with 2 pair 18 AWG – Decacom 74-316 (solid wire) or approved equivalent.
- .3 Provide a 120V, 15A, single phase circuit to each barrier free door operator motor. Refer to door hardware schedule in Section 08 70 00 and schematics on drawings for more information. See architectural door schedule for quantity and door type.
- .4 Final connections of Barrier Free Door. Push buttons by Barrier Free door supplier. Coordinate with Barrier Free Door Supplier.

**END OF SECTION**

## **1. General**

### **1.1 SUMMARY**

- .1 Section includes:
  - .1 General specification for the relay lighting control system
  - .2 The Electrical Contractors, as part of the work of this section, shall coordinate, receive, mount, connect and place into operation all equipment. The electrical contractor shall furnish all conduit, wire, connectors, hardware and other incidental items necessary for the complete and properly functioning relay lighting control system as described herein and shown on the plans.
- .2 Related sections:
  - .1 Section [262726 - Wiring Devices]
  - .2 Section [260923 – Lighting Control Devices:] Occupancy sensors used in conjunction with the lighting control system.
  - .3 Section [260943.13 – Digital-Network Lighting Controls:] Lighting control panels

### **1.2 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE)
  - .1 C62.41-1991 – Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
- .2 ASTM International (ASTM)
  - .1 D4674 -02a Standard Test Method for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Fluorescent Lighting and Window-Filtered Daylight
- .3 Canadian Standards Association (CSA) .
  - .1 CSA C22.2 # 14 Industrial Control Equipment
  - .2 CSA C22.2 # 184 Solid-State Lighting Controls
  - .3 CSA C22.2 # 156 Solid-State Speed Controls
- .4 European Commission (CE) - Harmonized European Standard.
  - .1 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .5 International Electrotechnical Commission .
  - .1 (IEC) 801-2 Electrostatic Discharge Testing Standard.
  - .2 IEC/EN 60669-2-1 Switches for household and similar fixed electrical installations - electronic switches.
- .6 International Organization for Standardization (ISO)
  - .1 9001:2000 – Quality Management Systems.
- .7 National Electrical Manufacturers Association (NEMA)
  - .1 WD1 (R2005) - General Color Requirements for Wiring Devices.
- .8 Norma Oficial Mexicana (NOM).

- .1 NOM-003-SCFI Productos eléctricos - Especificaciones de seguridad (Electrical products - Safety Specifications)
- .9 Underwriters Laboratories, Inc. (UL):
  - .1 489 (2002) - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
  - .2 508 (1999) - Standard for Industrial Control Equipment.
  - .3 924 (2003) - Emergency Lighting and Power Equipment

### **1.3 SYSTEM DESCRIPTION**

- .1 Lighting Control System
  - .1 Factory assembled switching panels. [and] [interfaces and modules]
  - .2 Low voltage [wall stations] [and] [control interfaces] [and] [sensors].

### **1.4 SUBMITTALS**

- .1 Submit under provisions of Section [013300.]
- .2 Specification Conformance Document: Indicate whether the submitted equipment either:
  - .1 Meets specification exactly as stated.
  - .2 Meets specification via an alternate means and indicate the specific methodology used.
- .3 Shop Drawings; include:
  - .1 Load schedule indicating actual connected load, load type, and voltage per circuit, circuits and their respective control zones, circuits that are on emergency, and capacity, phase, and corresponding circuit numbers.
  - .2 Schematic of system.
- .4 Product Data: Catalog cut sheets with performance specifications demonstrating compliance with specified requirements.

### **1.5 QUALITY ASSURANCE**

- .1 Energy Management Lighting Control System:
  - .1 Listed by [CE] [CSA] [UL] specifically for the required loads. Provide evidence of compliance upon request.

### **1.6 PROJECT CONDITIONS**

- .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.

- .3 Lighting control system must be protected from dust during installation.

## **1.7 WARRANTY**

- .1 Provide manufacturer's 3 year parts warranty and a limited 10-year warranty shall be provided on all relay cards. These shall be standard warranties and will be in affect for all installations from the date of invoice.

## **1.8 MAINTENANCE**

- .1 Make ordering of new equipment for expansions, replacements and spare parts available to end user.
- .2 Make new replacement parts available for minimum of ten (10) years from date of manufacture.
- .3 Provide toll free factory direct technical support hotline.
- .4 Provide on-site service support for troubleshooting within 24 hours anywhere in continental United States.
- .5 Offer renewable service contract on yearly basis, to include parts, factory labor and annual training visits. Make service contracts available up to ten (10) years after date of system commissioning.

## **2. Products**

### **2.1 MANUFACTURERS**

- .1 Acceptable Manufacturer: Eaton Lighting Systems (Formerly Cooper Controls) – Systems: ControlKeeper
- .2 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers:
  - .1 ControlKeeper Metering [CKM]
  - .2 ControlKeeper Metering with Breakers [CKMB]
  - .3 ControlKeeper TouchScreen [CKT]
  - .4 ControlKeeper 4A [CK4A]
  - .5 ControlKeeper 4 [CK4]
  - .6 ControlKeeper 2 [CK2]
- .3 Substitutions: [Not permitted.] [Under provisions of Division 012500.]
- .4 All proposed substitutions (clearly delineated as such) must be submitted in writing for approval by the design professional a minimum of 10 working days prior to the bid date and must be made available to all bidders. Proposed substitutes must be accompanied by a review of the specification noting compliance on a line-by-line basis.
- .5 Any substitutions provided by the contractor shall be reviewed at the contractor's expense by the PCA Departmental Representative at a rate of [\$200.00] per hour.

- .6 By using pre-approved substitutions, the contractor accepts responsibility and associated costs for all required modifications to circuitry, devices and wiring. The contractor shall provide complete engineered shop drawings (including power wiring) with deviations for the original design highlighted in an alternate color to the engineer for review and approval prior to rough-in.

## **2.2 GENERAL**

- .1 Provide hardware that is designed, tested, manufactured and warranted by a single manufacturer.
- .2 Lighting Controls: Ten-year operational life while operating continually at any temperature in an ambient temperature range of 0° C (32°F) to 40° C (104°F) and 90 percent non-condensing relative humidity.
- .3 Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment per IEC 801-2.

## **2.3 PANEL / RELAY PERFORMANCE REQUIREMENTS**

- .1 Electrolytic capacitors to operate at least 20° C below the component manufacturer's maximum temperature rating when device is under fully-loaded conditions in 40° C (104° F) ambient temperature.
- .2 Capable of withstanding repetitive inrush current of 50 times operating current without impacting lifetime of dimmer/relay.
- .3 Design and test relays to withstand line-side surges without impairment to performance.
  - .1 Panels: Withstand surges without impairment of performance when subjected to surges of 6,000 volts, 3,000 amps per ANSI/IEEE C62.41B.
- .4 Utilize air gap off, activated when user selects "off" at any control to disconnect the load from line supply.
- .5 Possess power failure memory such that if power is interrupted and subsequently returned, lights will automatically return to same levels (on or off) prior to power interruption within 3 seconds.
- .6 Non-dim circuits to meet the following requirements:
  - .1 Rated life of relay: Minimum 1,000,000 cycles.
  - .2 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
  - .3 Fully rated output continuous duty for inductive, capacitive and resistive loads.
- .7 Capable of controlling receptacle or plug loads with Latching Relay Option.
- .8 Power Metering Relay Cards to be used with the ControlKeeper Metering lighting panels CKMB.
  - .1 Individually Replaceable
  - .2 Minimum UL listed Short Circuit Current Rating (SCCR) of 65,000A.
  - .3 Rated life of relay: Minimum 1,000,000 cycles.

- .4 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
  - .5 Fully rated output continuous duty for inductive, capacitive and resistive loads.
  - .6 Capable of controlling receptacle or plug loads. PM-LRC
  - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: PM-SRC, PM-TPRC, PM-LRC
- .9 Serial Latching Relay Card to be used with the ControlKeeper lighting panels CKT, CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
  - .2 Four 20amp relays at 120/277/347VAC
  - .3 Manual Override per relay
  - .4 Accepts up to 6 AWG wire
  - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
  - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
  - .7 Capable of controlling receptacle or plug loads.
  - .8 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sLRC
- .10 Serial Standard Relay Card to be used with the ControlKeeper lighting panels CKT, CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
  - .2 Four 20amp relays at 120/277VAC
  - .3 Manual Override per relay
  - .4 Accepts up to 10 AWG wire
  - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
  - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
  - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sSRC-NO
- .11 Serial Two Pole Relay Card to be used with the ControlKeeper lighting panels CKT,CK4A.
- .1 Rated life of relay: Minimum 1,000,000 cycles.
  - .2 Two 20amp relays at 208/240/480VAC (two pole)
  - .3 Manual Override per relay
  - .4 Accepts up to 6 AWG wire
  - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
  - .6 Fully rated output continuous duty for inductive, capacitive, and resistive loads.
  - .7 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers: sTPRC-NO

## **2.4 POWER PANELS**

- .1 Product: Eaton Lighting Systems (Formerly Cooper Controls) ControlKeeper Relay Panel with Breakers CKMB
- .2 Mechanical:
  - .1 Listed to ULC listed as industrial control equipment.
  - .2 Delivered and installed as a CSA listed factory assembled panel.

- 
- .3 Field wiring accessible from front of panel without need to remove relay assemblies or other components.
  - .4 Panels passively cooled via free-convection, unaided by fans or other means.
  - .5 All panels include individual relay override and status LED as well as a Master Override switch. This allows the relays to be individually controlled without using the circuit breaker.
  - .6 [Surface mounted].
  - .3 Electrical:
    - .1 Panels contain branch circuit protection for each circuit unless the panel is a dedicated feed-through type panel or otherwise indicated on the drawings.
    - .2 Branch circuit breakers; meet following performance requirements:
      - .1 Listed to UL 489 as molded case circuit breaker for use on lighting circuits.
      - .2 Contain visual trip indicator; rated at up to 25,000 AIC.
      - .3 Thermal-magnetic construction for overload, short circuit and over-temperature protection. Use of breakers without thermal protection requires dimmers/relays to have integral thermal protection to prevent failures when overloaded or ambient temperature is above rating of panel.
      - .4 Accept tag-out/lock-out devices to secure circuit breakers in off position when servicing loads.
      - .5 Replaceable without moving or replacing relay assemblies or other components in panel.
      - .6 UL listed as switch duty (SWD) so that loads can be switched on and off by breakers.
    - .3 Minimum UL listed Short Circuit Current Rating (SCCR) of 65,000A.
    - .4 Rated life of relay: Minimum 1,000,000 cycles.
    - .5 Load switched in manner that prevents arcing at mechanical contacts when power is applied to load circuits.
    - .6 Fully rated output continuous duty for inductive, capacitive and resistive loads.
  - .4 TouchScreen Panel Processor
    - .1 Language selection: English
    - .2 Integral contact closure inputs.
    - .3 Integral 0-10V analog inputs
    - .4 Integral digital switch port
    - .5 Integral Serial Communication Port
    - .6 Integral USB Communication Port
    - .7 Integral Ethernet Communication Port
    - .8 Programming and system operation:
      - .1 Digital Switches, Network Commands and contact closure inputs
        - .1 Assign functionality of each input
          - .1 Select Relays or Groups of Relays
          - .2 Independent On/Off command functions (On/ Off/ No Command)
          - .3 Independent priorities per command (up to sixteen priority levels)
          - .4 Sixteen Mask features per panel
            - .1 Masking features include No On, No Off, Ignore, Reevaluate, No Timer based on time schedules and day of week programming.

- .5 Up to 999 minute timer
      - .6 Ability to issue and cancel Warn Off events
    - .2 Serial interface or Ethernet interface
      - .1 Communications protocol provided at no charge
      - .2 Any lighting panel can be monitored, programmed or controlled from any RS-232 or Ethernet connection
    - .3 Network Commands
      - .1 Any input can be programmed to broadcast its state or reading to the lighting control network
      - .2 Any input can be programmed as a Network Listener to receive state or reading from a broadcasted input.
    - .4 Contact closure output: Momentary, Maintained, Toggle
      - .1 Select Relays or Groups of Relays
      - .2 Independent On/Off command functions (On/ Off/ No Command)
      - .3 Independent priorities per command (up to sixteen priority levels)
      - .4 Sixteen Mask features per panel
        - .1 Masking features include No On, No Off, Ignore, Reevaluate, No Timer based on time schedules and day of week programming.
      - .5 Up to 999 minute timer
      - .6 Ability to issue and cancel Warn Off events
  - .2 Time clock
    - .1 Integral astronomical time clock
      - .1 Geographic location (city or latitude/longitude).
      - .2 Adjustable astronomic Offset (+) or (-)
      - .3 Adjustable date and time format.
      - .4 Adjustable starting and ending of daylight savings time.
      - .5 Selectable day of week time event programming
      - .6 Select Relays or Groups of Relays
      - .7 Independent On/Off command functions (On/ Off/ No Command)
      - .8 Independent priorities per command (up to sixteen priority levels)
      - .9 Review and modify time clock schedule to add, copy, modify and delete events.
- .5 Diagnostics and Service:
  - .1 Replacing relay does not require re-programming of system or processor.
  - .2 Relays: Include diagnostic LED's to verify proper operation and assist in system troubleshooting.
  - .3 Relay panels: Include tiered control scheme for dealing with component failure that minimizes loss of control for occupant.
    - .1 Failures on the lighting control system network are localized to the failed product. All other lighting control panels continue to fully function without Additionalaction. Systems that have a single point of failure on the network shall not be acceptable.
  - .4 If lighting control system fails, lights to remain at current level. Individual relay overrides provides local control of lights until system is repaired. Each lighting



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control panel include a master override to override the entire lighting panel.

- .6 Real Time Energy Meter per circuit
  - .1 Real Time Energy Metering data shall be supported via integral power metering circuitry on certain ControlKeeper Lighting Panels. [CKM], [CMKB]
    - .1 Electrical device to provide real time power metering of voltage and current shall be provided with each relay.
    - .2 Metered data can be polled via public command string from the on board Ethernet input.
    - .3 Metered data shall be reported based on actual connected relay load.

## **2.5 LOW VOLTAGE WALL STATIONS**

- .1 Product: Greengate Digital Switch white.
- .2 Electronics:
  - 1. Use Eaton Lighting Systems (Formerly Cooper Controls) LCCP or LCCNP wire for low voltage communication wiring for the Greengate Digital Switch.
  - 2. Use 18 AWG wire for low voltage dry contact switches. Number of conducts is based on type of switch.
- .3 Functionality:
  - .1 Upon button press, LEDs to immediately illuminate.
  - .2 LEDs to reflect the true system status. LED state is programmable to reflect either relay state or button push state.
  - .3 Allow for easy reprogramming without replacing unit.
  - .4 Replacement of units does not require reprogramming.
- .4 Provide faceplates with Low Voltage Wall Stations
- .5 Engrave wall stations with appropriate button, zone and scene engraving descriptions furnished prior to fabrication.

## **2.6 LOW VOLTAGE CONTROL INTERFACES**

- .1 Contact Closure
  - .1 Integral contact closures to accept both momentary and maintained contact closures.
  - .2 Systems that do not include integral contact closures shall not be acceptable.
- .2 Serial Interface
  - .1 Provide ability to communicate by means of serial communication by means of user-supplied PC or digital audiovisual equipment. Control to be located within 50 feet (15 meters) of source.
  - .2 Communications protocol to provide access to:
    - .1 Individual Relay Commands
    - .2 Individual Relay Status
    - .3 Input Status
    - .4 Network Override Commands
  - .3 Provide full programming, monitoring and override control using Keeper Enterprise Programming software.

- .3 Ethernet Interfaces; Eaton Lighting Systems (Formerly Cooper Controls) Model Ethernet Interface Module
  - .1 Provide ability to communicate by means of TCP/IP over Ethernet to ControlKeeper lighting control system by means of user-supplied PC or digital audiovisual equipment. Control to be located within 300 feet (100 meters) of Ethernet source.
  - .2 Communications protocol to provide access to:
    - .1 Individual Relay Commands
    - .2 Individual Relay Status
    - .3 Input Status
    - .4 Network Override Commands
  - .3 (Optional) Provide full programming, monitoring and override control using Keeper Enterprise Programming software.
  - .4 (Optional) The lighting zones may be controlled through a graphical representation software package called VisionTouch®. The software permits up to 255 floors or site plans to be illustrated for intuitive control. The software provides real-time feedback to the operator of network control overrides and relay status.
  - .5 (Optional) The lighting zones may be controlled through a graphical representation of four switches on multiple PC's that are connected to the building LAN. This software package for lighting control overrides is called VisionSwitch®. The software permits unlimited users connected to the building LAN to control their lighting zones. The software provides immediate feedback to the operator/user of network control overrides.
  - .6 (Optional) The lighting zones may be controlled using standard calendar based scheduling software. Create events which include individual and groups of relays and link them to any time and day on the calendar. This software package for lighting control event scheduling is called Event Manager. This software requires a SQL Server for operation connected to the lighting control system via the Ethernet Interface Module.
- .4 BACnet Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model AIM B NW:
  - .1 The ControlKeeper® network shall permit data protocol translation through a building automation interface Gateway. The BACnet Gateway shall permit BACnet communication protocol to operate individual relays, relay groups and read the status of those relays. The ControlKeeper® network shall respond efficiently to the requested information from the BACnet network.
  - .2 Provide PIC list definition and object model to other system manufacturers.
- .5 LonWorks Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model AIM L NW:
  - .1 Provide ability to communicate by means of LonWorks FTT-10 communication to centralized lighting system from user-supplied LonWorks FTT-10 twisted pair network.
  - .2 The ControlKeeper® network shall permit data protocol translation through a building automation interface Gateway. The LON Gateway shall permit LonWorks communication protocol to operate individual relays, relay groups and read the status of those relays. The ControlKeeper® network shall respond efficiently to the requested information from the LonWorks network.
  - .3 Provide LonWorks interface object model specification to secondary equipment manufacturers.
- .6 Emergency Lighting Interface; Eaton Lighting Systems (Formerly Cooper Controls) Model LRM120
  - .1 Provides total system listing to UL 924 when used with ControlKeeper system.

- .2 Senses the loss of normal power.
- .3 Provides an output to override the ControlKeeper lighting panels to the all On state.

## **2.7 SENSORS**

- .1 Refer Section 260923 – Lighting Control Devices and drawings: Occupancy sensors used in conjunction with the lighting control system.
- .2 Exterior Daylight Sensors:
  - .1 Calibrated with independent turn-on and turn-off thresholds; minimum 2 foot-candles difference between the turn-on and turn-off thresholds.
  - .2 Enclosed in weatherproof housing with shading and lens protection visor.

## **2.8 OPEN ADR VIRTUAL END NODE (VEN) FOR DEMAND RESPONSE**

- .1 The ControlKeeper shall be capable of receiving a signal from a Demand Response or OpenADR Virtual End Node device. When received the ControlKeeper will automatically adjust lighting to provide optimal energy savings and comply with Demand Response code requirements. Systems that do not support Demand Response capability shall not be acceptable.
  - .1 Automatically adjust the target lighting level by at least 15% but not more than 50%.
  - .2 System does not permit user override of the Demand Response system except in the cases of emergency or normal power loss. Systems that allow the user to adjust the lights higher than the demand response target light level shall not be acceptable.
  - .3 Each ControlKeeper shall be configurable for individual Demand Response reduction levels. Systems that only support global Demand Response reduction levels shall not be acceptable.
- .2 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Number:
  - .1 EBOX-2B-DC

## **2.9 EMERGENCY LIGHTING**

- .1 Emergency Power Control – A UL 924 listed device installs down line of an output that monitors a switched or dimmed circuit providing normal lighting to an area. The unit provides normal ON/OFF or 0-10V dimming 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:
  - .1 120/208 volts, 50/60 Hz, 20 amp ballast rating.
  - .2 Push to test button.
  - .3 Eaton Lighting Systems (Formerly Cooper Controls) Catalog Numbers:
    - .1 CEPC-1 (switching)
    - .2 CEPC-1-D (0-10V dimming)

## **2.10 ACCESSORIES**

- .1 The ControlKeeper® has several hardware accessories that may be utilized to enhance your lighting control application. Select from the network hardware accessories which accessories will be utilized for your application.

- 
- .1 ControlKeeper® TouchScreen (CKT)
    - .1 The CKT shall provide additional flexibility by providing up to 48 - 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CKT controllers, although accessible through the network, shall be fully stand-alone in their control capability. The CKT provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide thirty-two, 3-wire or 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 128 additional global commands for network control and shall reside in the CKT. Networks that rely on a single time clock for system operation shall not be acceptable.
  - .2 ControlKeeper® 4A (CK 4A)
    - .1 The CK 4A shall provide additional flexibility by providing four 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4A shall optionally provide four, 0-10VDC outputs to control dimming ballasts. The CK 4A controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4A provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four, 3-wire or eight, 2-wire dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide four analog inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4A. Networks that rely on a single time clock for system operation shall not be acceptable.
  - .3 ControlKeeper® 4 (CK 4)
    - .1 The CK 4 shall provide additional flexibility by providing four normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 4 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 4 provides full status indication of CPU status, network communication, power and HOA overrides. The controller shall provide four dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 4. Systems that utilize the master slave topology shall not be acceptable.
  - .4 ControlKeeper® 2 (CK 2)
    - .1 The CK 2 shall provide additional flexibility by providing two normally open or normally closed 20 amp @ 277 VAC rated relays that are addressable and fully programmable from the network. The relay wire terminations shall be able to accept 10 AWG. The CK 2 controllers although accessible through the network shall be fully stand-alone in their control capability. The CK 2 provides full status indication of CPU status, network communication, power, and HOA overrides. The controller shall provide two dry contact inputs that may be configured as maintained or momentary inputs. The controller shall provide up to 64 digital buttons for overrides. The controller shall provide 64 additional global commands for network control and shall reside in the CK 2. Systems that utilize the master slave topology shall not be acceptable.

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**2.11 SOURCE QUALITY CONTROL**

- .1 Perform full-function testing on completed assemblies at end of line. Statistical sampling is not acceptable.

**3. EXECUTION**

**3.1 EQUIPMENT INSTALLATION AND DOCUMENTATION**

.1 Installation

The control system shall be installed and fully wired as shown on the plans by the installing contractor. The contractor shall complete all electrical connections to all control circuits and override wiring.

.2 Documentation

The contractor shall provide accurate "as-built" drawings to the owner for correct programming and proper maintenance of the control system. The "as-builts" shall indicate the load controlled by each relay and the relay panel number.

.3 Operation and Service Manuals

The factory shall supply all operation and service manuals.

**3.2 PRODUCT SUPPORT AND SERVICE**

.1 Factory Support

Factory telephone support shall be available at no cost to the owner. Factory assistance shall consist of solving programming or application questions concerning the control equipment.

**3.3 SYSTEM DELIVERY AND ACCEPTANCE**

.1 Delivery

The contractor is responsible for complete installation of the entire system according to strict factory standards and requirements. The following items shall constitute factory standards and requirements:

- .1 All system equipment shall operate in accordance with specification and industrial standard procedures.
- .2 An operational user program shall exist in the control system. The program shall execute and perform all functions required to effectively operate the site according to the requirements.
- .3 Demonstration of program integrity during normal operation and pursuant to a power outage.
- .4 Contractor shall provide a minimum of two training hours on the operation and use of the control system. Additional support services shall be negotiated between the contractor and the building owner or manager.

**3.4 FACTORY COMMISSIONING (OPTIONAL)**

- .1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.

- .2 The electrical contractor shall provide both the manufacturer and the PCA Departmental Representative with twenty one working days written notice of the system startup and adjustment date.
- .3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

### **3.5 WARRANTY**

- .1 Warranty

Manufacturer shall supply a 3-year warranty on all hardware and software. A limited 10-year warranty shall be provided on all relay cards. These warranties will be in affect for all installations. Systems that provide special warranties based on installation shall not be acceptable.

**END OF SECTION**

**1. General**

**1.1 RELATED SECTIONS**

- .1 Section 26 09 23 Low Voltage Switching.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 26 05 01.
- .2 Data to indicate system components, mounting method, source of power and special attachments.
- .3 Supplier shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.
- .4 After award of tender, the Owner shall supply to the occupancy sensor supplier drawings showing the proposed location and type of all occupancy sensors. The supplier shall submit this lighting plan, clearly marked showing proper product, location and orientation of each sensor.
- .5 Submit any interconnection diagrams per major subsystem showing proper wiring.
- .6 Submit standard catalog literature that includes performance specifications indicating compliance to the specification.
- .7 Catalog sheets must clearly state any load restrictions when used with electronic ballasts.
- .8 At conclusion of commissioning period, supplier shall provide a spreadsheet listing the final setting of each parameter (sensitivity, time delay, orientation) of each sensor.

**1.3 WORK INCLUDED**

- .1 Supplier's scope of work to include all materials, appliances, control hardware, sensors, swivel mounting brackets, and equipment necessary for and incidental to the delivery and commissioning of a completely operational occupancy sensor lighting control system, as described herein. This contractor shall provide all labour, tools, wire, junction boxes, and equipment necessary for and incidental to the installation of the system.
- .2 Supplier shall examine all specification provisions and drawings for related electrical work required as work under Division 26. System shall be fully compatible with low voltage switching system in Section 26 09 23.
- .3 This contractor shall coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit, fixtures, HVAC systems and building management systems except as otherwise specified.

**1.4 EQUIPMENT QUALIFICATION**

- .1 Products supplied shall be from a single supplier that have been continuously involved in manufacturing of occupancy sensors. Mixing of suppliers shall not be allowed.
- .2 All components shall be CSA or CUL certified, and met all applicable code requirements.

- .3 Wall switch products must be capable of withstanding the effects of inrush current. Submittals shall clearly indicate the method used.

## **1.5 SYSTEM DESCRIPTION**

- .1 The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.
- .2 The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.
- .3 Occupancy sensor shall work in cases where the light fixtures are eight line voltage switched or where they are low voltage switched.
- .4 Supplier shall warrant to this contractor all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with specifications for a period of five (5) years. The supplier's obligation shall include repair or replacement, and testing without charge to the Owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the Owner's acceptance of the project.

## **2. Products**

### **2.1 COMPONENT REQUIREMENTS**

- .1 Wall switch sensors shall be capable of detection of occupancy at desktop level up to 30 m<sup>2</sup>, and gross motion up to 100 m<sup>2</sup>.
- .2 Wall switch sensors shall accommodate loads from 0 to 800 W at 120V; 0 to 1500 W at 120V and shall have 180° coverage capability with adjustable internal shutters to reduce coverage.
- .3 Wall switch products shall utilize zero crossing circuitry which increases relay life, protects from the effects of inrush current and increase sensor's longevity.
- .4 Wall switch sensors shall have no leakage current to load, in manual or in Auto / Off mode for safety purposes and shall have voltage drop protection.
- .5 Wall switch sensors shall provide a field selectable option to convert sensor operation from automatic-ON to manual-ON.
- .6 Where specified, vandal resistant wall switch sensors shall utilize a hard lens with a minimum 1.0mm thickness. Product utilizing a soft lens will not be considered.
- .7 Passive infrared sensors shall utilize pulse count processing and digital signature analysis to respond only to those signals caused by human motion.
- .8 Passive infrared sensors shall provide high immunity to false triggering from RFI (hand-held radios) and EMI (electrical noise on the line).
- .9 Passive infrared sensors shall have a multiple segmented Fresnel lens, in a multiple-tier configuration, which grooves in to eliminate dust and residue build-up.



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- .10 Daylighting control shall be accomplished by separate photo sensors and daylight sensors. Photo sensors are described under section 26 06 24 for relay controlled lights. Daylight sensor to be single zone, on / off switching type, automatic calibrations, easy to read LCD display & LED status. Allow for onsite calibration by Electrical Contractor.
  - .11 Dual technology sensors shall be either corner mounted or ceiling mounted in such a way as to minimize coverage in unwanted areas. Wiring shall be brought from the ceiling in either case.
  - .12 Dual technology sensors shall consist of passive infrared and ultrasonic technologies for occupancy detection. Products that react to noise or ambient sound shall not be considered.
  - .13 Ultrasonic sensors shall utilize advanced signal processing to adjust the detection threshold dynamically to compensate for constantly changing levels of acidity and air flow throughout controlled space.
  - .14 Ultrasonic operating frequency shall be crystal controlled at nominally 40 kHz within  $\pm 0.002\%$  tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.
  - .15 Sensors that cause interference with patients using cochlear implants or hearing aids are not acceptable and will be replaced by suitable project within the five (5) year warranty period at the supplier's expenses.
  - .16 All sensors shall be capable of operating normally with electronic ballasts, LED drivers compact fluorescent lamp system and rated motor loads.
  - .17 Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.
  - .18 Sensors shall utilize technology for automatically adjustable time delay and sensitivity settings.
  - .19 All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
  - .20 In the event of failure, a bypass manual override shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
  - .21 All sensors shall provide an LED as a visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
  - .22 Sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified units to achieve this function are not acceptable.
  - .23 All sensors shall have UL rated, plastic enclosures, white finish.
  - .24 All sensors shall have auxiliary contacts.

## 2.2 CIRCUIT CONTROL HARDWARE

- .1 Control units (power packs and auxiliary relay or slave packs): for ease of mounting, installation and future service, control unit(s) shall be able to externally mount through at 16 mm knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer (except slave packs) to provide low-voltage power. Control unit provide power to a minimum of two (2) sensors.
- .2 Relay contacts shall have ratings of 3A – 120 Vac tungsten, 20A – 120 Vac ballasted.
- .3 Control wiring between sensors and controls units shall be Class II, No. 18-24 AWG, stranded CSA certified, PVC insulated or TEFLON jacketed cable suitable for use to plenums, FT-4 or CMR rated.
- .4 Minimum acceptable wire gauge from the circuit control hardware relays shall be #214 AWG.

## 2.3 ACCEPTABLE MANUFACTURERS

- .1 Refer to table below for applicable sensor types. Actual sensor type and location within the room shall be recommended by the supplier. All catalog numbers below refer to project manufactured by The Watt Stopper Inc. All sensors are to be suitable for mounting to outlet boxes. Acceptable manufacturers are Leviton and sensor switch.

- .2 Ceiling sensors:

Type	Technology	Coverage Area (at 80%)	Standard of Acceptance
C1	Ultrasonic	45 m <sup>2</sup>	WT-600
C2	Ultrasonic	85 m <sup>2</sup>	WT-1100
C3	Passive Infrared	37 m <sup>2</sup>	C-200-1
C4	Dual Technology	74 m <sup>2</sup>	DT-300
C5	Ultrasonic	19 lineal m	WT-2250
C6	Passive Infrared	22 m <sup>2</sup>	WPIR
C7	Passive Infrared	150 m <sup>2</sup>	CX-100

- .3 Control Unit:

- .1 Power Packs: Power supplied from low voltage lighting control system. Locate power packs near occupancy sensors as recommended by manufacturer.

## 3. Execution

### 3.1 INSTALLATION

- .1 The supplier shall recommend prior to rough-in any changes to quantity or location of sensors in order to adequately provide coverage for the room. It shall be this contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric within the range of coverage(s) of controlled areas per the supplier's recommendations.
- .2 Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants

at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate the rooms which are to be provided with sensors.

- .3 It is the supplier's responsibility to arrange for supplier's factory authorized representative to attend pre-installation meetings at the project site, to verify placement of sensors and installation criteria prior to rough-in.
- .4 Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space to overcome local difficulties due to space limitations or interference of structural components. The supplied shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.
- .5 All sensors shall initially be set to a 15 minute time delay user adjustable from 1 s to 30 min), except where otherwise noted on the drawings.
- .6 Sequence of operation shall be as follows: When motion is detected, the occupancy sensor starts its time-out timer and sends an ON signal to the relay scanner to activate associated relays, and also enables the daylight sensors, and turn the light on. Whenever motion is again detected, the time-out timer is reset to zero time. The time-out timer only expires when no motion has occurred during a time equal to the time-out setting. Upon time-out expiry, the occupancy sensor sends an OFF signal to the relay scanner and disables the daylight sensors, and turns the lights off.

### **3.2 COMMISSIONING**

- .1 Upon completion of the installation, in conjunction with the Contractor and the Owner, the entire system shall be completely commissioned by the supplier's factory authorized technician. This team will verify all adjustments and sensor placements to ensure a trouble-free occupancy-based lighting control system

**END OF SECTION**

## **1. General**

### **1.1 SECTION INCLUDES**

- .1 Low Voltage Switchboard – Furnish and install switchboard(s) as specified herein and where shown on the associated schedules and drawings.

### **1.2 REFERENCES**

- .1 The switchboard(s) and overcurrent protection device(s) referenced herein are designed and manufactured according to the latest revision of the following specifications.
  - .1 Switchgear assemblies: CSA C22.2 No.31
  - .2 UL891
  - .3 Panelboards: CSA C22.2 No.29
  - .4 Molded Case Circuit Breakers: CSA C22.2 No. 5
  - .5 UL489
  - .6 Enclosed Switches: CSA C22.2 No. 4

### **1.3 SUBMITTAL AND RECORD DOCUMENTATION**

- .1 Approval documents shall include drawings. Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance location and requirements, single-line diagrams, equipment schedule and switchboard instrument details.

### **1.4 QUALIFICATIONS**

- .1 Company specializing in manufacturing of switchboard products
- .2 Switchboards shall be manufactured in accordance with standards listed Article 1.02 – REFERENCES.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Inspect and report concealed damage to carrier within their required time period.
- .2 Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.
- .3 Store in a clean, dry environment. Maintain factory packaging and, if required, provide an additional heavy canvas or heavy plastic cover to protect enclosure(s) from dirt, water, construction debris, and traffic.

### **1.6 OPERATIONS AND MAINTENANCE MATERIALS**

- .1 Manufacturer shall provide installation instructions:
  - Instructions for Safe Installation, Operation and Maintenance of Switchboards Rated 600 Volts or less.

## **1.7 WARRANTY**

- .1 Manufacturer shall warrant specified equipment free from defects in materials and workmanship for the lesser of one (1) year from the date of installation or eighteen (18) months from the date of purchase.

## **1.8 RELATED SPECIFICATIONS**

- .1 Section 260526 – Grounding and Bonding
- .2 Section 261313 – Enclosed Circuit Breakers
- .3 Section 262313 – Enclosed Switches
- .4 Section 262416 – Panelboards
- .5 Section 264300 – Surge Protective Device (SPD)
- .6 Section 262300 – Low-Voltage Switchgear
- .7 Section 26091380 – Web Enabled Power Distribution
- .8 Section 26091310 – Electrical Power Monitoring and Control

## **2. Products**

### **2.1 MANUFACTURERS**

- .1 Shall be Square D Company
- .2 Substitutions must be submitted in writing three weeks prior to original bid date with supporting documentation demonstrating that the alternate manufacturer meets all aspects of the specification herein.

### **2.2 TERMINATIONS**

- .1 Termination lugs shall be CSA/UL Listed to accept solid or stranded [copper and aluminum conductors] [copper conductors only]. Termination lugs shall be suitable for cables sized per the 75C column of the CE Code table. It is permissible for primary cables terminating in a bussed auxiliary section to be sized to the 90C column of the CE Code.

### **2.3 ENCLOSURE**

- .1 The switchboard shall be totally enclosed, dead front, freestanding or freestanding wall supported, and rear aligned with front, side or rear access.
- .2 The switchboard shall be NEMA Type 1 – with drip hood.
- .3 NEMA Type 1 enclosure shall be Sprinkler Protection CEC26-008.
- .4 The framework shall be formed steel and secured together to support all cover plates, bussing and component devices during shipment and installation. All closure plates are to be single tool, screw removable. Ventilation shall be provided when required. Each section shall include a single-piece removable top plate.
- .5 The switchboard enclosure shall be painted on all exterior surfaces. The paint finish shall be ASA49 grey unless otherwise specified.
- .6 Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and for floor mounting. An option of a steel base channel shall be made available

## **2.4 BUSSING**

- .1 The switchboard shall be high conductivity solid silver-plated copper bus.
- .2 The through bus shall have a maximum ampacity of 400A, 600A, 800A, 1,000A, 1200A, 1600A. The switchboard bussing shall be of sufficient cross-sectional area to meet the CSA C22.2 No. 31 standard for temperature rise.
- .3 The switchboard shall be rated with a minimum short circuit rating of 50,000A at 208Vac.
- .4 Provisions shall be made for future splicing of additional sections.
- .5 All bolts used on bus bar joints shall be a minimum of grade 5.
- .6 The utility metering compartment shall have provisions for window type/bar type current transformers as supplied by the applicable public utility.

## **2.5 MAIN DISCONNECT DEVICES**

- .1 Main Circuit Breaker
  - .1 Electronic trip molded case, full function, circuit breaker
    - .1 Shall be rated for 80% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
    - .2 Shall be rated for 100% continuous current and be PowerPact P or R style breaker with MICROLOGIC trip system.
    - .3 Rated ampacity shall be 1000A, 1200A, 1600A See drawings.
  - .2 Thermal magnetic molded case circuit breaker
    - .1 Shall be rated for 80% continuous current and be PowerPact M, P or R style breaker with standard electronic trip system.
    - .2 Rated ampacity shall be 1000A, 1200A, 1600A See drawings.
    - .1 Stored energy electronic trip insulated case circuit breaker
      - .2 Shall be a MASTERPACT NW, two-step stored energy circuit breaker.
      - .3 Rated ampacity shall be 1000A, 1200A, 1600A See drawings
      - .4 Circuit breaker(s) shall have 10kA, 14kA, 18kA 25kA 35kA 42kA 50kA 65kA interrupting capacity at 208Vac. See drawings.
      - .5 Shall be rated for 100% continuous current.
      - .6 Provide a fixed instantaneous (High Level Selective Override) circuit on breaker(s). The circuit shall have a defeatable instantaneous adjustment to allow the breaker to remain closed for up to 30 cycles during overcurrents below the rms symmetrical short time withstand ratings. The circuit shall instantaneously trip when current levels exceed applicable withstand ratings.
    - .7 Electronic Trip System

- .1 Circuit breaker trip system shall be a **MICROLOGIC** electronic trip unit.
- .2 All trip units shall be removable to allow for field upgrades.
- .3 Trip Units shall incorporate "True RMS Sensing" and have LED long-time pickup indications.
- .4 **MICROLOGIC** trip unit functions shall consist of adjustable long-time pickup and delay, [optional short-time pickup and delay], instantaneous [optional neutral protection and optional ground-fault pickup and delay].
- .5 Adjustable long-time pickup ( $I_r$ ) and delay shall be available in an adjustable rating plug that is UL Listed as field-replaceable. Adjustable rating plug shall allow for nine long-time pickup settings from 0.4 to 1 times the sensor plug ( $I_n$ ). Other adjustable rating plugs shall be available for more precise settings to match the application. Long-time delay settings shall be in nine bands from 0.5–24 seconds at six times  $I_r$ .
- .6 [Short-time pickup shall allow for nine settings from 1.5 to 10 times  $I_r$ . Short-time delay shall be in nine bands from 0.1–0.4  $I_2 t$  ON and 0–0.4  $I_2 t$  OFF.
- .7 Instantaneous settings on the trip units with LSI protection shall be available in nine bands from 2 to 15 times  $I_n$ . The Instantaneous setting shall also have an OFF setting when short-time pick-up is provided.
- .8 All trip units shall have the capability for the adjustments to be set and read locally by rotating a switch. [Optional: trip units shall have the capability to electronically adjust the settings locally and remotely to fine increments below the switch settings. Fine increments for pickup adjustments are to be one ampere. Fine increments for delay adjustments are to be one second.
- .9 Trip unit shall provide local trip indication [and capability to indicate local and remote reason for trip, i.e., overload, short circuit or ground fault.
- .10 [Ground-fault protection shall be available for solidly grounded three-phase, three-wire or three-phase, four-wire systems. Trip unit shall be capable of the following types of ground-fault protection: residual, source ground return, and modified differential. Ground-fault sensing systems may be changed in the field.
- .11 [Ground-fault settings for circuit breaker sensor sizes 1200 A or below shall be in nine bands from 0.2 to 1.0 times  $I_n$ . The ground-fault settings for circuit breakers above 1200 A shall be nine bands from 500 to 1200 A.
- .12 [Neutral current transformers shall be available for four-wire systems.
- .13 Trip units shall be capable of communicating on four wire **MODBUS**® networks without software interfaces (black boxes).
- .14 Trip units shall be available to provide additional protection by offering adjustable inverse definite minimum time lag (IDMTL). IDMTL provides optimized coordination by the

- .15 adjustment of the slope of the long-time delay protection. Trip units shall be available to provide real time metering. Metering functions include current, voltage, power and frequency. Metering accuracy shall be 1.5% current, 0.5% voltage, and 2% power. These accuracies include CT and meter.
- .16 Trip units shall be available to provide harmonic analysis and waveform capture.
- .17 A means to seal the trip unit adjustments in accordance with NEC Section 240-6(b) shall be provided.
- .18 The following table indicates the standard and optional features of the Trip Units. Select the appropriate trip unit (s) for the system performance desired.

Features	Micrologic Trip Unit Series			
	Standard	A	P	H
True RMS Sensing	X	X	X	X
LI	X	X	X	X
LSI	o	o	X	X
LSIG/Ground –Fault Trip		o	o	o
Ground Fault Alarm (no trip)			X	X
Ground Fault Trip and Programming Alarm			o	o
Adjustable Rating Plugs	X	X	X	X
LED - Long-time Pickup	X	X	X	X
LED - Trip indication		X	X	X
Digital Ammeter		X	X	X
Phase loading Bar Graph		X	X	X
Zone Selective Interlocking		X	X	X
Communications		o	X	X
LCD Dot Matrix Display			X	X
Advanced User Interface			X	X
Protective Relay Functions			X	X
Thermal Imaging			X	X
Neutral Protection			X	X
Electronic Contact Wear Indication			X	X
Temperature Indication			X	X
Incremental Fine Tuning of Settings			X	X
Selectable Long-time Delay Bands			X	X
Power Measurement			X	X
Waveform Capture				X
Data Logging				X

**X=Standard o=Option**

- .2 Main Fusible Switch
- .1 Shall be QMQB type fusible switch 400 through 1,200A, BOLT-LOC fixed mounted bolted pressure switch 1,600 through 3,000A.
- .2 Bolted pressure contacts shall be made by providing an additional



- pressure or clamping action at both ends of the switchblade when the blades are fully closed.
- .3 Manual operated switches shall have quick-make, quick-break front operating mechanisms.
- .4 Accessories shall be supplied as follows:
  - Capacitor trip power supply]
  - Blown main fuse indication
  - Phase failure relay with capacitor trip power supply
  - Key interlock
- .5 Equipment ground fault protection
  - .1 Provide a zero-sequence type ground fault system including current sensor and appropriate relaying equipment. The current sensor shall enclose all phase (and neutral, if present) conductors to be monitored. The current sensor frame shall be so constructed that one leg can be opened to allow the removal of the sensor without disturbing the cables or requiring drop-links in the bussing. A test winding shall be provided to simulate the flow of ground fault current through the current sensor for testing.
  - .2 The ground fault relay shall be of solid state construction and have adjustable pick-up for ground fault currents from 100 amperes to 1200 amperes.

## **2.6 NOT USED.**

## **2.7 Metering and Accessories**

- .1 Main Metering
  - .1 Metering requirements that exceed the capabilities of the circuit breaker trip units shall use the Schneider Electric Powerlogic Circuit Monitor 4000T Powerlogic PM8244, Powerlogic PM5563, [Powerlogic ION7550 Powerlogic ION7650, Powerlogic ION8650
  - .2 CT's shall be appropriately sized for use on the main
  - .3 Separate HMI displays shall be mounted on Main breaker door
  - .4 Instrument compartment door
  - .5 Meter integrated communication available via Serial port or Ethernet port depending on meter type.

- .2 Communications
  - .1 Equipment can be selected with communications from among the following options
    - .1 Modbus RS48, without device Web pages
    - .2 Modbus RS48, with device Web pages
    - .3 Modbus RS485 to Ethernet Modbus TCP
    - .4 Direct Ethernet Modbus/TCP
  - .3 Energy Reduction Maintenance Setting Switch (ERMS)
    - .1 For each Main Tie or Feeder circuit breaker, provide a Maintenance OFF ON selector switch on the compartment door to switch the circuit breaker instantaneous tripping characteristics to an alternate setting temporarily during maintenance activity.
    - .2 Provide a lock feature for the ERMS switch so that it may be locked in either the OFF or ON maintenance mode position.
    - .3 Provide a blue LED indicating light to indicate trip unit is in the ERMS mode.
    - .4 Wire contacts on all ERMS switches to a common alarm input to plant control system.

## 2.8 GROUND FAULT PROTECTION

- .1 3-phase 4-wire, connected equipment having multiple sources shall have a modified differential ground fault system (MDGF). The manufacturer shall complete the MDGF design prior to building equipment to insure that the proper main or tie breaker (s) operate properly during the following occurrences on the main bus.
  - .1 Insure the system will trip with the occurrence of a ground fault at any location in the switchgear.
  - .2 Insure system will not trip without ground fault and with normal current flow.
  - .3 Insure system will not trip due to large single-phase currents.
  - .4 Insure system will trip with combination of normal current flow and ground fault current flowing together.
  - .5 Insure system will not trip with circulating currents through the neutral due to multiple grounds and sources external to the immediate low voltage power sources.
- .2 The manufacturer shall be required to include additional CT's, ground fault relays, interlocks, wiring, components etc. to insure the ground fault systems operates without nuisance tripping on the main bus of the switchgear.
- .3 The manufacturer shall include a wiring diagram of the MDGF system along with a test procedure using high current injection equipment.

## 2.9 DISTRIBUTION SECTION DEVICES

- .1 Group mounted circuit breakers through 100A to 1200A
  - .1 Breakers and all components shall be designed, manufactured and tested in accordance with applicable CSA standards.
  - .2 Circuit breaker(s) shall be rated for 80% continuous current.
  - .3 Circuit breakers(s) shall have 10kA, 14 kA, 18 kA, 25 kA 35 kA 42 kA 50 kA 65 kA interrupting capacity at 208Vac. Two tier CSA or UL listed series ratings are acceptable. When series ratings are applied with integral or

- 
- remote upstream devices, a label or manual shall be provided showing the CSA or UL approved series ratings including:
- Voltage
  - Size and type of upstream fuses or breakers
  - Size and type of branch devices that can be used
- .4 Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
- .5 The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
- .6 Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
- .7 Line-side circuit breaker connections are to be jaw type.
- .8 All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.  
(Select Electronic trip 100%, Electronic trip 80% or Thermal Magnetic)
- .1 Electronic trip molded case full function 100% rated circuit breakers
- .1 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
  - .2 Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule/ drawing.
  - .3 Local visual trip indication for overload, short circuit and ground fault trip occurrences.

- .4 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
- .5 Communications capabilities for remote monitoring of circuit breaker trip system, to include phase and ground fault currents, pre-trip alarm indication, switch settings, and trip history information shall be provided.
- .6 Circuit breaker shall be provided with Zone Selective Interlocking (ZSI) communications capabilities on the short-time and ground fault functions compatible with all other electronic trip circuit breakers and external ground fault sensing systems as noted on schedules/drawings.
- .7 Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- .2 Electronic trip molded case standard function 80% rated circuit breakers
  - .1 All electronic circuit breakers shall have the following time/current response adjustments: Long Time Pickup, Long Time Delay, Short Time Pickup, Short Time Delay, Ground Fault Pickup Ground Fault Delay and Instantaneous settings. Each adjustment shall have discrete settings (fully adjustable) and shall be independent of all other adjustments.
  - .2 Circuit breaker trip system shall be a microprocessor-based true RMS sensing designed with sensing accuracy through the thirteenth (13th) harmonic. Sensor ampere ratings shall be as indicated on the associated schedule/drawing.
  - .3 Local visual trip indication for overload, short circuit and ground fault trip occurrences.
  - .4 Long Time Pickup indication to signal when loading approaches or exceeds the adjustable ampere rating of the circuit breaker shall be provided.
  - .5 Furnish thermal magnetic molded case circuit breakers for 250A frames and below.
- .3 Thermal magnetic molded case circuit breakers
  - .1 Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
  - .2 Circuit protective devices shall be Square D molded case circuit breakers. Circuit breakers shall have 10kA, 14kA 18kA, 25kA. 35kA. 50kA. 65kA. True current limiting\* interrupting capacity at 208Vac. Ampere ratings shall be as shown on the drawings.  
\* Manufacturer shall submit one set of published  $I_p$  and  $I^2t$  let-through curves (as required by CSA or UL) to the owner.

### **3. Execution**

#### **3.1 INSTALLATION**

- .1 Install switchboards in accordance with manufacturer's written instructions, and applicable standards and safety codes.

**3.2 FIELD QUALITY CONTROL**

- .1 Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- .2 Measure steady state load currents at each switchboard feeder; rearrange circuits in the switchboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.
- .3 Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

**END OF SECTION**

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**1. General**

**1.1 DESCRIPTION**

- .1 Provide molded case circuit breaker switches and panelboards type CDP for 120/208 volt distribution as indicated on the drawings. Approved manufacturer Schneider to maintain series rating with main distribution. Integrated equipment rated with upstream protective devices.

**2. Products**

**2.1 MOULDED CASE CIRCUIT BREAKER**

- .1 Rating: voltage and ampere ratings as shown, 3 pole unless shown otherwise.
- .2 Construction: Equipped with thermal time delay trip, magnetic instantaneous trip, overcentre toggle mechanism, silver alloy contacts, high contact pressure, common trip for 2 or 3 pole, air chute arc extinguishers, three position handle,
- .3 Frame Sizes: Schneider frame sizes shown on the drawings and indicate standard or hard case. In all cases, breakers shall be of a type completely protected by the upstream breakers used in the feeder to the panelboard.
- .4 Connectors: Solderless pressure lugs, sized for cables, bolt-on bus connections.
- .5 Special Features: Where indicated on the drawings, provide special features, such as shunt trips for remote operation, keyed interlocks, non-auto, solid

**2.2 INDIVIDUAL MOUNTED MOULDED CASE CIRCUIT BREAKER**

- .1 Breaker Switches:
  - .1 Enclosures: CSA Code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in "OFF" position, EEMAC-1 unless shown otherwise. Exterior breakers and switches showed WP on drawings to have EEMAC-12 enclosures. Increase enclosure size above standard for large cables.
  - .2 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to switch rating, in enclosure.

**2.3 CDP PANELBOARDS**

- .1 Construction: To CSA Standards, apply CSA approval labels.
- .2 Voltage and ampere ratings as shown, 3 phase, 4 wire solid neutral for 4 wire distribution system.
- .3 Tubs: CSA code gauge galvanized steel, braced to support interiors, 102 mm x 32 mm support channels full width front and back on floor mounted.
- .4 Mains: Copper bus ampere rating as shown on the drawings, braced to minimum 42 KA unless shown otherwise on the drawings. Minimum bracing to I.C. of noted breakers.
- .5 Neutral Bus: Provide neutral bus with ampere rating equal to the panelboard mains for all distribution systems with grounded neutral conductor connections. Provide ground bars to panels as noted.

- .6 Breaker Arrangement: As shown on the drawings. Minor changes permitted to suit manufacturer.
- .7 Front Covers, Doors: CSA code gauge galvanized steel; fronts to cover wiring gutter space between breakers and tub sides, same size as tubs and flush with sides; with steel trim attached to back of covers to close space between covers and breakers; doors with concealed hinges, combination locks and latches, to
- .8 Finish: One primer coat and one finish coat on all metal surfaces and doors.
- .9 Panelboards in Switchboards: Modify enclosure construction to suit switchboard.
- .10 Breaker Spaces: Provide spaces for future breakers with ampere ratings and frame sizes as shown. Allow at least 40% space.
- .11 Special Features: Provide drip hoods, non-ferrous entry plates and other special features as shown on the drawings.
- .12 Main Breakers: Three pole, molded case circuit breakers, ampere sizes and frame sizes as shown.
- .13 CU/AL rated.

### **3. Execution**

#### **3.1 INDIVIDUAL MOUNTED MOULDED CASE CIRCUIT BREAKER**

- .1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise provide steel angle frame supports. Where switches are grouped, mount in uniform arrangement.
- .2 Wiring: Connect line and load cables to all switches.
- .3 Identification: Provide lamacoid plate on each switch showing voltage, phases and wires, source of supply and load being fed -  
  
Voltage, phases and wire e.g. 120/208, 3 phase, 4  
wire Fed from MDP No. 1  
To Panel A

#### **3.2 CDP PANELBOARDS**

- .1 Mounting: Provide supports independent of conduits, mount as shown on the drawings. Bolt floor mounted panelboards to floor.
- .2 Wiring: Connect supply and all branch circuit breakers. Install branch breaker cables in neat bundles at sides of cable gutters. Install cables to branch circuit breakers horizontally.
- .3 Identification: Provide lamicoid plate on each panelboard cover showing panelboard designation, voltage and source of feed -  
  
Panelboard "A"  
Voltage, phases and wires e.g. 120/208V, 3 phase, 4  
wire Fed from CDP "B"

- .4 Identify each branch circuit breaker with a lamicoid plate to show load  
being fed - To Panel "PPA"

**END OF SECTION**



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**1. General**

**1.1 DESCRIPTION**

- .1 Provide panelboards for 120/208 volt branch circuit distribution as indicated on schedules shown on the drawings, complete with all items listed.
- .2 Construct panelboards to CSA Standards, apply CSA approval labels.
- .3 Panelboards to be manufactured by Schneider.
- .4 Supply shop drawings on all panelboards, switchboards and CDP's.

**2. Products**

**2.1 MATERIALS**

- .1 Tub: CSA code gauge galvanized steel, reversible top and bottom, finish painted ANSI 61 grey enamel or as specified in Section 26 05 01.
- .2 Mains: Copper, ampere ratings as shown, solderless lug connectors sized for cables in panels without main breakers, bolt-on connectors for all main breakers and branch circuit breakers.
- .3 Neutral Bars: Same ampere ratings as mains, solderless lugs for connections.
- .4 Front shields to cover breaker assembly and neutral bars, leaving wiring gutters accessible when fronts removed.
- .5 Front Covers, Doors: CSA code gauge galvanized steel, with doors, concealed hinges, combination locks and latches, interior plastic covered circuit directory cardholders, concealed mounting screws, finish painted, same size as tubs where surface mounted, overlapping trim with wall gaskets where flush
- .6 Locks, Keys: All locks keyed alike.
- .7 Branch Circuit Breakers: Thermal magnetic with "ON", "OFF" and "TRIPPED" positions, single, two and three pole as shown; ampere ratings as shown; bolt-on line connections, solderless lug load connections; common trip for two and three pole; rated 240 volt 10,000 amps symmetrical short circuit interrupting capacity in 120/208 volt (Unless noted otherwise on single line drawing.) Breakers to be integrated equipment rated with upstream protective devices.
- .8 Spaces: Stamp out spaces, install removable fillers where breaker spaces are required.
- .9 Ground Fault Circuit Interrupters: Breakers having both 5 ma ground fault sensitivity and over current protection, of the amperage rating indicated, shall be installed in the panelboards where required. Wire each ground fault breaker with a separate neutral conductor wired through the interrupter to the ground
- .10 CU/AL Rated.

---

**3. Execution**

**3.1 MOUNTING**

- .1 Provide supports independent of conduits. Match trim and door heights on adjacent panelboards. Coordinate mounting heights with fire hose cabinets and other equipment as instructed by the A/E.

**3.2 WIRING**

- .1 Install branch circuit wiring in neat bundles at sides of wiring gutters, with wires to branch breakers horizontal.

**3.3 IDENTIFICATION**

- .1 Provide lamicoid plate securely and permanently attached to the exterior of each panelboard door showing panelboard designation, voltage and
- .2 For all ground fault breakers, provide a sign indicating that circuits are so protected and that equipment should be tested regularly.

**3.4 BRANCH CIRCUIT DIRECTORY**

- .1 Provide typed directory identifying all branch circuits. Directory to indicate device and location.

**3.5 LOCKING STRAPS**

- .1 Locking Straps: To permit automatic tripping of breakers but prevent manual switching, for exit lights, receptacles feeding emergency battery packs, data racks, security panels, UPS receptacles, and where designated.

**3.6 KEYS**

- .1 Provide 3 keys to Owner per panel.

**3.7 CONDUIT STUBS**

- .1 From each panelboard installed flush, provide 3 - 12 mm and 2 - 25 mm spare conduits from the panelboard tub to an accessible location in the ceiling space

**END OF SECTION**

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## **1. General**

### **1.1 RELATED WORK**

- .1 Installation of anchor devices, Section 26 05 29 – Hangers, Supports and Inserts, channel base Cast-in-Place sills, setting Concrete templates.

### **1.2 REFERENCES**

- .1 CAN/CSA-Q9000-92, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

### **1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 26 05 01 – Electrical General Requirements.
- .2 Indicate:
  - .1 Outline dimensions
  - .2 Configuration of identified compartments.
  - .3 Floor anchoring method and dimensioned foundation template.
  - .4 Cable entry and exit locations.
  - .5 Dimensioned position and size of busbars and details of provision for future extension.
  - .6 Schematic and wiring diagrams.

### **1.4 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in Section 26 05 01 – Electrical General Requirements.
- .2 Include data for each type and style of starter.

### **1.5 SOURCE QUALITY CONTROL**

- .1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.
- .2 Owner to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.
- .3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA- Q9000.

## **2. Products**

### **2.1 SUPPLY CHARACTERISTICS**

- .1 600 V as indicated on the drawings, 60 Hz, Y connected, 3 phase, 3 wire, grounded.

### **2.2 GENERAL DESCRIPTION**

- .1 Compartmentalized vertical sections with common power busbars.
- .2 Floor mounting, free standing, enclosed dead front.

- .3 Indoor CSA 2 enclosure, front mounting.
- .4 Class I Type A.

## **2.3 VERTICAL SECTION CONSTRUCTION**

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.
- .3 Each unit to have complete top and bottom steel plate for isolation between units.
- .4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel
- .5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place
- .6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.
- .7 Incoming cables to enter at top with terminals as indicated.
- .8 Provision for outgoing cables to exit via top or bottom with terminals.
- .9 Removable lifting means.
- .10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.
- .11 Divide assembly for shipment to site, as indicated complete with hardware and instructions for re-assembly.

## **2.4 SILLS**

- .1 Continuous 76 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

## **2.5 BUSBARS**

- .1 Main horizontal and branch vertical, three phase high conductivity solid copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:
  - .1 Main horizontal busbars: 600 A.
  - .2 Branch vertical busbars: 300 A.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 42 kA rms symmetrical or as indicated by the fault study.

- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

## **2.6 GROUND BUS**

- .1 Copper ground bus extending entire width of motor control centre.
- .2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

## **2.7 STARTER UNIT COMPARTMENTS**

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
  - .1 Engaged position - unit stabbed into vertical bus.
  - .2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.
  - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
  - .4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for 3 padlocks to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.
- .9 Provide single phase protection for all three phase motors either by relaying, differential overloads, or EMCS shutdown.

## **2.8 WIRING IDENTIFICATION**

- .1 Provide wiring identification in accordance with Section 26 05 53 - Electrical General Requirements.

## **2.9 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.

- .1 Motor control centre main nameplate: engraved 1.
- .2 Individual compartment nameplates: engraved as indicated.

## **2.10 FINISHES**

- .1 Apply finishes in accordance with Section 26 05 53 - Identification.
- .2 Paint motor control centre exterior light gray and interiors white.

## **2.11 ACCEPTABLE MANUFACTURERS**

- .1 Schneider

## **3. Execution**

### **3.1 INSTALLATION**

- .1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure correct overload heater elements are installed.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 01 26 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.
- .2 Ensure moving and working parts are lubricated where required.
- .3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 h period.

**END OF SECTION**

## **1. General**

### **1.1 RELATEDWORK**

- |    |   |                  |
|----|---|------------------|
| .1 | Connections to Mechanical Equipment     | Section 25 30 01 |
| .2 | Connections to Wiring Systems Installed | Section 26 27 11 |
| .3 | Motor Identification                    | Section 25 05 55 |

### **1.2 STARTER REQUIREMENTS**

- .1 In general, there are three categories of starting equipment for three phase motors.
  - .1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.
  - .2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.
- .2 Provide manual motor starters for all single phase motors unless otherwise indicated on the motor schedule.
- .3 Provide interlocking between starters where required.
- .4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc., whether integrally or remote mounted shall be heavy-duty oil tight, unless otherwise specified.
- .5 Review and coordinate all starter characteristics with specific motors. Ensure all two speed motor starters are compatible with motors supplied by Division 25.

### **1.3 CONTROLS**

- .1 The work of this Division shall not include the wiring of HVAC controls, such as freeze stats, fire stats, E.P. and P.E. switches.

### **1.4 SHOPDRAWINGS**

- .1 Obtain wiring diagrams and information from other trades on control systems. Coordinate and incorporate information on motor control centre shop drawings.
- .2 Prepare shop drawings and wiring diagrams for motor control centre under supervision of suitably qualified staff.
- .3 Consult with the A/E during preparation of shop drawings as required to ensure correct interpretation.

## **2. Products**

### **2.1 MOTOR STARTERS GENERAL**

- .1 Except where specifically noted otherwise, this Division shall supply and install all motor starters. Starters to be combination type with current limiters when indicated in new grouped 4 plex Motor Control.
- .2 Starters to IEC 292 or EEMAC standards. Interrupting capacity minimum 10 kA.

- .3 All individually mounted motor starters shall be enclosed in a general-purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.

## **2.2 MANUAL MOTOR STARTERS:**

- .1 Where manual motor starters are indicated, provide manual motor starter switches with "ON" pilot lights, and overload protective devices, manual reset, trip indicating handle.
- .2 Starters to have quick make quick break toggle switch operation, rated volts, and poles, to suit application. Locking tab to permit locking in the "ON" of "OFF".

## **2.3 FULL VOLTAGE MAGNETIC STARTERS:**

- .1 All three phase magnetic motor starters to be across-the-line magnetic starters, except as noted. Each FVNR starter shall contain within its enclosures:
  - .1 Contactor with three overload devices having either one form A and one form B contact, or an auxiliary relay. Overload trip contacts shall be wired to the line side of the contactor coil such that the neutral side of the coil is wired directly to the grounded circuit.
  - .2 A control transformer of sufficient VA capacity to provide 120 volt control complete with primary and secondary fuses for all ungrounded conductors installed with starter. Fuses to be English Electric "red spot" fuse fitting CCRS154. Size for load plus 20% sparer capacity.
  - .3 Two sets of auxiliary contacts (2NO and 2 NC) in addition to standard with provision to convert one set to normally closed.
  - .4 Red pilot light to indicate energized motor circuit and where called for green pilot light to indicate de-energized motor circuit. Pilot lights shall LED be push-to-test transformer type, heavy duty, oil tight.
  - .5 Thermistor control relay and accessories for all motors 22.4 kW and above.
  - .6 Starters for motors 5hp and larger shall have single phase protection.
- .2 All combination motor starters shall be of the circuit breaker type complete with HRC Form J fuses, unless otherwise indicated. Combination starters shall have external operating handle with lock off facilities, lock on position. Entry door shall be fitted with switch/door interlock devices.
- .3 Accessories as indicated except standard duty HOA, 2 N/O and 2 NC spare auxiliary contacts.
- .4 Supply and install overload heaters and one overload device on each phase.
- .5 Provide lamicoid nameplates with lettering as indicated. The equipment name and number shall be indicated. See "Identification" Section 26 05 01.
- .6 Switches shall not be accessible to unauthorized personnel, e.g. mount in service rooms.

## **3. Execution**

### **3.1 STARTER VERIFICATION**

- .1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:
  - .1 Check of control circuits
  - .2 Verify that overload relay installed is correctly sized for motor sued.
  - .3 Record overload relay size and motor nameplate amperage.



- .4 Visual inspection of fuses and contactors.
- .5 Ensure all connections are tight.
- .2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.
- .3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.
- .4 Refer to Section 26 05 82 "Motor Identification".

### **3.2 OVERLOAD RELAYS**

- .1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.
- .2 Overload heaters when equipped with an adjustable dial setting to be set up to suit site conditions and motor characteristics.

**END OF SECTION**

**1. General**

**1.1. SCOPE**

- .1 The work under this section includes electronic meters including test switch and instrument transformers as specified herein and shown on the Drawings. Included are the following topics:

**1.2. RELATED WORK**

- .1 Applicable provisions of Division 1 govern work under this Section
- .2 Section 01 91 01 or 01 91 02 – Commissioning Process
- .3 Section 26 08 00 – Commissioning of Electrical
- .4 Section 26 24 13 – Switchboards
- .5 Section 26 24 16 – Panelboards

**1.3. REFERENCES**

- .1 ANSI C57.13 – Instrument Transformers

**1.4. SUBMITTALS**

- .1 Provide product data showing model numbers, dimensions, mounting requirements, and parameters measured and displayed.

**1.5. OPERATION AND MAINTENANCE DATA**

- .1 All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

**2. Products**

**2.1. UTILITY METERING**

- .1 Provide a stand-alone CT cabinet, or a separate utility metering section in the switchboard. Provide a meter socket with a 1-inch conduit to the CT cabinet. Coordinate approved manufacturer(s), style, and location of metering equipment with local utility requirements.

**2.2. ELECTRONIC METER at MAIN ELECTRIC SERVICE (Non-Utility Metering)**

- .1 Electronic meter with digital display (LED or LCD), shall accept input from standard current transformers rated 5 amperes. Meters for systems operating at 480V and below shall measure circuit potential without the use of external potential transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system or a three-phase, three-wire delta system.
- .2 Meter accuracy shall be 0.5% of actual reading (not full-scale measurement).
- .3 Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:
  - .1 Current: per phase
  - .2 Voltage: phase-to-phase and phase-to-neutral
  - .3 Real Power (kW): three-phase total
  - .4 Reactive Power (kVAR): three-phase total
  - .5 Apparent Power (kVA): three-phase total
  - .6 Power Factor: three-phase
  - .7 Real Energy (kWh): three-phase total
  - .8 Maximum Demand

- .1 Real Power (kW): three-phase total
- .2 Apparent Power (kVA): three-phase total
- .4 All meter potential leads and control power leads shall be fuse protected. Provide a fused disconnecting device or circuit breaker with downstream fuses in the main switchboard or panelboard for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.
- .5 Provide a Meter Interface Gateway device to convert the meter's Modbus RTU output (measured values listed above) to BACnet/IP for interface Building Automation System (BAS). Meter gateway device shall include a prebuilt template for the PQMII of the information. Gateway to be provided is: Real Time Automation – model RTA-460MX-S051. Consult with personnel for proper wiring and termination procedures and gateway software configuration.
- .6 The electrical contractor shall be responsible for providing all communication wiring between the meter and the interface gateway and shall provide Ethernet communication wiring from the interface gateway to the IT closet.
- .7 Building Automation System (BAS) data jacks will be installed according to the building standard except that a data jack is not needed, and a patch cord can be used between the utilizing equipment and the network switch port under the following exceptions:
  - .1 If the utilizing equipment is mounted on or within the vertical sides of the floor or wall rack.
  - .2 If the utilizing equipment is mounted within the same telecommunications room and can be reached with a 40 foot or shorter patch cord that is routed with existing cabling in the racks, trays, J-hooks, etc...and is not stretched tight.

NOTE: If a patch cord is used in exceptions A or B above, the patch cord must be labeled on each end listing the termination point on the opposite end.

EXAMPLE:

Switch name and port #.....to..... equipment name  
s-weeks-156-1-access, port 22.....MS-SECVT0 north wall

[Provide a Meter Interface Gateway as described in the "Meter Interface Gateway" subsection of this specification.]

## **2.3. METER TEST SWITCH**

- .1 Provide a 600 volt ten-pole (4 potential and 6 current shorting) test switch with cover, ABB Type FT-1, or approved equal, connected between each meter and the CT and potential leads. The six leads (2 per phase) from the CT's shall be connected to the current shorting terminal positions on the test switch. The four leads ((3) phase and (1) neutral) from the PT's or bus shall be connected to the potential terminal positions. The test switch shall be located on the face of the switchgear adjacent to the meter or behind a panel cover in an easily accessible location.
- .2 Meter test switch is required on all meter installations at switchboards and main distribution panels. Meter test switch is not required for sub-meters, or meters installed at branch panels, automatic transfer switches, and other downstream locations.

## **2.4. SUB-METER(S)**

- .1 Electronic meter with digital display shall accept input from standard current transformers rated 5 amperes. Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers in lieu of Current Transformers. Meter shall be suitable for connection to a three-phase, four-wire wye system, a three-phase, three-wire delta system, or a 120/240V single-phase system. Meter specification is based on Electro Industries Shark 100 or equal.
- .2 Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
- .3 Meter shall display actual numeric values without requiring the use of a multiplier. Meter shall measure and display the following:

- .1 Current: per phase
- .2 Voltage: phase-to-phase and phase-to-neutral
- .3 Real Power (kW): three-phase total
- .4 Reactive Power (kVAR): three-phase total
- .5 Apparent Power (kVA): three-phase total
- .6 Power Factor: three-phase
- .7 Real Energy (kWh): three-phase total
- .8 Maximum Demand:
  - .1 Real Power (kW): three-phase total
  - .2 Apparent Power (kVA): three-phase total

[Meters for dormitory suites [shall be provided with LCD displays.] [shall not be provided with displays.]]

[Provide Meter Interface Gateway per the paragraph included in this specification section.]

- .4 Provide additional fusible disconnect switch(es)/circuit breaker(s) and enclosures per the PROVISIONS FOR SUB-METERS paragraph included in this specification section.
- .5 MULTI-POINT SUB-METERING SYSTEM: Where multiple sub-meters are desired in a common location, the following multi-point sub-metering system may be used:
  - .1 The Unit shall consist of either of two circuit configurations: 8 multifunction electrical measuring points (meters) for 3 phase power systems or 24 multifunction electrical measuring points (meters) for single phase power systems. The Unit's meters shall perform to spec in harsh electrical applications in high and low voltage power systems.
  - .2 Meter accuracy shall be 1.0% of actual reading (not full scale measurement).
  - .3 The Unit shall have optional data-logging memory of up to 32MB. With data-logging, the Unit shall support:
    - .1 Two pre-configured Historical logs: Log 1 for trending Voltage and Frequency, Log 2 for trending Energy use over time.
    - .2 An Alarm/Limits log that records the state of the 16 limits that can be programmed for the meter
    - .3 A System Events log to store events that happen in, or to the meter, including Startup, Reset commands, Log retrievals, and attempts to log on with a password.An I/O Change log to record changes in the inputs and outputs of the Relay Output/Status Input board.
  - .4 The Unit's meters shall be traceable revenue meters. The Unit which shall contain utility grade test pulses allowing power providers to verify and confirm that the meters are performing to their rated accuracy
  - .5 The Unit shall offer the following communication ports
    - 1. Com 1 shall support RS485 and optional RJ45 Ethernet/802.11b Wi-Fi. It shall support Modbus RTU, Modbus ASCII, and Modbus TCP; and baud rates from 9,600 to 57,600.
    - 2. Com 2 shall be a USB Serial port. It shall support Modbus ASCII and a baud rate of 57,600.
    - 3. Com 3 shall support RS485. It shall support Modbus RTU and Modbus ASCII; and baud rates from 9,600 to 57,600.
  - .6 The Unit shall have a Relay Output/Status Input board.
    - 1. The board shall have 2 Relay Outputs for control applications. The relay outputs shall be able to be triggered by the user-programmed limits in the meters. The user shall be able to assign up to 16 limits, including below-and above-limit conditions for any value the meter measures.

2. The board shall have 4 KYZ Counting Inputs. The KYZ inputs shall be able to be configured to count pulses from gas, water, condensate, and other commodity measuring devices.
- .7 The Unit shall consist of an all-metal enclosure and shall have the following physical properties:
  1. The Unit shall be able to be mounted within an electrical panel.
  2. The Unit shall have a stud-base connection for current inputs

## **2.5. METER INTERFACE GATEWAY**

- .1 Provide a meter interface gateway to allow the meter(s) (daisy-chained to a single interface location) to communicate with the BAS system protocol listed below. The interface gateway shall convert the meter data from the meter's native language to the BAS protocol.
- .2 If the meters can communicate with the BAS system without the use of an interface gateway, then no gateway is required.
- .3 Existing Building Automation System (BAS) communication protocol:
  - .1 BACnet/IP. Meters that have internal BACnet/IP communication interface: Electro Industries Shark 100B series or equal.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/IP interface (either on-board or a separate gateway) to the BAS system.

The Division 26 electrical contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the telecom switch. Coordinate with the facility IT staff.

- .2 BACnet/MSTP. Meters that have internal BACnet/MSTP communication interface: Veris H8163 series, Delta Controls DSM-PWR, or equal. For delta three phase feeders without a neutral leg, the Veris H8163 cannot be used.

[The Main Electric Service meter] [and all Sub-meters] shall have a BACnet/MSTP interface (either on-board or a separate gateway) to the BAS system.

The Division 23 Controls contractor shall be responsible for providing all communication wiring between the meters, between the meters and the interface gateway, and between the gateway and the BAS system. Coordinate with HVAC controls.

- .4 Manufacturers of gateway devices that can provide a BACnet interface for electrical meters with other native protocols: Industrial Control Communications, Inc. - Millennium Gateway Series, Real Time Automation – 460 Series, Delta Controls DSM-PWR, FieldServer, Tridium, or Johnson Controls. All programming of the gateway device to provide the BACnet objects to the building automation system shall be included
- .5 The interface gateway shall transmit all of the measured values listed under the meter descriptions in this specification section.

## **2.6. PROVISIONS FOR SUB-METERS**

- .1 OVERCURRENT PROTECTION FOR POTENTIAL LEADS AND CONTROL POWER LEADS: If the sub-meter(s) are located in the main switchboard, provide a fusible disconnect or circuit breaker in the metering section of the switchboard for the protection of the potential transformers or potential leads as required for the sub-meter(s). If the sub-meter(s) are located adjacent to a panelboard, then the contractor must provide a 3-pole

15 amp circuit breaker in that panelboard as required for the potential transformers or potential leads for the sub-meter(s).

- .2 All meter potential leads and control power leads shall be fuse protected. Provide fuses in the disconnecting device or downstream fuses from the circuit breaker for protection of the meter potential leads and control power leads. Fuses shall be sized per manufacturer's recommendations.

- .3 **ENCLOSURE(S)**

- .1 If the sub-meters are located adjacent to the switchboard or panelboard, then:  
The meters shall be provided in a common meter enclosure.

The meters shall be capable of being mounted in a common enclosure when there is more than one (1) meter.

The metering enclosure shall be provided with separate wiring troughs for line voltage and low voltage wiring.

The enclosure shall come equipped with a control power transformer.

The enclosure shall come with voltage fuses and a shorting block for use with current transformers.

The enclosure shall have a lockable door.

## **2.7. ACCESSORIES**

- .1 Provide shorting block(s) for the CT leads.

## **2.8. CURRENT TRANSFORMERS**

- .1 Current Transformers: ANSI C57.13; 5 ampere secondary, with primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
  - .2 Sub-meters may use 0-2V Current Sensors or 0-0.333V Current Transducers In lieu of Current Transformers.
  - .3 Mount and brace transformers to withstand 100,000 amp short circuit current.

## **2.9. POTENTIAL TRANSFORMERS**

- .1 Provide potential transformers (PT's) only if required by the meter manufacturer. Most meters can measure 480V potential and below without the use of external PT's.
  - .2 Potential Transformers: ANSI C57.13; 120 volt secondary, burden and accuracy consistent with connected metering and relay devices, 60 Hz.
  - .3 Potential transformers on 480/277 volt systems shall be rated 277 – 120 volts, connected phase-to-neutral, and installed on each phase.

## **3. Execution**

### **3.1. INSTALLATION**

- .1 The meters shall be mounted in the locations indicated on the drawings. Mounting height shall be 5'-6" or less from finished floor.
  - .2 New meters installed in existing equipment:
    - .1 All unused openings shall be covered with a metal closure plate painted to match the existing enclosure.
    - .2 Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and #10 AWG stranded copper wire, 600 volt type SIS insulation.

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Splices are not allowed

- .3 Provide a separate enclosure for the new meter if adequate space is not available in the existing panels.
- .4 Dangerous voltage will develop in the open circuit secondary windings of energized current transformers. De-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers
- .5 Verify the proper operation of all meters. Compare the meter display readings to measurements taken with a clamp on amp-meter and hand held volt meter.
- .6 Provide all programming and field set-up of the meters required for measurement and communication of the electrical data.

### **3.2. CONSTRUCTION VERIFICATION**

- .1 Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 26 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

### **3.3. AGENCY TRAINING**

- .1 All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

**END OF SECTION**

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**1. General**

**1.1 SYSTEM**

- .1 Conduit and outlets to form empty raceway system as indicated on the drawings.

**2. Products**

**2.1 COMPONENTS**

- .1 Conduit: Refer to Section 26 05 33.
- .2 Wall Outlet Boxes: Receptacle, blank coverplates and outlets as shown.
- .3 Wire Mold: Legrand G4000 series where shown.

**3. Execution**

**3.1 GENERAL**

- .1 Supply and install pullwire in all empty conduits.
- .2 Minimum conduit size 21mm.
- .3 Provide bushings on all conduits stubbed onto ceiling space.
- .4 Mount bottom of data outlets at 304 mm above finished floor or as noted drawings.
- .5 Junction boxes for outlets to be flush mounted in wall. Appropriate extension rings are to be provided where outlets are to be installed in millwork, backboards, chalkboards, etc.

**END OF SECTION**



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**1. General**

**1.1 WORK INCLUDED**

- .1 Provide and connect all wiring devices for the complete installation.

**2. Products**

**2.1 MANUFACTURER**

- .1 Wiring devices to be of one manufacture throughout project unless noted.
- .2 Manufacturers shall be Acuity, Leviton, and Hubbell or approved equals.
- .3 Manufacturers shall be Leviton Decora style white for all key switches or approved equals. Provide a minimum of thirty (30) keys. Toggle switches not allowed.

**2.2 DEVICES**

- .1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.
- .2 Devices to be white with High Impact Smooth Nylon coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

**2.3 SWITCHES**

- .1 Switches to be Leviton Decora white
- .2 120 volt, 15 amp, single and double pole, three and four-way: Leviton Decora series white
- .3 For wet locations use the following switches: 20A, 120V single pole white, side wired press-switch, as Leviton Decora series
- Leviton Universal dimmer DSL06-450W Led white
- Leviton Decora rocker slide control white
- Leviton ATE04-1L, ATE06-1L, ATE06-1L, IPE04-1L2, VPE04-1L, VPE04-1L, VPE06-1L
- .4 Do not gang Dimmer switches. Derate per manufacturer recommendation if ganged.

**2.4 RECEPTACLES**

- .1 Receptacles to be CSA C22.2 No. 42-M1984, duplex, 15A, 125 volt, U-ground.
- .2 Duplex 15 ampere, 120 volt, 3 wire, white, U-ground, as Leviton series.
- .3 Duplex 15 ampere, 120 volt, 3 wire, white, U-ground ground fault receptacle, Leviton series
- .4 Single 15 ampere 250 volt, 3 wire receptacle white with High Impact Smooth Nylon, as Leviton series.
- .5 Duplex 20 ampere, 125 volt, 3 wire, white, U-ground as Leviton NEMA 5-20R for standard outlet or equal.

- .6 Use single 5.20RA (T-slot) 20A duplex receptacle where indicated Leviton series white..

## **2.5 COVERPLATES**

- .1 Provide coverplates for all wiring devices, including but not limited to telephone, computer, television.
- .2 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.
- .3 Use High Impact Smooth Nylon coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified including receptacles and light switches.
- .4 Weatherproof coverplates shall be as Leviton series for flush mounting and/or surface mounted. Must be Weatherproof in use to comply with CEC.
- .5 Use gasketed DS covers on FS and FD type boxes.

## **2.6 SPECIAL WIRING DEVICES**

- .1 Class "A" ground fault circuit interrupter receptacles, similar to above, complete with zero sequence transformer , trip on 5 mA leakage current with provision for test and reset. 15A and 20A T-Slot.
- .2 Duplex 15 ampere, surge suppression receptacle as Hubbell No. 5262S. These outlets are required in all data communications rooms and rooms with more than ten computers (if the circuit is not from a SPD protected panel).
- .3 Twist Lock receptacles: where indicated and for theatrical lighting power bars.

## **3. Execution**

### **3.1 INSTALLATION**

- .1 Duplex receptacles used with data to be mounted at 787 mm to centre.
- .2 Install wall switches 48 inches (1200 mm) inches above floor, OFF position down.
- .3 Install switches vertically in gang type outlet box when more than one switch is required in one location.
- .4 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.

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- .1 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
  - .2 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.
  - .3 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.
  - .4 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.
  - .5 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.
  - .6 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the A/E's representative at the site. The above shall be used as a guide, but shall be subject to final verification prior to installation.
  - .7 Supply and install a separate neutral conductor from branch circuit panel to devices for all dimmer control circuits.
  - .8 All wiring devices to be white in color.
  - .9 Drill opening for poke through fitting installation in accordance with manufacturer's instructions.
  - .10 Provide weatherproof, gasketed cover plates on flush mounted devices where shown, type and configuration to suit flush device and its orientation.
  - .11 Install blank and device cover plates on switches, receptacles and boxes.
  - .12 Provide GFCI protected 20Ampere receptacles in accordance with NEC - "Ground Fault Protection for Personnel" in bathrooms, garages, and receptacles mounted outside, and within 6 feet (1.8 m) of sinks in kitchen areas.
  - .13 All GFCI receptacles in wet areas shall be in weatherproof enclosure.
  - .14 In addition, GFI protection shall be provided for:
    1. Electrical receptacles within 6 feet (1.8 m) of the sinks or developing tanks in Dark rooms, and within 6 feet (1.8 m) of chemical bath tanks in electrolysis areas.
    2. Laboratory receptacles within 6 feet (1.8 m) of the sink, including sinks inside fume hood enclosures.
    3. Out-door electrical receptacles with weatherproof enclosure/protection.
    4. Receptacles within six feet of an emergency eye wash/shower.
    5. Receptacle feeding water cooler units and drinking fountains
  - .15 Permanently and effectively ground wiring devices in accordance with Division 26 Section "Secondary Grounding for Electrical Systems".

**END OF SECTION**

## **1. General**

### **1.1 RELATED DOCUMENTS**

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### **1.2 SUMMARY**

- .1 Section Includes:
  - .1 Cartridge fuses rated 600-V ac and less for use in enclosed switches and enclosed controllers.
  - .2 Spare-fuse cabinets.

### **1.3 SUBMITTALS**

- .1 Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - .1 Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - .2 Current-limitation curves for fuses with current-limiting characteristics.
  - .3 Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  - .4 Coordination charts and tables and related data.
- .2 Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - .1 Ambient temperature adjustment information.
  - .2 Current-limitation curves for fuses with current-limiting characteristics.
  - .3 Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  - .4 Coordination charts and tables and related data.

### **1.4 QUALITY ASSURANCE**

- .1 Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- .2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .3 Comply with NEMA FU 1 for cartridge fuses.
- .4 Comply with NFPA 70.

### **1.5 COORDINATION**

- .1 Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### **1.6 EXTRA MATERIALS**

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- .2 Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than

three of each size and type.

## **2. Products**

### **2.1 MANUFACTURERS**

- .1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - .1 Cooper Bussmann, Inc.
  - .2 Ferraz Shawmut, Inc.
  - .3 Littelfuse, Inc.

### **2.2 CARTRIDGE FUSES**

- .1 Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## **3. Execution**

### **3.1 EXAMINATION**

- .1 Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- .2 Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- .3 Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- .4 Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- .5 Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 FUSE APPLICATIONS**

- .1 Cartridge Fuses:
  - .1 Service Entrance: Class RK1, time delay.
  - .2 Feeders: Class RK1, time delay.
  - .3 Motor Branch Circuits: Class RK1, time delay.
  - .4 Other Branch Circuits: Class RK1, time delay.
  - .5 Control Circuits: Class CC, fast acting.

### **3.3 INSTALLATION**

- .1 Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

### **3.4 IDENTIFICATION**

- .1 Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION**

**1. General**

**1.1 SUMMARY**

- .1 Related Documents:
  - .1 Drawings and general provisions of the Subcontract apply to this Section.
  - .2 Review these documents for coordination with additional requirements and information that apply to work under this Section.
- .2 Section Includes:
  - .1 Enclosed molded case circuit breakers.
- .3 Related Sections:
  - .1 Division 01 Section "General Requirements."
  - .2 Division 01 Section "Special Procedures."
  - .3 Division 01 Section "Common Work Results for Electrical".
  - .4 Division 26 Section "Secondary Grounding for Electrical Systems".

**1.2 REFERENCES**

- .1 General:
  - .1 The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
  - .2 Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.
  - .3 Refer to Division 01 Section "General Requirements" for the list of applicable regulatory requirements.
  - .4 Refer to Division 26 Section "Common Results for Electrical" for codes and standards, and other general requirements.
- .2 ANSI/NFPA 70 - National Electrical Code.
- .3 NFPA – National Fire Protection Association:
  - .1 Standard for Electrical Safety in the Workplace (NFPA 70E & Worksafe BC)
- .4 NEMA – National Electrical Manufacturers Association:
  - .1 NEMA 250 Enclosures for Electrical Equipment
  - .2 NEMA AB1 Molded Case Circuit Breakers
- .5 UL – Underwriters' Laboratories:
  - .1 UL 489 Molded Case Circuit Breakers and Enclosures.

**1.3 SUBMITTALS**

- .1 Submit under provisions of Division 26 Section "Common Results for Electrical - Review of Materials" and Division 01 Section "General Requirements."
- .2 Submit five (5) copies of Product Data and Shop Drawings for equipment and component devices. Include time–current curves of circuit breaker trip units.
  - .1 Include dimensional outline drawings; conduit entrance locations and requirements; voltage rating, continuous and short-circuit current ratings; cable terminal sizes and temperature ratings.

- .3 Operation and Maintenance Data:
  - .1 Maintenance Data: Furnish five (5) copies of recommended maintenance procedures and intervals. Include spare parts data listing; source and current prices of replacement parts and supplies.
  - .2 2. Furnish Time–Current curves of circuit breaker trip units. Time–Current curves shall be first generation originals on full size 11 by 17 inches (280 by 432 mm) paper.

#### **1.4 QUALITY ASSURANCE**

- .1 Products shall be tested, approved and labeled/listed by Underwriters Laboratories, Inc., or by a nationally recognized testing laboratory (NRTL) as listed in Division 26 Specification "Common Work Results for Electrical."
- .2 Electrical equipment and materials shall be new and within one year of manufacture, complying with the latest codes and standards. No used, re-built, refurbished and/or re-manufactured electrical equipment and materials shall be furnished on this project.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver materials to site in unopened cartons or bundles as appropriate, clearly identified with manufacturer's name, Underwriter's or other approved label, grade or identifying number.
- .2 Handle in accordance with manufacturer's written instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

### **2. Products**

#### **2.1 MANUFACTURERS**

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

#### **2.2 MOLDED CASE PROTECTIVE DEVICES**

- .1 Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics
- .2 Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.
- .3 Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
- .4 Circuit breakers 15 to 100 ampere frame shall be provided with fixed thermal-magnetic trip units.
- .5 Circuit breakers 225 ampere frame and above shall be provided with field-changeable, field-adjustable thermal-magnetic trip units with inverse time-current characteristics. Trip mechanisms shall be provided with the following trips: [instantaneous] [long time] [short time].
- .6 Circuit breakers 400 ampere frame and above shall be provided with microprocessor-based RMS sensing trip units with features noted on the drawings. Trip mechanisms shall be provided with the following trips: [instantaneous] [long time pickup] [long time delay]

- [short time pickup] [short time delay] [I2t function] [ground fault pickup] [ground fault delay].
- .7 Circuit breakers for HVAC and refrigeration unit equipment shall be listed by UL as Type HCAR.

## 2.3 ACCESSORIES

- .1 Provide accessories as indicated on the Drawings.
- .2 Shunt Trip Device: Coil rated for 120/208 volts, AC.
- .3 Undervoltage Trip Device: Coil rated for 120 /208 volts, AC.
- .4 Auxiliary Contacts: Rated at 120/ 208 volts, AC, see dwg. for rating. Contacts on an auxiliary switch; operation is designated "a" if open when the main circuit breaker contacts are open and "b" if closed when the main circuit breaker contacts are closed.
- .5 Alarm Switch: Rated at 120/ 208 volts, AC, see dwg. for rating. Alarm switch shall operate upon the tripping of the circuit breaker. Contacts on an auxiliary switch; operation is designated "a" if open when the main circuit breaker contacts are open and "b" if closed when the main circuit breaker contacts are closed.
- .6 Auxiliary Switch: Rated at 120/ 208 volts, AC, see dwg. for rating. Switch shall be interlocked with the main circuit breaker contacts.
- .7 Electrical Operator: Rated for 120/ 208 volts, AC.
- .8 Neutral Bus, insulated from enclosure: See drawings for Ampere rating.

## 2.4 ENCLOSURES

- .1 Provide enclosures fabricated from [steel] [aluminum] [plastic] suitable for locations as indicated on the drawings and as described below:
- .1 NEMA 1 surface or flush-mounted general purpose enclosures intended for indoor use.
- .2 NEMA 12 dust-tight enclosures intended for indoor use to provide protection against circulating dust, falling dirt and dripping non-corrosive liquids.
- .3 NEMA 3R rain-tight enclosures intended for outdoor use in damp locations or to provide protection against rain.
- .4 NEMA 4/4X watertight stainless steel intended for indoor or outdoor use to provide protection against windblown dust and rain, splashing rain, hose-directed water, and damage from corrosive agents
- .5 NEMA 7, Class I, Group C and D hazardous location cast aluminum intended for indoor use in locations classified as Class I, Group C and D as defined in the National Electrical Code
- .6 NEMA 9, Class II, Groups E, F and G hazardous location cast aluminum intended for indoor use in locations classified as Class II, Groups E, F and G as defined in the National Electrical Code
- .2 Provide a factory installed ground termination block sized for the grounding conductor indicated on the Drawings.
- .3 Provide operator handle mechanisms that are padlockable in the "OFF" position. In the case of electrically operated breakers, provide a permanently installed device for padlocking in the "OFF" position.
- .4 All enclosed circuit breakers shall have nameplates that contain a permanent record of catalog number and maximum rating.
- .5 Enclosures shall be finished using the manufacturer's standard process and shall be ANSI 61 gray color.



### **3. Execution**

#### **3.1 INSTALLATION**

- .1 Install circuit breaker enclosures plumb with suitable supports and per manufacturer's recommendations. Where mounted on concrete wall, install with 1/2 inch (13 mm) steel spacers behind the switch enclosure. Mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5W per CBC.
- .2 Height: Install top of circuit breaker enclosure 78 inches (1980 mm) above finished floor, unless otherwise noted on drawings.
- .3 Provide engraved nameplates with the designation indicated on the Drawings.
- .4 Perform field adjustments of the circuit breakers as required to place the equipment in final operating condition. The settings shall be in accordance with the approved protective device coordination study or as directed by the Project Manager.

#### **3.2 FIELD QUALITY CONTROL**

- .1 Comply with requirements of NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems and the manufacturer's inspection, testing, calibration and start-up procedures. The manufacturer's technician shall perform inspection, testing, calibration and start-up, with assistance from the Subcontractor as necessary, and in the presence of the University's representative. Schedule testing and start-up with at least ten (10) working days advance written notification.
- .2 Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and check tightness of connections with a calibrated torque wrench.
- .3 Electrical Tests: Measure and record insulation resistance of the enclosed circuit breaker and its components (phase-to-phase and phase-to-ground) prior to energization. The Subcontractor shall not be responsible for defective insulation in equipment that has been supplied by the University, unless such damage is due to negligence or incorrect handling or installation workmanship of the Subcontractor.
  - .1 The insulation resistance of each circuit phase-to-phase and phase-to-ground shall be measured. For circuits rated less than 600 volts, the resistance shall not be less than 100 megohms.
  - .2 Systems rated above 240 volts shall be tested with a 1000-volt Megohmmeter. Circuits rated 240 volts and below shall be tested with a 500-volt Megohmmeter. The D.C. potential shall be applied for thirty (30) seconds.
  - .3 Test and record phase rotation (clockwise) and sequence (A-B-C).
- .4 Provide the University with five (5) certified copies of field test reports.

**END OF SECTION**

**1. General**

**1.1 SECTION INCLUDES**

- .1 Equipment, fabrication and installation for ground fault protection.
- .2 See Section 26 23 00 - Low Voltage Switchgear.
- .3 See Section 26 24 02 - Service Entrance Board.

**1.2 RELATED SECTIONS**

- .1 Section 01 29 83 - Payment Procedures for Testing Laboratory Services.
- .2 Section 01 33 00 - Submittal Procedures.
- .3 Section 01 45 00 - Quality Control.
- .4 Section 01 91 13 – General Commissioning (Cx) Requirements.
- .5 Section 26 05 00 – Common Work Results - Electrical.

**1.3 PAYMENT PROCEDURES**

- .1 Pay for field testing of ground fault equipment performed by equipment manufacturer.

**1.4 REFERENCES**

- .1 Canadian Standards Association (CSA)
- .2 CAN/CSA-C22.2 No. 144, Ground Fault Circuit Interrupters.
- .3 National Electrical Manufacturers Association (NEMA)
- .4 NEMA PG 2.2, Application Guide for Ground Fault Protection Devices for Equipment.

**1.5 SUBMITTALS**

- .1 Submit product data and shop drawings.
- .2 Submit test report for field testing of ground fault equipment to Departmental Representative and certificate that system as installed meets criteria specified.

**2. Products**

**2.1 EQUIPMENT**

- .1 Ground fault protective equipment: components of one manufacturer.
- .2 Provide ground fault protection on 1000A, 600V, 4 wire, 3 phase service and 2000 A, 208V, 4 wire, 3 phase service and above: to NEMA PG 2.2 and CAN/CSA-C22.2 No. 144.
- .3 Ground fault unit to contain:
  - .1 Ground sensing relay suitable for operation at 500 mA as indicated on electrical drawings. Control voltage: 120 V.
  - .2 Ammeter with scale 0 to 5 A to indicate ground current value.
  - .3 Three position sensitivity control switch to select value of leakage current at which relay will operate.
  - .4 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
  - .5 Switch:
    - .1 SPDT contacts for alarm and trip.
    - .2 Mechanical target indication.
    - .3 Manually reset.
  - .6 Reset button for contacts and target.
  - .7 Suitable for panel mounting.

- .4 Zero sequence transformer toroidal type with 300 - 3000 mA range.
- .5 Neutral:
  - .1 Use an artificial neutral and grounding resistor.
  - .2 Use neutral ground resistor unit.
- .6 System to operate instantaneously at ground current setting.

## **2.2 FABRICATION**

- .1 Install following components in equipment specified in other Sections and as indicated.
  - .1 Zero sequence transformer.
  - .2 Ground fault relay.
  - .3 Ground resistor unit.

## **2.3 RELATED EQUIPMENT**

- .1 Shunt trip breakers. Load break disconnect switch.

## **3. Execution**

### **3.1 INSTALLATION**

- .1 Do not ground neutral on load side of sensor.
- .2 Install phase conductors including neutral through zero sequence transformer.
- .3 Install ground fault protection system.
- .4 Make connections as indicated and in accordance with manufacturer's recommendations.

### **3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 – Common Work Results - Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .2 Arrange and pay for field testing of ground fault equipment by ground fault equipment manufacturer before commissioning service.
- .3 Check trip unit settings to ensure proper working operation and protection of components.
- .4 Demonstrate simulated ground fault tests.

**END OF SECTION**

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**1. General**

**1.1 RELATED IN SPECIFIED IN OTHER SECTIONS**

- |    |                               |                  |
|----|-------------------------------|------------------|
| .1 | General Requirements          | Division 1       |
| .2 | General Electrical Provisions | Section 26 05 01 |
| .3 | Main Distribution Equipment   | Section 26 24 13 |
| .4 | Panelboards                   | Section 26 24 17 |

**1.2 REGULATORY REQUIREMENTS**

- .1 Units to list CSA approval.
- .2 Size with voltage, current and interrupting capacities required by the Canadian Electrical Code.

**2. Products**

**2.1 MOULDED CASE BREAKERS**

- .1 Moulded case automatic circuit breakers: 600 and 250 volt bolt-in type with thermal and magnetic trip, quick make/ quick break type, trip free position separate from "On" or "Off" positions, for manual and automatic operation, interrupting rating minimum 10 kA or as indicated in panel schedules or as required for application. Common trip breakers shall have single handle for multi-pole applications. Wafer or duplex type breakers will not be accepted. Width of breaker to be minimum 25 mm per pole.
- .2 Ground fault Interrupting Breakers: As above with 5 mA or 30 mA leakage trip to suite application. All heat trace circuits to be installed with 30 mA trip. Install ground fault protection as indicated on drawings and at breakers required by the CEC

**2.2 ENCLOSURES**

- .1 Where separately mounted outside equipment, to be CSA Type 1 or 2 in dry, heated areas, EEMAC Type 3 in outdoor locations, and EEMAC Type 4 in corrosive atmosphere.

**3. Execution**

**3.1 INSTALLATION**

- .1 Install disconnect switches as required by the CEC and as indicated on the drawings. All motors shall have a disconnect installed at the motor. Remote disconnect such as breakers are not acceptable.
- .2 Factory install breakers in panel boards in size and quantity indicate on the panel boards schedules.
- .3 Install correct type and size of fuse in fused disconnects.

**END OF SECTION**

**1. General**

**1.1 DESCRIPTION**

- .1 Provide disconnect switches for 120/208 volt distribution as indicated on the drawings, as manufactured by Schneider, Cutler Hammer, Siemens & Eaton.
- .2 Disconnects to be to CAN/CSA C22.2 No. 4-M89 and required by CEC to suit application.

**2. Products**

**2.1 DISCONNECT SWITCHES**

- .1 Ratings: 600/240 volts for 120/208-volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.
- .2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-2 and EEMAC-3 where exposed to weather.
- .3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 26 05 01.
- .4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism.
- .5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.
- .6 Fuse Holders: Provide fuse holders on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

**2.2 FUSES**

- .1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

**3. Execution**

**3.1 DISCONNECT SWITCHES**

- .1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise, provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.
- .2 Wiring: Connect line and load cable to all switches.
- .3 Fuse Rating: Install so that the rating is visible.

- .4 Identification: Provide lamaroid plate on each switch showing voltage, source of supply and load being fed, for example:  
  
Door Controller  
120/208 Volts  
Fed from PPA
- .5 Install disconnect switches complete with fuses as indicated on drawings.

**END OF SECTION**

---

**1. General**

**1.1 RELATEDWORK**

- .1 Mechanical

**1.2 WORKINCLUDED**

- .1 Installation of Variable Speed Drives to be completed by this Division as per mechanical specifications.
- .2 The system shall be complete and shall include all components necessary to comprise as a functional system.

**1.3 RELATEDWORK BY OTHERS**

- .1 Mechanical Contractor to supply Variable Speed Drives as per mechanical specifications.

**2. Products**

- .1 Not used

**3. Execution**

**3.1 GENERAL**

- .1 The Mechanical Contractor shall provide the VFD manufacturer a shop drawing of each motor application, to ensure that VFD(s) and motors are fully compatible.
- .2 Motor application data are shown on the mechanical drawings / specifications.

**3.2 INSTALLATION**

- .1 Electrical Contractor to install VFD(s), filters, and associated equipment in locations as indicated on drawings, and cooperate with Division 23 regarding connecting up all necessary wiring.

**END OF SECTION**

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**1. General**

**1.1 RELATED WORK**

- |    |   |                  |
|----|---|------------------|
| .1 | General Electrical Requirements         | Section 26 05 01 |
| .2 | Luminaire Schedule (Unless on drawings) | Section 26 51 00 |
| .3 | Exit Lights                             | Section 26 53 00 |

**1.2 WORK INCLUDED**

- .1 This section includes for the supply and installation of luminaires complete with lamps, driver, supports and accessories, and for the supply of plaster frames, trim rings and back boxes for plaster or dry wall ceilings or concrete.

**1.3 CODE REQUIREMENTS**

- .1 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by provincial, municipal or other regulatory agencies having jurisdiction.
- .2 Luminaires to conform to CSA C22.2 No. 9, ANSI C82.1 and lamps to ANSI C78. LED drivers with ENEC mark and EMC tested, IP20 for indoor and IP65 for outdoor

**1.4 COORDINATION WITH OTHER DIVISIONS**

- .1 Confirm compatibility and interface of other materials with luminaire and ceiling system. Report discrepancies to the A/E and defer ordering until clarified.
- .2 Supply plaster frames, trim rings and back boxes to other trades as the work requires.
- .3 Coordinate with other trades to avoid conflicts between luminaires, supports and fittings and mechanical or structural building elements.

**1.5 SHOP DRAWINGS**

- .1 Submit a complete list of the types of lighting luminaires, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc., for review.
- .2 Submit complete photometric data based on actual luminaires proposed for the project. Photometric data must be produced by an independent testing laboratory.

**1.6 SAMPLES**

- .1 Provide samples of luminaires, lamps, drivers and accessories when requested by the A/E.

**2. Products**

**2.1 GENERAL**



- .1 Provide, wherever possible, commercially available luminaires meeting the specified requirements and as indicated on the drawings. Different luminaires may be supplied by different manufacturers. Similar luminaires shall be supplied by the same manufacturer.
- .2 It is Contractors responsibility to perform all NECB calculation and get approvals from City if different fixture is utilized. Submit alternate specification to PCA Departmental Representative prior to tender close. Alternate specifications are only valid with PCA Departmental Representative written approval.  
Alternates specifications are not allowed for exterior luminaires. Provide as per Specifications on the drawings.  
  
Recessed pot-lights shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access. Unit shall be complete with plaster rings and supports as required. Ballasts
- .3 Provide only luminaires which are structurally well designed and constructed and which use new materials of the highest commercial grade available. Unless specifically noted otherwise, luminaires to be of the quality stated in the manufacturers catalogues and data sheets. Luminaires shall be designed for adequate dissipation of ballast and lamp heat.
- .4 Louvres shall be supplied by this division and shall be acrylic with finish as specified or as selected by PCA Departmental Representative.
- .5 Use self-aligning ball joint hangers for stem suspended luminaires.
- .6 Use cadmium plated chains for suspended luminaires in unfinished areas.
- .7 Supply and install aligning channels for mounting suspended continuous row luminaires.

## 2.2 LED LUMINAIRES

- .1 Light Emitting Diodes (LED)
  - .1 CRI shall be greater than or equal to 75.
  - .2 Rated LED life time shall demonstrate 70% lumen maintenance at 35,000 hours as defined in the IESNA standards.
  - .3 LED's shall be IES LM-79 and LM-80 tested and certified.
- .2 LED Drivers (Electronic- Instant Start)
  - .1 Drivers shall comply with ANSI C62.41 Category A for Transient protection.
  - .2 Driver to be compliant with ROHS.
  - .3 Driver to be EMI compliant in accordance with FCC 47 Sub Part 15, CISPR 15, CISPR 22 Class A, EN61000-3-2, -3-3, -4-4, -4-5.
  - .4 Driver to be compliant with Safety regulations in accordance with UL879, UL1012, UL935, IEC61347-2-2, EN61558-1, EN61558-2-17, EN60065, IEC6100-4-5.
  - .5 Drivers shall contain no PCB's nor mercury.
  - .6 Drivers shall be primary fused.
  - .7 Output ripple maximum 10%
  - .8 Temperature: -40 to +80 degree Celsius for exterior luminaires, 0 to +80 degree Celsius for interior luminaires,
  - .9 Efficiency minimum 93%.
  - .10 Power factor >0.9 at full load.
  - .11 Input 120V
  - .12 Output 120 – 425 VDC, 0.35Amp ±5%.
  - .13 Frequency 50-60 Herz.
  - .14 Total Harmonic Distortion < 10% at Full Load at 120 Volt and <15% at 347 Volt.
  - .15 Driver to be fully encased and potted.
  - .16 Life time rated at minimum 50,000 hours.

### **3. Execution**

#### **3.1 INSTALLATION**

- .1 Install recessed luminaires to permit removal from below to gain access to outlet or pre-wired luminaire box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with No. 14 AWG conductors) may be used but shall be independently supported, (e.g., not from the connectors), and have anti-shorts installed. With either type of connection method, the length of the flexible connection shall not exceed 2 meters.
- .2 For recessed luminaires in particular for HID pot-lights and fluorescent luminaires, support luminaire independent of suspended ceiling system.
- .3 Where luminaires are surface-mounted on T-bar ceilings, support unit from structure and stabilize luminaire with sheet metal screws into a T-bar at both ends.
- .4 When luminaires are installed in valances with solid lens, ensure presence of adequate ventilation openings into ceiling space to dissipate heat.

#### **3.2 WORKMANSHIP**

- .1 Completely clean all luminaires, including lenses, lamps, hangers and interiors at completion of project and before final acceptance of project.
- .2 Provide suitable extension couplings for wall mounted luminaires.
- .3 Hang and mount luminaires to prevent distorting frame, housing, sides or lens frame and permit correct alignment of several luminaires in a row.
- .4 Support luminaires as indicated on the drawings, level and plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housings rigidly and adjust to a neat flush fit with mounting surface.
- .5 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.
- .6 Where luminaires are required to be supported from the building structure, use a minimum of 2 - 6.35 mm rods per luminaire.
- .7 For remotely mounted ballasts, supply mounting boards and space ballasts in accordance with manufacturer's direction. Size wiring from ballast to remote luminaires to meet manufacturer's requirements.
- .8 Remove any noisy ballasts from the luminaires and replace at no additional cost to the Owner prior to completion and final acceptance of the installation.
- .9 Coordinate entire installation with other trades prior to rough stage on site to avoid conflicts. During installation, locate ductwork and any other items that may cause interference in the ceiling space. Notify general contractor M and E coordinator promptly of any conflicts.
- .10 In mechanical rooms and areas install lighting after piping and ductwork is installed to permit final light locations to be determined. Allow for additional necessary chain, hanger
- .11 rods and supports as may be necessary.

### **3.3 BRANCH CIRCUIT WIRING**

- .1 Where the drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated and required. Run conduit parallel to major building lines.
- .2 Conductors shall be #12 R90 x-link minimum.
- .3 Conduits shall be sized in accordance with code requirements for the wire count installed. In no case shall conduit less than 21 mm be used for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a derating of 80% as per CEC 4-004 (1) (C).
- .4 Special lamps not specified in this Section to be as called for in the Luminaire Schedule.
- .5 All lamps supplied to be suitable for luminaire burning position.

### **3.4 LUMINAIRE ALIGNMENT AND CLEANING**

- .1 Align luminaires in continuous rows to form straight uninterrupted line.
- .2 Align individual mounted luminaires parallel or perpendicular to building lines.
- .3 Thoroughly clean all fixtures, including reflectors, lamps diffusers louvers and lenses.
- .4 Adjust lenses, frames and trims to eliminate light leaks.

### **3.5 LUMINAIRE SUPPORTS**

- .1 For suspended ceiling installations support luminaires from ceiling grid in accordance with local inspection requirements.
- .2 Install blocking behind drywall mounted fixtures to support luminaire. Do not mount fixture to drywall with inserts or toggle bolts.
- .3 Fixtures surface mounted on t-bar shall be support with approved t-bar clips.
- .4 Support fixtures in T-Bar tiles with 13 by 38 mm channel supports that are tied to the ceiling support system.
- .5 Combustible materials such as wood blocking may not be used in ceiling spaces to support fixtures or electrical items.

**END OF SECTION**

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**1. General**

**1.1 WORK INCLUDED**

- .1 Supply emergency lighting units complete with all accessories.

**1.2 SPECIAL CODES**

- .1 Canadian Electric Code, Part 1, Section 46 "Emergency Systems, Unit Equipment and Exit Signs".
- .2 CSA Standard C22.2 No. 141-M1985 "Unit Equipment for Emergency Lighting".
- .3 National Building Code and BC Building Code.

**2. Products**

**2.1 GENERAL**

- .1 Supply and install battery power emergency lighting where shown on the drawings. Lights are to switch "ON" automatically in the event of failure of normal power, and "OFF" on restoration of power. The batteries shall be automatically recharged from a 120 VAC supply, Output Voltage 24 V.

**2.2 LINE CONNECTION**

- .1 Each battery unit shall be equipped with AC line cord and plug.

**2.3 UNITS**

- .1 Units to contain solid state battery charger, transfer switch and batteries. Provide all relays, hardware and circuitry for operation specified. Units to have push-to-test switch, "ON" and "charging" lights with extended lamp life and be complete with automatic self diagnostic circuitry.

**2.4 BATTERIES**

- .1 Unless specifically indicated, of sufficient watt-hour capacity to power the loads connected to each individual unit for 30 minutes, 12 volt, 10 year long life sealed lead acid batteries, contained within the units.
- .2 DC Power: Flexible conduit to be an electrical box.

**2.5 HEADS**

- .1 Remote and/or integral lighting heads to be as shown on drawings. Fixtures to be adjustable 4W/24V LED MR16 type.
- .2 Wire guards to be installed on all remote heads in the locker rooms and gymnasiums.

**2.6 MOUNTING BRACKET**

- .1 Metal Shelf type, specifically made for unit supplied.

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**2.7 MANUFACTURER**

- .1 Stanpro see drawings for model no. & wattage information complete with mounting bracket and automatic self Diagnostic circuitry. Other approved manufacturers: Emergi-Lite, Ready-Lite, Dual-Lite, Aim Lite.

**2.8 LOW VOLTAGE DISCONNECT**

- .1 To disconnect battery on drop in voltage at a level which will damage the battery permanently, i.e. below 85% of nominal voltage.

**3. Execution**

**3.1 INSTALLATION**

- .1 Mount battery units with the bottom of the enclosure not less than 2.2 m above the floor, where practicable.
- .2 Install duplex receptacle adjacent to unit and connect to 1Ø 120V unswitched area lighting circuit.
- .3 Where applicable wire from unit to DC circuitry in exit lights.
- .4 Wiring from units to remote heads and/or exit lights shall be sized to prevent voltage drop of more than 5%.

**END OF SECTION**

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**1. General**

**1.1 RELATEDWORK**

- |    |   |                  |
|----|---|------------------|
| .1 | General Electrical Requirements   | Section 26 05 01 |
| .2 | Lighting Equipment  | Section 26 50 00 |
| .3 | Luminaire Schedule (unless on drawings)   | Section 26 51 00 |
| .4 | Unit Equipment for Emergency Lighting   | Section 26 52 00 |
| .5 | Canadian Standards Association (CSA)<br>CSA C22.2 No.141, Unit Equipment for<br>Emergency Lighting.<br>CSA C860, Performance of Internally-Lighted Exit<br>Signs.<br><br>NFPA 101, Life Safety Code |                  |

**1.2 WORK INCLUDED**

- .1 Supply exit lights suitable for mounting as indicated, with lamps and accessories.
- .2 Provide heavy duty substantial wire guards on all exit lights in gymnasium.

**1.3 CODE REQUIREMENTS**

- .1 Canadian Electrical Code, Part 1, Section 46, Emergency Systems, Unit Equipment and Exit Signs.

**2. Products**

**2.1 LUMINAIRES**

- .1 Manufacture: Stanpro as shown on drawings or approved equals. Other approved manufacturers: Ready-Lite, Emergi-Lite., Lithonia, Aim lite
- .2 General Construction: Extruded aluminum faceplates, white finish, with letters cut through to expose fiberglass diffusers, with directional arrows as indicated on drawings. The LED sign shall consume less than five watts per face and shall have solid state design.
- .3 Mounting: End to wall, wall or ceiling, single or double sides as indicated. Multiple knock-outs for universal mounting not acceptable.
- .4 Units to be complete with integral battery and electronic components to allow for AC to DC automatic transfer. Battery to be rated for 10-year life and unit to be complete with self and manual test.
- .5 Provide heavy duty substantial wireguards on exit lights located in gymnasium.

**2.2 STANDARD UNITS**

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Electrical Code for Preferred Packaging guidelines.

- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple - LED-4 W, 120 V, over 500,000 hours with average surface brightness of 3000 candela.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm, with 13 mm thick stroke red on extruded aluminum face, reading EXIT.
- .7 Downlight: white glass in bottom of unit.
- .8 Third lamp socket for emergency lamp lighting circuit.
- .9 Face plate to remain captive for relamping.

## **2.3 SELF-POWERED UNITS**

- .1 Exit lights: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.
- .2 Housing: cold rolled steel minimum 1.0 mm thick, satin aluminum enamel finish.
- .3 Face and back plates: extruded aluminum.
- .4 Lamps: multiple -, LED-12W 120 V over 500,000 hours.
- .5 Operation: designed for 25 years of continuous operation without relamping.
- .6 Letters: 150 mm high x 19 mm wide, with 13 mm thick stroke, red on extruded aluminum face, reading EXIT.
- .7 Downlight: white glass in bottom of unit.
- .8 Third lamp socket for emergency lamp lighting circuit.
- .9 Face plate to remain captive for relamping.
- .10 Supply voltage: 120 V, ac.
- .11 Output voltage: 12 or 24 V dc.
- .12 Operating time: minimum 30 minutes and as required by code.
- .13 Recharge time: 12 hours
- .14 Battery: sealed, maintenance free, warranty to Section 26 52 00 – Emergency Lighting, 1.5 – Emergency Lights.
- .15 Charger: solid state, voltage/current regulated, inverse temperature compensated, short circuit protected, with regulated output of plus or minus 0.01 V for plus or minus 10% V input variation.
- .16 Solid state transfer circuit.
- .17 Signal lights: solid state, for 'AC Power ON'.
- .18 Lamp heads: integral on unit, 345° horizontal and 180° vertical adjustment. Lamp type: as indicated.
- .19 Mounting: suitable for universal mounting directly on junction box and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .20 Cabinet: finish: standard.
- .21 Auxiliary equipment:
  - .1 Lamp disconnect switch.
  - .2 Test switch.
  - .3 AC/DC output terminal blocks inside cabinet.
  - .4 RFI suppressor.
  - .5 Cord and single twist-lock plug connection for AC power supply.

## **2.4 DESIGN X1**

- .1 Recessed, wall, end to wall, ceiling mounting as indicated.
- .2 Single or double face with running man pictogram face plate to remain captive for relamping as indicated.

- .3 Arrow: right or left as indicated.
- .4 Wireguard

### **3. Execution**

#### **3.1 INSTALLATION**

- .1 Install exit lights to manufacturer's recommendations, listing requirements, NFPA standard and local regulatory requirements.
- .2 Connect fixtures to exit light circuits using RW90 wire in EMT conduit.
- .3 Connect emergency lamp sockets to emergency circuits.
- .4 Ensure that exit light circuit breaker is locked in on position.
- .5 Provide tests in accordance with Section 26 05 00 – Common Work Results - Electrical and Section 01 91 13 – General Commissioning (Cx) Requirements.
- .6 Connect exit lights to separate branch circuits and to emergency battery packs as indicated. Provide red bolt on breaker for exit sign and Identify circuit breakers feeding exit light circuits and install locking straps.

#### **3.2 CLEANING**

- .1 Proceed in accordance with Section 01 74 11 – Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 PVC conduit shall not be used with wiring for exit lights unless embedded in concrete or block wall.
- .4 Install exit lights on ceiling's only when not possible to wall mount. Install 6inch below ceiling level.

**END OF SECTION**



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**1. General**

**1.1 RELATED SECTIONS**

.1	Identification	Section 26 05 53
.2	Conduits	Section 26 05 33
.3	Cable Trays	Section 26 05 36
.4	Outlet Boxes, Pull Boxes, Cabinets and Miscellaneous Raceways	Section 26 05 32
.5	Wiring Devices	Section 26 27 26
.6	Hangers, Supports and Inserts	Section 26 05 29
.7	Low Voltage Communication Raceway System	Section 27 05 28

**1.2 SYSTEM DESCRIPTION**

- .1 Structured telecommunications wiring system consist of unshielded-twisted-pair and optical fiber cables, terminations, connectors, cross-connection hardware and related equipment installed inside building for occupant's telecommunications systems, including voice (telephone), data. Conduit, cabling and outlets to form a complete and operating Category 6 horizontal cabling system for data and telephone as indicated on the drawings and detailed in this specification.
- .2 Provide all cabling and associated components as described in the specifications and drawings.
- .3 Cable system shall have end-to-end Category 6 rated products with components manufactured by a single manufacturer.
- .4 Approved manufacturers are: AMP, Belden, Systimax, Leviton and Panduit.
- .5 Install voice and data backbone cables in conduit as indicated on the drawings. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure.
- .6 Backbone cabling systems consists of backbone cables, intermediate & main cross-connects and mechanical terminations.
- .7 The communication cabling system shall be supplied and installed as a sub-contract to Division 26 – Electrical.

**1.3 REFERENCES**

- .1 The following industry standards are the basis for the structured cabling system described in this document
- .2 Canadian Standards Association (CSA International)
  - .1 C22.2 NO. 214-08 – Communications cables (Bi-national standard, with UL 444)

- .2 C22.2 NO. 232-09 – Optical fiber cables
- .3 CAN/CSA C22.1-06 – Canadian Electrical Code.
- .3 Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA)
  - .1 ANSI/TIA-568-C.1–2009+A1:2012, Commercial Building Telecommunications Cabling Standard
  - .2 ANSI/TIA-568-C.2–2009+A1:2010, Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
  - .3 ANSI/TIA-568–C.3–2009+A1:2011, Optical Fiber Cabling Components Standard
  - .4 ANSI/TIA-568–C.4–2011, Broadband Coaxial Cabling and Components Standard
  - .5 ANSI/TIA-569-C–2012, Telecommunications Pathways and Spaces
  - .6 ANSI/TIA/EIA–598–C–2005, Optical Fiber Cable Color Coding
  - .7 ANSI/TIA–606–B–2012, Administration Standard for Commercial Telecommunications
  - .8 ANSI/TIA–607–B–2011, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - .9 ANSI/TIA–758–B–2012, Customer-Owned Outside Plant Telecommunications Infrastructure Standard
  - .10 ANSI/TIA–862–A–2011, Building Automation Systems Cabling Standard
  - .11 ANSI/TIA–942–A–2012, Telecommunications Infrastructure Standard for Data Centers.
  - .12 ANSI/TIA–1152–2009, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  - .13 NFPA
    - .1 NFPA 70 National Electric Code (NEC)
  - .14 ISO/IEC
    - .1 ISO 11801 Generic Cabling for Customer Premises
- .4 If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- .5 This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

#### 1.4 SUBMITTALS

- .1 Prior to start of work the contractor shall submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof compliance of this specification. The contractor shall employ a Registered Communication Distribution Designer who has current RCDD membership with BICSI.
- .2 Submit appropriate cut sheets and samples of all products, hardware and cabling.
- .3 Do not start any part of the telecommunications system installation until approval for all system shop drawings have been approved. Installer is to confirm pathways from outlet to rack will accommodate maximum cable length including service lops prior to materials arriving on site

- .4 The Contractor shall receive approval from the Owners on all substitutions of material. No substituted materials shall be installed except by written approval from the Owner.

## **1.5 QUALITY ASSURANCE**

- .1 The Contractor shall provide a complete warranty to guarantee a high performance cabling systems that meet application requirements. The guarantee shall include all cable installed in the structured cabling system. The Cable shall be warranted for a period of at least 25 years.
- .2 The installing contractor shall submit proof that they are certified by the manufacturer of the system components to install and certify the system.

## **1.6 DRAWINGS**

- .1 It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the contractor in bidding the job. The Contractor shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications. .
- .2 The telecommunications contractor shall verify all dimensions at the site and be responsible for their accuracy.
- .3 Prior to submitting the bid, the telecommunications contractor shall call the attention of the PCA Departmental Representative to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

## **2. Products**

### **2.1 HORIZONTAL DATACABLES**

- .1 4 pair, Category 6 (CAT6) 23 AWG
- .2 Jacket colour – Blue FT 6 rated
- .3 The cable shall meet or exceed the requirements of ANSI/EIA/TIA 568-B-2.1.
- .4 The UTP-based cabling system shall use matched components from a single manufacturer, and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.

### **2.2 HORIZONTAL VOICE CABLE**

- .1 4 pair, Category 6 (CAT6) 23 AWG UTP cable
- .2 Jacket colour – White FT6 rated
- .3 The cable shall meet or exceed the requirements of ANSI/EIT/TIA 568-B-2.1

- .4 The UTP-based cabling system shall use matched components from a single manufacturer, and the cabling system shall be certified to deliver system performance over the lifetime of the applications for which the cabling system was originally designed to support.

### **2.3 FIBER OPTIC BACKBONE CABLE**

- .1 Fiber optic backbone cable to be a laser optimized 50/125 micron OM3 multi mode fiber surrounded by aramid strength members and a PVC outer jacket. Cable shall be tested to comply with ANSI/TIA-568-C.3. 12 strand Multi Mode Minimum from data room to each sub rack.
  - .1 Cable to have an FT6 compliant riser rated sheath.
  - .2 Terminate Fiber optic cable on rack mounted termination panels. Panels to come with integrated front trough with provisions for labeling and rear cable management bar.
  - .3 Fiber terminations to be Type SC . The optical fiber field-installable connector shall be field installable, without requiring epoxy or polishing.
  - .4 Terminate all fibers.
  - .5 Outdoor rated cable to be used for all inter-building pathways.
  - .6 Contractor shall supply and install a 12 strand MM fiber tie between each wiring closet/cabinet and main computer room location in the main communications room.
  - .7 Minimum bend radius Ten times the cable diameter or as per manufacturer's recommendation which ever is more stringent.

### **2.4 COPPER BACKBONE VOICE CABLE**

- .1 Voice backbone to be a 25, 50 or 100 pair Cat 6 24 AWG, UTP, NEC/NFPA CMR rated and be independently verified for compliance. Cable shall meet or exceeds all TIA/EIA-568-A Category 5 and ISO 11801 Class D requirements.
- .2 Cable jacketing to be GRAY and shall be lead free. Cable shall be verified and characterized to 100 MHz Cable shall be supplied on reels.
- .3 Terminate cables on wall mounted IDC cross-connect systems. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designationstrips.
- .4 Contractor shall supply and install a 50 pair CAT6 copper tie between demarcation locations to the main telephone room. Contractor shall supply and install a minimum of 25 pair Cat 6 copper tie between main telephone room and each wiring closets. Contractor may be required to increase cabling by 50 pair increments to ensure that a minimum 25% spare capacity exist when they confirm number of pair required to meet telephone requirements from each wiring closet.

### **2.5 CONNECTORS**

- .1 Horizontal Data:
  - .1 Category 6 jacks.
  - .2 Telecommunication jacks shall be 8-position/8-conductor modular outlet accepting standard modular RJ45 type plugs and IDC terminations. Jacks shall have UL and CSA approval.
  - .3 Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination.

- .4 All terminations for this project shall use the T568A wiring scheme.
- .5 Colour – Blue
- .6 Horizontal Voice
- .1 Category 6 jacks.
- .2 Telecommunication jacks shall be 8-position/8-conductor modular outlet accepting standard modular RJ45 type plugs and IDC terminations. Jacks shall have UL and CSA approval.
- .3 Each modular jack shall be provided with a bend-limiting strain relief. The strain relief shall provide cylindrical support to limit the bend radius at the point of termination.
- .4 All terminations for this project shall use the T568A wiring scheme.
- .5 Colour – White

## **2.6 PATCH CORDS**

- .1 Patch cords for interconnection of switches to patch panels supplied by Owner.

## **2.7 PATCH PANELS**

- .1 Panels shall be available in 24 Port and 48 Port Configurations, with height of 1 RU (1.75 inches) for each group of 24.
- .2 Patch panel to come with removable rear mounted cable management bar front and rear identification labels.
- .3 Fiber patch panels to be 12 port panels with ST connectors at each termination point.

## **2.8 EQUIPMENT RACKS**

- .1 Floor Mounted racks
  - .1 Racks to be 19" wide x 36" deep x 84" high, four posts, free standing equipment racks.. fabricated of 2.5 mm min painted steel., drilled and tapped both sides for No. 12 screws. Complete with grounding lug.
  - .2 Designed to accommodate standard width EIA 483 mm panels.
  - .3 Receptacle bar with 3m power cord , minimum 10 outlets complete with surge suppressor
  - .4 Refer to drawings for quantity and location.
  - .5 Equipment racks to be equal to Mid Atlantic R4 Series or equivalent.
- .2 Vertical Cable Management
  - .1 Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief.
  - .2 The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
  - .3 Provide and install two (2) vertical cable management for each free standing rack.
  - .4 Vertical cable manager to be equal to Mid Atlantic DRCC-44 or equivalent.
- .3 Horizontal Cable Management
  - .1 Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases.

- .2 The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
- .3 Provide and install one (1) horizontal cable management for each patch panel.
- .4 Grounding and Bonding
  - .1 The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
  - .2 All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc., entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.
  - .3 All wires used for telecommunications grounding purposes shall be identified with a green or with a wrap of green tape insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.
- .5 Firestop
  - .1 All penetrations through fire-rated building structures (wall and floors) shall be sealed with an appropriate firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.
  - .2 Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (P.ENG.), licensed (Actual or reciprocal) in the Province where the work is to be performed. A drawing showing the proposed firestop system, stamped/embossed by the P.ENG. shall be provided to the Owner's Technical Representative prior to installing the firestop system (s).

### **3. Execution**

#### **3.1 INSTALLATION**

- .1 shall be installed in accordance with manufacturer's recommendations and best industry practices.
- .2 A plastic or nylon pull cord with a minimum test rating of 90 kg (200lb.) shall be co-installed with all cable installed in any conduit.
- .3 Cables at equipment racks shall be neatly bundled with Velcro tie wraps.
- .4 All telecommunication and data wiring to be installed in cable trays and conduit as detailed on the drawings. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-A maximum fill for the particular raceway type of 40%.
- .5 The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

- .6 Do not exceed the maximum tensile strength rating of the cable when pulling into conduit or cable trays. Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.
- .7 Provide horizontal and vertical wire management accessories on the equipment racks to route incoming horizontal cables in an orderly manner.
- .8 At each equipment rack, provide 3 meter cable loop to allow for future rack relocation within the equipment room. Neatly tie cable loop to the equipment rack.
- .9 Cable may not be spliced. Secure and support cables at intervals not exceeding 30" and not more than 6" from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
- .10 Separation from EMI Sources:
  - .1 Comply with BICSI TDMM and TIA / EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources including electrical power lines and equipment.
  - .2 Separation between open communication cables or cables in non-metallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - .1 Electrical Equipment Rating Less Than 2 kVA: a minimum of 5 inches (127mm).
    - .2 Electrical Equipment Rating Between 2 and kVA: a minimum of 12 inches (300mm)
    - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 24 inches (610mm).
  - .3 Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - .1 Electrical Equipment Rating Less Than 2kVA: a minimum of 2.5 inches (64mm).
    - .2 Electrical Equipment Rating Between 2 and 5kVA: a minimum of 6 inches (150mm).
    - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 12 inches (300mm).
  - .4 Separation between communication cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosure shall be as follows:
    - .1 Electrical Equipment Rating Less than 2kVA: No Requirement.
    - .2 Electrical Equipment Rating Between 2 and 5kVA: a minimum of 3 inches (76mm).
    - .3 Electrical Equipment Rating More Than 5kVA: a minimum of 6 inches (150mm).

### 3.2 CABLE TERMINATION

- .1 shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-B standard document, manufacturer's recommendation and best industry practice.

- .2 Pair untwist at the termination shall not exceed 12mm (one-half inch). Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.
- .3 The cable jacket shall be maintained to within 25mm (one inch) of the termination point.
- .4 Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.
- .5 Cable termination shall start at the upper left point of the terminal block mount and proceed in a left to right manner downward for each succeeding cable row.
- .6 All cross-connection data cables to the equipment rack shall be run down the backside of the cable raceway between the racks and up before terminating on the back side of the patch panels.

### **3.3 FIRESTOP SYSTEM**

- .1 All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.
- .2 Comply with TIA/EIA-569-9, Annex A, "Fire Stopping".

### **3.4 GROUNDING SYSTEM**

- .1 The TBB shall be designed and/or approved by a qualified P.ENG., licensed in the Province that the work is to be performed. The TBB shall adhere to the recommendations of the ANSI/TIA/EIA-607 standard, and shall be installed in accordance with best industry practice.
- .2 A licensed electrical contractor shall performed installation and termination of the main bonding conductor to the building service entrance ground.

### **3.5 LABELING**

- .1 All labels shall be mechanically generated. All network labeling applications shall be performed as described in TIA/EIA-606-A Administration Standard for Commercial Telecommunications Infrastructure.
- .2 NOTE: The contractor shall confirm labeling criteria with the PCA Departmental Representative and Owner prior to labeling cables.

### **3.6 TESTING**

- .1 General: All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-B. All pairs of each cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed.
- .2 Consult with PCA Departmental Representative if cable test over length for replacement or



.3 Copper Channel Testing:

- .1 All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional testing is required to verify Category performance. Horizontal cabling shall be tested using a Level 3 test unit for Category 6 performance compliance.
- .2 Continuity: Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.
- .3 Length: Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-B Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.
- .4 Category 6 performance: For performance testing should be done according to the published ANSI/TIA/EIA-568-B.2-1

.4 Optical Fiber Cable Tests

- .1 Test instruments shall meet or exceed applicable requirements in TIA/ EIA-568C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- .2 Link End to End Attenuation Tests:
  - .1 Horizontal and multimode backbone link measurements. Test at 850 or 1300 nm in one direction according to TIA / EIA-526-14-A, Method B, One Reference Jumper.
  - .2 Attenuation Test results for backbone links shall be less than 2.0db. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568B.1.

.5 Record results on cabling contractor supplied forms as accepted by the Owners representative.

.6 The owner and/or Owners representative reserves the right to request additional testing when failures are encountered.

.7 Submit test results to the Owner for review and place in O&M Manual

.8 The Owner reserves the right to perform random tests prior to project closeout.

**3.7 PRODUCTS PROVIDED BY THE OWNER**

- .1 Owner will provide and install all active equipment components, including UPS.
- .2 Coordinate active equipment locations with the Owner prior to terminating cables.

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### 3.8 SYSTEM DOCUMENTATION

- .1 Completion of the installation, the telecommunication contractor shall provide one (1) full documentation set and one (1) electronic set to the PCA Departmental Representative for approval.  
Documentation shall include the items detailed in the sub-section below.
- .2 Documentation shall be submitted within then (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase.
- .3 The PCA Departmental Representative May request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify document findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the PCA Departmental Representative, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- .4 **Test Results:** Documentation shall be provided in electronic format within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.
- .5 The **As-Built** drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner
- .6 The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic form (AutoCAD).

**END OF SECTION**

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**1. General**

**1.1 DESCRIPTION**

- .1 Provide encased pvc conduit or fibre duct from property line to main telephone terminal board. Refer to drawings for location of telephone board, exact conduit size and Number of conduits required.
- .2 Contractor to coordinate entire telephone & cable vision installation with Utility company. Include cost in total tender price. Also coordinate with the owner to insure all costs are accounted for and the installation meets the Owner's needs.
- .3 Provide a #6 ground cable to main telephone board. Allow for minimum 200 pair cable installation from the Utility Company.
- .4 Telephone and cablevision outlet to be standard spec grade device box 50mm x 75mm c/w white cover plates. Terminate telephone wiring at appropriate outlets.
- .5 Supply and install "bix" blocks are required. Terminate all telephone cable on telephone board.

**2. Products**

**2.1 CABLING**

- .1 Voice cabling contractor to refer to Section 27 10 00 for all cabling requirements.

**3. Products**

**3.1 DEVICES**

- .1 Size all telephone outlet boxes and conduit as shown on drawings.
- .2 Provide pull boxes in all runs in excess of 30 meters or where more than two 90° bends occur.
- .3 Conduit shall conform to the requirements of Section and shall be a minimum 21mm.
- .4 Mount bottom of outlets at 1,500mm a box finished floor or as noted on drawings. Typically, in bottom of fourth block course in concrete block walls.
- .5 Junction boxes for outlets to be flush mounted in wall. Appropriate extension rings are to be provided where outlets are to be installed in millwork, backboards, chalkboards, etc.

**END OF SECTION**

**I. GENERAL**

**1.1 SUMMARY**

- .1 The work covered under this Section consists of furnishing all labor, material and services to install a complete audiovisual system as indicated on the Contract Documents.
- .2 The scope of work covered under this Section includes but is not limited to:
  1. Equipment and installation labor as noted on the Contract Documents for a fully functional system. Miscellaneous components, hardware, interconnections and terminations required for proper operation of all systems.
  2. All components or systems indicated on the Contract Documents.
  3. The Installing Contractor shall be responsible for the following:
    - a. Verification of accuracy and completeness of equipment lists, dimensions, mounting details and equipment compatibility
    - b. Accurate documentation of the system operation and installation.
    - c. One year warranty of the equipment and installation.
    - d. Test equipment, tools, ladders, lifts and scaffolding required for installation.
    - e. Daily and final cleanup of debris caused by installation.
    - f. Quality Control / Commissioning of system
    - g. End user training and training manuals

**1.2 SYSTEM(S) DESCRIPTION**

**1.3 INSTALLING CONTRACTOR**

- .1 Certification:
  1. The Installing Contractor shall have a current INFOCOMM's "Audio Visual Solutions Provider" (AVSP) certification. The certifications shall match the level and complexity of the scope of work as follows:
    - a. System Category One (\$10,000 to \$49,000)
      - AVSP Sapphire status will be preferred as a minimum status for this work.
    - b. All Other System Categories
      - AVSP Emerald status will be a minimum status for this work.

**1.4 INSTALLING CONTRACTOR PERSONNEL QUALIFICATIONS**

- .1 Summary: The Installing Contractor shall assign at least one full-time employee to the work whose qualifications meet the following minimum requirements.
  - .1 On-Site AV Supervision
    - a. Certifications:

- Shall have a current INFOCOMM Certified Technology Specialist certification with an installation endorsement (CTS-I) in good standing
- b. Qualifications:
  - Shall be capable of supervising a turn-key audiovisual system installation including, but not limited to, all cabling, speakers, projection equipment, mounting hardware and electrical components including the necessary equipment, interconnections, transducers, labor, and services required to meet the functional requirement outlined in the Contract Documents.
  - Shall provide all quality control (QC) and safety inspections as needed throughout installation.
  - Shall conduct all AV system commissioning tests, and proof-of-performance testing/demonstration in accordance with the Contract Documents.
- 2. Other Installation Personnel:
  - a. Certification:
    - Must have a CTS certification
    - No more than four (4) CTS certified installers for every CTS-I certified installer on-site.
  - b. Qualifications:
    - Shall be capable of working within industry standards with minimal supervision. The work shall include, but is not limited to, cabling, loudspeakers, projection equipment, mounting hardware and electrical components including the necessary equipment, interconnections, and transducers and the downloading, or installation, of pre-developed control programs in the field.
- 3. On-Site Support Personnel:
  - b. Certification:
    - CTS Preferred
  - c. Qualifications:
    - Has a good general knowledge of AV installation procedures and standards, and must be trained in construction site safety. Performs support work under direct supervision of CTS and CTS-I installers.
- 4. AV Control Programmer: AV control and DSP programming for system equipment includes recommendations for control system features and functionality; input to AV system design; control system logic diagram, control system performance specification, block diagrams, control system program and user interface, system debug, program and source code and other system documentation as required.
  - a. Certification

- Must have a CTS certification, CTS-I or CTS-D certification preferred
- Individuals performing the AV control programming shall have manufacturer's control system programming training and certification for the specified AV control system
- Individuals performing AV-DSP programming and setup shall have manufacturer's system programming training and certification from the manufacturer for specified equipment.

5. Commissioning Personnel

- a. Shall have a current AQAV Certified Quality Technician (CQT) certification in good standing.
- Qualifications: Shall be capable of performing commissioning tests during staging and final commissioning of the system according to the Av 9000: Quality management System For the Audio Visual Technology Industry.

6. Sub-contracting of AV work

- a. Conditions: Sub-Contractors must conform to the same certification standards listed above, and have prior approval.

**1.5 INSTALLING CONTRACTOR** All equipment and installations under this contract shall conform to the following:

- .1 ANSI/NFPA 70 National Electrical Code.
- .2 ANSI/IEEE C2 National Electrical Safety Code TIA/EIA Standards 568 A (including TSB 67), and 607.
- .3 IEE/ANSI 142 1982 Recommended Practice for Grounding of Industrial and Commercial Power Systems.
- .4 *ANSI/TIA-569B Commercial Building Standard for Telecommunications Pathways and Spaces*
- .5 NFPA 72-2010; *National Fire Alarm and Signaling Code [intelligibility requirements]*

**1.6 INSTALLING CONTRACTOR REFERENCES/GUIDES**

- .1 Infocomm International, (2009) AV Installation Handbook (2nd ed.)
- .1 Giddings, P. (1990). Audio Systems Design and Installation. Boston: Focal Press.
  - .2 AQAV, (2015) AV 9000:2015 Quality management System for the Audio Visual Technology Industry.
  - .3 ANSI/INFOCOMM 1M-2009, *Audio Coverage Uniformity in Enclosed Listening Areas*
  - .4 ANSI/INFOCOMM, *Networked AV Systems*

**1.7 WORK PRODUCT OWNERSHIP**

- .1 Throughout the course of the project, all supporting documentation, work-in-

progress, programed source code and software, written and electronic files, including all documentation and software necessary to edit and adapt the system, shall remain the property of Parks Canada and shall be provided to Parks Canada upon project completion and/or at any time during the course of a project upon request in an unsecured, unencrypted and easily modifiable format as prescribed by Parks Canada.

1. All deliverables to be supplied to Parks Canada on compact disc media, and/or printed materials when requested
- .1 Software – Control System, DSP, and All Other Applicable Equipment
  1. The software developer shall retain intellectual property rights to the operation software. The Owner shall be granted a license in perpetuity for use. The following requirements shall apply.
    - a. All source code becomes the exclusive property of Parks Canada.
    - b. All source code changes must be fully documented.
    - c. All custom programs for remote control system touch panels, and other programmed devices, shall become the property of Parks Canada and shall be submitted with the final systems documentation, and/or as requested in the DVD/CD-ROM and USB solid state media.
    - d. Subsequent to system certification, source code changes and/or additional programming, whether requested by Parks Canada or performed by the Installing Contractor, will be warranted by the Installing Contractor for a period of one (1) year, with the Installing Contractor responsible for the diagnosis and repair.
    - e. The vendor shall ensure that the current program is saved to CD-ROM and/or USB-solid state media, and backed up on electronic hard-disc/server.
    - f. No program resident in a control system shall be overwritten until a back-up of the resident program is made.
    - g. All documentation, not residing in the code, must be provided on CD-ROM and/or USB-solid state media in Adobe PDF and Microsoft Office format.
  - .2 The Installing Contractor shall also offer an annual "Software Maintenance" contract.
    - A. This shall cover all software provided as part of this system and/or written for this system, and shall include both routine upgrades to applications and operating systems, as well as any modifications to software that may be required by Any Company.
    - B. The Software Maintenance contract shall commence immediately after expiration of the warranty period, and continue for three (3) years.
  - .3 Written Release:
    - A. A written release will be given by the Installing Contractor for all control programming done by the Installing Contractor's personnel or sub-contractors. The release shall acknowledge Parks Canada's ownership and right to modify programming directly, or to have the programming modified by others on Parks Canada's behalf.

- B. A CD shall be supplied with the written release that includes the program and source code for the system in an unencrypted format.

## 1.8 CONTRACTOR SUBMITTALS

- .1 Prior to fabrication, the Contractor shall submit to Parks Canada, for approval, any custom designs pertaining to the systems. Contractor is to provide six (6) sets of all documentation. Drawing submittals shall be submitted electronically on CD-ROM, DVD- ROM or USB-solid state media. These designs include, but are not limited to, the following:
- .1 Complete system construction and point to point wiring schematic drawings, including all component values, and showing complete letter and number identification of all wire and cable as well as jacks, terminals and connectors. All connections types are to be shown.
  - .2 Provide bound technical specification details (cut sheets) on all equipment required to complete this project.
  - .3 All control system front panel layouts, where applicable.
  - .4 All panels, plates, and designation strips, including details relating Terminology, engraving finish and color.
  - .5 All custom designed consoles, tables, carts, support bases, and shelves. Schematic drawings of all custom components, assemblies, and circuitry, including wall and/or floor plates.
  - .6 All unusual equipment modifications,
  - .7 Run sheets or field wiring details
  - .8 Patch panel assignment layout drawings
  - .9 Front mechanical drawings of each equipment rack.
  - .10 Complete spreadsheet lists of IP network devices, protocols used, and IP and MAC Address lists and required ranges for coordination with the Owner's IT department.
  - .11 Lists shall include information regarding location on the Owner's network or dedicated audiovisual physical subnet, VPN requirements, and other pertinent information for integration of IP networked audiovisual equipment into the Owner's Enterprise network.
  - .12 All items of equipment, whether a stock manufactured item or custom-built item, shall be supported by complete and detailed schematic drawings and replacement parts lists. No "black boxes" or unidentified components shall be acceptable under this specification
  - .13 Verification of the focal lengths of projection lenses to achieve the specified image sizes.
  - .14 Verification of audio uniformity coverage and speaker coverage layout.
  - .15 A site RF wireless frequency spectrum analysis of RF spectrum to be used by any specified equipment. A spectrum analyzer shall be used with software and recording of results on a typical weekday during normal anticipated hours of use. Results shall be submitted with a frequency analysis and assignment plan.



- .16 Proposed commissioning and testing procedures and processing, including testing documentation and results to be provided to the Owner prior to Owner's Punch list checkout..
- .17 Proposed training programs, including schedule, component-level and systems-level training sessions, and Staff who will be conducting the training, along with qualifications and resumes.
- .18 If the Contractor will be providing manufacturer training, then the submittal shall include component or systems training by each manufacturer, along with the manufacturer's training staff and their qualifications.
- .19 This information shall be provided prior to commissioning, for the Park Canada and Consultant's review and approval.
  - a. End-user guides, subject to Owner review and approval, which are "function-oriented" in showing a step-by-step operation process for the main startup and functions of each room system. The end-user guides must be comprehensive in scope and cover each user application of the room capabilities. User-guides of the "traditional" laminated sheet of user-interface photos with tagged annotations will NOT be accepted.
- .20 Close Out Submittals
  - a. At the completion of the installation, the Contractor shall electronically provide six (6) copies each of the following:
  - b. Test results, in "spreadsheet" format, of electrical audio and/or video performance testing for all systems end-to-end in every room and/or between rooms as applicable.
  - c. Total equipment database.
  - d. NOTE: It is the sole responsibility of the Contractor to fully test the audiovisual systems prior to owner check-out and verification. Until these test results are provided, no audiovisual systems check-out or verifications (functional or otherwise) will be performed by the OWner. If any anomalies in system performance are detected, the Contractor shall correct these before performing any other tests.
  - e. Equipment manufacturer's operation manuals for each piece of equipment.
  - f. "As-built" drawings. A final, approved copy shall be placed in a metal pocket mounted on the inside of the rear door of the rack.
  - g. System functional block drawing identical to the specification drawing with the addition of all input and output circuit cable and terminal block numbers as well as all jack field circuit I.D. designations. A copy of this drawing shall be framed in protective plastic and mounted near the equipment racks.
  - h. A System Operation and Maintenance Manual. This manual shall be produced by the Contractor especially for the systems detailed herein. The "Operation" section shall describe all typical procedures necessary to activate each system to provide for the functional

- i. requirements as listed under the Detailed Specifications. Manuals will use graphical representation of touch panel screens, as to easily be identified by user. Owner's Manuals and/or Operations manuals supplied by manufacturers for a given piece of equipment, though required, are not acceptable substitutes for these materials.
- j. The reader of this manual shall be assumed to be technically competent, but unfamiliar with this particular facility. Additionally, the Contractor shall provide a single page of basic operating instructions for each room, and other audio-visually equipped spaces.

## 1.9 WARRANTY

- .1 The warranty period shall start after final checkout and signed off by the owner or Parks Canada representative. The warranty shall cover 365 calendar days starting on the day of acceptance.
  - .2 To maintain certain manufacturer's warranties, equipment must be installed, aligned and serviced by those installers authorized by that manufacturer to perform those duties. If the Installing Contractor is not authorized, by the manufacturer, it is the Installing Contractor's sole responsibility to make the appropriate arrangements and bear all cost and consequences
  - .3 In cases where the manufacturer's warranty period is greater than specified in the Contract Documents, the Installing Contractor shall provide that warranty for the full extent of the manufacturer's warranty period.
    - .1 The Installing Contractor shall exclude any labor costs incurred by removing and re-installing the defective items after the system's one-year warranty.
  - .4 In cases where the manufacturer's warranty period is less than 12 months, the Installing Contractor shall warrant the system(s) in accordance with the Contract Documents.
- 
- .5 All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of Substantial Completion.
  - .6 In the case of Installing Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, the Installing Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.
  - .7 In the event of malfunction or failure of any audiovisual equipment provided by the Installing Contractor, the Installing Contractor shall be responsible for replacement of faulty equipment, or providing "loaner" equipment at no cost to the Owner for the duration of the repairs. In the event that "loaner" equipment is provided, said equipment shall meet or exceed the original equipment specifications until the original equipment is replaced.

- .8 In cases where the Installing Contractor is providing and installing audiovisual equipment and/or hardware to be integrated with equipment furnished by others, it shall be the responsibility of the Installing Contractor to warrant their equipment as described in the Contract Documents unless said equipment shows misuse and or abuse by others during re-installation or connection of equipment by others.
- .9 Telephone Support
  - 1. The Installing Contractor shall respond via telephone within two (2) hours to any request for service.
  - 2. This first contact should outline the nature of the problem or functional anomaly.
  - 3. The Installing Contractor shall make available personnel knowledgeable with the installed system who can address specific system issues described by the system operators.
  - 4. Telephone support shall be available between normal business hours, Monday through Friday.
- .10 On-Site Support
  - 1. The warranty shall be an "on-site" warranty, with a twenty-four (24) hour response time.

## **2 PRODUCTS**

### **2.1 GENERAL**

### **2.2 SYSTEMS**

- .1 Description, See drawings for speaker specifications.
- .2 Operation Sequences
- .3 Performance
- .4 Manufacturers
  - a.Substitution Limitations
  - b.Product Options

### **2.3 CONTROL SYSTEM PROGRAMMING**

- .1 Required Deliverables
  - a.In Microsoft Excel, a page by page, button by button list will be provided for system commissioning. This should include the function of each button, page flips, popup pages etc.
  - b.Program Requirements

### **2.4 DSP (DIGITAL SIGNAL PROCESSING) PROGRAMMING**

- .1 Required Deliverables
- .2 Program Requirements

**2.5 MATERIALS**

**.1 Cable**

**a. Audio**

**a. Fixed Installation**

**(1) Speaker Cable**

**a. 18/2 Twisted Pair Cable with Overall Jacket**

**1. Non-Plenum**

- a. Manufacturer: Extron, Model: SPK18, 22-150-03
- b. Manufacturer: Gepco 1800
- c. Or pre-approved equal

**2. Plenum**

- a. Manufacturer: Extron, Model: SPK18P, 22-153-03
- b. Manufacturer: Gepco 1800HS
- c. Or pre-approved equal

**b. 16/2 Twisted Pair Cable with Overall Jacket**

**1. Non-Plenum**

- a. Manufacturer: Extron, Model: SPK16, 22-151-03
- b. Manufacturer: Gepco 1600
- c. Manufacturer: Liberty 16-2C-COM
- d. Or pre-approved equal

**2. Plenum**

- a. Manufacturer: Extron, Model: SPK16P, 22-154-03
- b. Manufacturer: Gepco 1600HS
- c. Manufacturer: Liberty 16-2C-P
- d. Or pre-approved equal

**c. 14/2 Twisted Pair Cable with Overall Jacket**

**1. Non-Plenum**

- a. Manufacturer: Extron, Model: SPK14, 22-152-03
- b. Manufacturer: Gepco 1400
- c. Manufacturer: Liberty 14-2C-GRY
- d. Or pre-approved equal

**2. Plenum**

- a. Manufacturer: Extron, Model: SPK14P, 22-155-03
- b. Manufacturer: Gepco 1400HS
- c. Manufacturer: Liberty 14-2C-P-BLK
- d. Or pre-approved equal

- d. 12/2 Twisted Pair Cable with Overall Jacket
  - 1. Non-Plenum
    - a. Manufacturer: Gepco 1200
    - b. Manufacturer: Liberty 12-2C-GRY
    - c. Or pre-approved equal
  - 2. Plenum
    - a. Manufacturer: Gepco 1200HS
    - b. Manufacturer: Liberty 12-2C-P-BLK
    - c. Or pre-approved equal
- (2) Microphone
  - a. 22 AWG Stranded Oxygen-free BC, Foam Polypropylene Insulation, & 95% TC Braid.
    - 1. Manufacturer: Gepco XB201M
    - 2. Manufacturer: Belden 8451
    - 3. Or pre-approved equal
- (3) Line Level Balanced
  - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
    - 1. Manufacturer: Gepco 61801EZ
    - 2. Manufacturer: Extron STP22, 22-156-03
    - 3. Or pre-approved equal
- (4) Line Level Unbalanced
  - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
    - 1. Manufacturer: Gepco 61801EZ
    - 2. Manufacturer: Extron STP22, 22-156-03
    - 3. Or pre-approved equal
  - b. Portable/Lectern/Flexible
    - (1) Microphone
      - a. 22 AWG Stranded Oxygen-free BC, Foam Polypropylene Insulation, & 95% TC Braid.
        - 1. Manufacturer: Gepco XB201M
        - 2. Manufacturer: Belden 8451
        - 3. Or pre-approved equal
    - (2) Line Level Balanced
      - a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
        - 1. Manufacturer: Gepco 61801EZ
        - 2. Manufacturer: Extron STP22, 22-156-03
        - 3. Or pre-approved equal
      - (3) Line Level Unbalanced

- a. 22 Gage STP, Low Attenuation, Low Crosstalk Audio Cable.
  - 1. Manufacturer: Gepco 61801EZ
  - 2. Manufacturer: Extron STP22, 22-156-03
  - 3. Or pre-approved equal
- .2 Connectors
  - a. Audio
    - a. Balanced
      - (1) 1/4" TRS male cable mount connector, solder on, Nickel/gold plated
        - a. Manufacturer: Neutrik NJ3FC6 female
        - b. Manufacturer: Neutrik NP3X male
        - c. Manufacturer: Switchcraft 297 male
        - d. Manufacturer: Switchcraft 131 female
        - e. Or pre-approved equal
      - (2) 1/4" TRS panel mount jack, solder on,
        - a. Manufacturer: Neutrik "locking jacks series"
        - b. Manufacturer: Switchcraft "enclosed jack"
        - c. Or pre-approved equal
      - (3) XLR 3-pin cable mount connector, solder on, Nickel/gold plated
        - a. Manufacturer: Neutrik NC3MXX male
        - b. Manufacturer: Neutrik NC3FXX female
        - c. Manufacturer: Switchcraft A3F female
        - d. Manufacturer: Switchcraft A3M male
        - e. Or pre-approved equal
      - (4) XLR 5-pin cable mount connector, solder on, Nickel/gold plated
        - a. Manufacturer: Neutrik N5CFX female
        - b. Manufacturer: Neutrik N5CMX male
        - c. Manufacturer: Switchcraft A5F female
        - d. Manufacturer: Switchcraft A5M male
        - e. Or pre-approved equal
      - (5) XLR 3-pin panel mount connector, solder on,
        - a. Manufacturer: Neutrik NC3FD-LX female
        - b. Manufacturer: Neutrik NC3MD-LX male
        - c. Manufacturer: Switchcraft D3F female
        - d. Manufacturer: Switchcraft D3M male
        - e. Or pre-approved equal
      - (6) XLR 5-pin panel mount connector, solder on,

- a. Manufacturer: Neutrik NC5FD-LX female
  - b. Manufacturer: Neutrik NC5MD-LX male
  - c. Manufacturer: Switchcraft D5F female
  - d. Manufacturer: Switchcraft D3M male
  - e. Or pre-approved equal
- (7) XLR-1/4" Combination panel mount connector, solder on,
- a. Manufacturer: Neutrik "Combo" series male
  - b. Manufacturer: Neutrik "Combo" series female
  - c. Or pre-approved equal
- b. Speaker Level
- (1) Lockable loudspeaker cable mount connector, solder on
- a. Manufacturer: Neutrik "speakON series" female
  - b. Manufacturer: Neutrik "speakON series" male
  - c. Manufacturer: Switchcraft "HPC series" female
  - d. Manufacturer: Switchcraft "HPC series" male
  - e. Or pre-approved equal
- (2) Lockable loudspeaker panel mount connector, solder on
- a. Manufacturer: Neutrik "speakON series" female
  - b. Manufacturer: Neutrik "speakON series" male
  - c. Manufacturer: Switchcraft "HPC series" female
  - d. Manufacturer: Switchcraft "HPC series" male
  - e. Or pre-approved equal
- c. Unbalanced
- (1) 1/4" mono cable mount connector, solder on, Nickel/gold plated
- a. Manufacturer: Neutrik NYS224 male
  - b. Manufacturer: Neutrik NP2X female
  - c. Manufacturer: Switchcraft 280 male
  - d. Manufacturer: Switchcraft 121 female
  - e. Or pre-approved equal
- (2) 3.5mm mini stereo cable mount connector, solder on, Nickel/gold plated
- a. Manufacturer: Extron 3.5 mm Mini Stereo-HQ male, 100-331-01
  - b. Manufacturer: Switchcraft 35HDNN male
  - c. Or pre-approved equal
- (3) RCA cable mount connector, solder on
- a. Manufacturer: Extron RCA-HQ male, 100-334-01
  - b. Manufacturer: Neutrik NYS352G

- c. Or pre-approved equal
  - (4) 1/4" mono panel mount jack, solder on,
    - a. Manufacturer: Neutrik "locking jacks series"
    - b. Manufacturer: Switchcraft "enclosed jack"
    - c. Or pre-approved equal
  - d. Category Cable
    - a. Cat 6 crimp plug
      - (1) Liberty 11108080034
      - (2) Comprehensive RJ45P-6
      - (3) Or pre-approved equal
    - b. Cat6a Crimp Plug
      - (1) Manufacturer: Liberty RJ45-STP-L6
      - (2) Or pre-approved equal
- .3 Pre-manufactured Cables and Adapters
  - a. All pre-manufactured cables should have the following minimum specifications:
    - a. **High performance cables designed for transmission of video.**
    - b. **Terminated with high quality 75 ohm BNC connectors.**
    - c. **VGA shell grounded for ESD electrostatic discharge protection.**
    - d. **Injection mold with overall foil shield for improved EMI electromagnetic interference isolation.**
    - e. **Acceptable manufacturers**
      - (1) **Manufacturer: Extron**
      - (2) **Manufacturer: Liberty**
      - (3) **Manufacturer: Comprehensive**
      - (4) Or pre-approved equal
- .4 Hardware
  - a. Wall/floor plates and rack panels
    - a. NEMA gang plates shall be standard or jumbo sized as required at each location.
    - b. Plates shall be sized to fit rough opening or fit box opening.
    - c. Text and graphics shall be engraved.
    - d. Connectors shall be fitted to plates using nuts, screws, or by the method designated by connector. No rivets.



- e. Acceptable manufacturers
  - (1) Manufacturer: Panel Crafters
  - (2) Manufacturer: Whirlwind
  - (3) Or pre-approved equal

### **3 - EXECUTION**

#### **3.1 PREPARATION**

- .1 Before starting installation, verify proper installation of the following work by others -
  - 1. Document and submit a single report for each space with AV to the Parks Canada Departmental Rep before any work is started on-site
  - 2. Carry out this requirement for each phase of work on-site (field wiring, and system/equipment installation) for each space with AV.
- .2 Frequency Coordination - Prior to ordering equipment, the Installing Contractor shall coordinate the frequencies of all wireless devices to prevent unwanted interaction between devices and rooms.
  - 1. This includes, but is not limited to, wireless microphones, assisted listening system devices, wireless control panels, etc.
  - 2. Frequency coordination shall take place with the use of a spectrum analyzer and frequency allocation/analysis software.
  - 3. Documentation of this frequency coordination shall be provided to the Owner for review.

#### **3.2 QUALITY CONTROL/COMMISSIONING**

- 1. See related Performance Standards and Testing Procedures paragraphs in Part 3 of this technical section.
- 2. The main AV milestones that testing will be required:
  - .1 Prototype verifications (off-site and on-site)
  - .2 Staging Testing
  - .3 Final System Commissioning
  - .4 Final Checkout

#### **3.3 INSTALLATION PRACTICES**

- .1 General
  - 1. All installation practices shall be in accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with the applicable standards, requirements, and recommendations described in the Contract Documents, referenced material, and the *U of I Facilities Standards*.
  - 2. Installation shall include the delivery to the installation site, unloading, setting in place, fastening to walls, floors, ceilings, counters, or other structures where required, interconnecting wiring of the system components, equipment alignment and adjustment, and all other work

whether or not expressly required herein which is necessary to result in complete and fully operational systems.

.2 Physical Installation

1. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors
2. All accessories, including rack mounting hardware, power supplies, etc., shall be obtained from the original equipment manufacturer. Unless otherwise noted or specified, third party accessories shall not be used

3. Trim and Escutcheon Components

- a. To insure a proper finished appearance, the AV Installing Contractor shall furnish and install trim/escutcheon components at all conditions where A/V components pass through the finished ceilings. This would include but not be limited to video projector supports, television monitor/receiver supports and any other component which is not specifically supplied with integral flanges/trim components; i.e. speaker mounts, assistance listening devices, etc
- b. The visible component of any trim should be minimal in size, preferably no wider than 1/2". All trim components at the ceiling plane shall be finished to match the approved ACT ceiling grid system components.
- c. All trim components shall be submitted for review and approval prior to fabrication

4. Mounting

- a. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
- b. Fastenings and supports shall be adequate to support their loads with a safety factor of at least five (5). All boxes, equipment, etc., shall be secured plumb and square.
- c. All displays and video projectors must have security cables attached to the building structure or other approved methods to assist in the prevention of loss.
- d. Other equipment, not designated as 'Portable' shall be provided with security fasteners, secured to furniture, or otherwise secured, using approved methods or materials as described in the Contract Documents

.3 Cable Installation

1. Cable General Installation

- a. All wire bundles are to be neat and combed free of cable crossovers.
- b. All cables shall be grouped according to the signals being carried. In order to reduce signal contamination, separate groups shall be formed for the following cable families:
  - Power cables
  - Control cables
  - Audio cables carrying signals less than – 20 dBm
  - Audio cables carrying signals between – 20 dBm and +20 dBm

- Audio cables carrying signals above +20 dBm
  - c. All cables shall be cut to the length dictated by the run. No splices shall be permitted in any pull boxes.
  - d. Cables running in plenum areas without conduit shall be plenum rated cable, and match the specified cable above.
    - (a) It is the responsibility of the Installing Contractor to inspect the Contract Documents, and verify in what spaces plenum cable shall be used.
    - (b) No claims for additional monies, based on the use of plenum cable, will be allowed
2. Cable – Rack/Termination Points
- a. Cable separation/routing:
    - (a) All power cables, control cables, and high level cables shall be run on the left side of an equipment rack as viewed from the rear.
    - (b) All other cables shall be run on the right side of an equipment rack, as viewed from the rear.
  - b. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings
  - c. Cables shall not protrude from the back of racks.
  - d. Cables ties shall be placed at appropriate intervals of no greater than six inches for vertical bundles, two inches for horizontal bundles.
  - e. All vertical cable bundles shall be attached to the rack frame.
  - f. For equipment mounted in drawers or on slides, the interconnecting cables shall be provided with a service loop of appropriate length
  - g. All cable entry shall be through the tops of racks or through entrance holes in the base of the rack. No cable shall enter racks through front, rear or side panel openings
  - h. All system wire, after being cut and stripped, shall have the wire strands twisted back to their original lay and be terminated by approved soldered or mechanical means.
  - i. Except where noted otherwise in the specifications, NO BARE WIRE TERMINATIONS WILL BE ACCEPTED.
  - j. Heat-shrink tubing shall be used to insulate the ground or drain wire.
  - k. Unused wires at the end of a cable shall remain unstripped and shall be laid back and held in place with wire ties.
  - l. All solder connections shall be made with rosin-core solder using temperature-controlled solder stations.
    - (a) Care shall be taken to avoid cold or cracked solder joints. Any connections that do not appear to be clean and shiny, or which show signs of cracking, shall be resoldered by the Installing Contractor before acceptance of the system.
  - m. Mechanical connections using insulated, crimp-type connectors shall be bonded to the connector by soldering the wire to the metal part of the connector.

- n. Connections made with screw actuated pressure type terminal strips shall be made by stripping approximately 1/4 inch of insulation from the stranded conductor. Then the un-tinned wire shall be inserted into the terminal and the screw tightened using a secure fitting precision screwdriver
  - o. Terminal blocks, boards, strips, or connectors shall be furnished for all cables which interface with racks, cabinets, consoles, or equipment modules.
  - p. All cables shall have proper connector housing.
- 3. Cable – Labeling
  - a. All cables, regardless of length, shall be marked with a permanent, self-laminating wrap-around number or letter cable marker at both ends, similar to the Brady and Panduit products for laser/ink-jet printers, and handheld thermal printers.
    - (a) A000x for audio
    - (b) V000x for analog video
    - (c) D000x for digital video
    - (d) N000x for network
    - (e) C000x for control
    - (f) P000x for power
    - (g) Or other pre-approved schemes
  - b. Labels must be computer-generated for legibility.
  - c. Wire labels done by hand in the field must be replaced with computer generated labels.
  - d. There shall be no unmarked cables at any place in the system.
  - e. Marking codes used on cables shall correspond to codes shown on drawings and or run sheets.
  - f. All wire markers shall face a common direction.
- 4. Connector Plate Receptacles
  - a. Audio (microphone or line level) – XLR, locking type.
  - b. Audio (line level—Mono or Stereo) – 1/4" jack, locking type Jack shall be insulated from panel type
  - c. Audio (loudspeaker level) – lockable loudspeaker panel mount connector Type.
  - d. Audio (multipin analog mic/line level) – 61 pin circular bayonet type – Jack shall be insulated from panel type.
  - e. Intercom Panels – XLR type.
  - f. Video – BNC type.
  - g. VGA – DB-15HD jack, isolated from panel type, with hex nuts.
  - h. RF (CCTV/CATV) – "F" type. Receptacles shall be insulated from panel type.

- i. RF (Wireless Antennae) – BNC type, 75 or 50 Ohm, as required. Receptacles shall be insulated from panel type.
  - j. Digital Audio Snake/UTP transmission – RJ-45 type.
  - k. Note: All connectors on wall plates, or in other exposed locations, are to be recessed.
- .5 Grounding – In order to minimize problems resulting from improper grounding, and to achieve maximum signal-to-noise ratios, the following grounding procedures shall be adhered to:
- 1. System Grounds:
    - a. A single primary “system ground” shall be established for the systems in each particular area. All grounding conductors in that area shall connect to this primary system ground.
    - b. The system ground shall be provided in the audio equipment rack for the area, and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors.
    - c. A copper conductor having a maximum of 0.1 Ohms total resistance shall connect the primary system ground bar to the nearest approved electrical ground.
    - d. Secondary system grounding conductors shall be provided from all racks, audio consoles, and grounding point for the area. Each of these grounding conductors shall have a maximum of 0.1 Ohms total resistance.
    - e. Under no conditions shall the AC neutral conductor, either in the power panel or in a receptacle outlet, be used for a system ground
  - 2. No metallic conduit will terminate into the rack cabinet.
  - 3. Audio Cable Shields
    - a. All audio cable shields shall be grounded at one point only. There are no exceptions.
    - b. For inter and intra-rack wiring, this requires that the shield be connected at one end only.
    - c. For ungrounded portable equipment, such as microphones, the shield shall be connected at both ends but grounded at only one end.
  - 4. Audio Receptacles
    - a. All audio receptacles that are provided and installed by the Installing Contractor shall be insulated from the mounting panel, outlet box, or wireway. Unless otherwise detailed herein, this shall be accomplished by using insulated-from-panel type receptacles.
  - 6. Caution
    - a. Because of the great number of possible variations in grounding systems, it shall be the responsibility of the Installing Contractor to follow good engineering practices.

### 3.3 PERFORMANCE STANDARDS

- .1 Using the proper test equipment the following shall be checked:

1. DC resistance between the rack and equipment.Audio systems functionality.
2. Audio equipment operation.
3. Control system functionality.
4. Control system operation.
5. User interface functionality.
- .2 The Testing Process will continue throughout the Warranty Period of the AV system.

### 3.4 TEST PROCEDURES

- .1 Calibrated Test Instruments required (minimum)
  1. Sensitive AC voltmeter, -80dBu sensitivity or more, 20Hz -30KHz response, able to measure signal to noise ratio, THD, electrical levels within the system. Note that some systems require measurements up to 100 volts and may require an external pad.
  2. Sound Pressure Level Meter, ANSI Type II, with A and C weighting filters, fast or time averaged.
  3. Audio Signal Generator, 20Hz-30kHz, sine wave, pink noise, and continuous sine wave sweep.
  4. Amplified Loudspeaker 100 mm producing 60 dBa at one meter, and 70 dBa at one meter, pink noise, sine wave, and speech files.
  5. 200Mhz Oscilloscope, with TV sync (analog video only).
  6. Analog Signal Generator NTSC/PAL, plus computer patterns at all required resolutions and refresh rates required for the systems under test. For systems with composite video, include Pluge pattern. (analog video only)
  7. Digital Signal Video Generator for computer patterns for all resolutions and refresh rates required for the systems under test, HDMI/DVI/HD-SDI with and without HDCP.
  8. The ability to measure STI-PA (source analyzer).
  9. Colorimeter/luminance meter, 10% accuracy.
  10. Infrared thermometer.
  11. Test media with known levels (audio, video, etc): Cd's, VS, DVD's etc.
  12. AD/DC multimeter.
  13. Light meter, lux/foot-candles.
  14. Outlet tester (to test power outlet wiring).
  15. The ability to measure electrical power (watt meter, clamp meter, etc).
  16. Cable sets, cable assemblies, adapters as required to sample and measure in-or-out of circuit as req'd.

### 3.5 STAGING CHECKOUT (PROTOTYPE SHOP CHECKOUT)

- .1 Staging of systems and equipment at the Installing Contractors shop will be done to expedite the on-site installation by allowing the assembly and checkout where the resources are, and prior to the project site being ready.

1. Prototypical system testing for proof of concept in projects with multiple like systems. This will allow the identification and prevention of making the same mistake multiple times.
- .2 Installing Contractor will successfully perform, document, and then submit all the test results to the Owner
- .3 Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do Staging Checkout verification
  1. All verification testing is the responsibility of the Installing Contractor. This includes qualified personnel and proper test equipment.
  2. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner.
  3. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Any charge for additional time incurred by the Owner, required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the Installing Contractor.
- .4 Checkout will include:
  1. Appropriate Testing with as many of the various inputs and outputs that can be used to emulate the full system operation
    - a. Ensure there are no equipment problems
    - b. Test as much of the control system operation as possible and to make sure the user interface is intuitive
  2. Inspection
    - a. Workmanship
    - b. Safety related issues
    - c. Serviceability of the system
- .5 Once successful completion of the Staging Checkout has been acknowledged the Installing Contractor can:
  1. for "One-Off" Type of System – Prepare or proceed to the next phase of the installation
  2. for Prototypical – continue the assembly of the other like rooms while testing, documenting and submitting results for each system.

### **3.6 ON-SITE PROTOTYPE CHECKOUT**

- .1 Prototypical system testing for proof of concept in projects with multiple like systems. This will allow the identification and prevention of making the same mistake multiple times.
- .2 Installing Contractor will successfully perform, document, and then submit all the test results to Parks Canada. Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do On-Site Prototype Checkout verification
  1. All verification testing is the responsibility of the Installing Contractor. This includes qualified personnel and proper test equipment.
  2. See Section 3.4 Testing and 3.5 Testing Procedures for more details on testing and testing procedures

3. AV Consultant will be responsible to note any minor infractions on a "punch list" and Installing Contractor will be responsible for fixing these items before next checkout phase.
4. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Any charge for additional time incurred by the Consultant required to over-see the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the Installing Contractor
- .3 Checkout will include:
  1. Appropriate Testing with all field cables and connections made, and all equipment operational.
    - a. Insure there are no equipment and field wire problems
    - b. Test the complete control system operation and to make sure the user interface is intuitive
  2. Inspection
    - a. Workmanship
    - b. Safety related issues
    - c. Serviceability of the system
- .4 Once successful completion of the On-Site Prototype Checkout has been acknowledged the Installing Contractor can continue the build-out of the other like rooms.

### **3.7 FULL SYSTEM COMMISSIONING**

#### **.1 Installing Contractor's Full System Checkout**

1. Installing Contractor will accomplish a complete system(s) inventory of all equipment, and inspection of all workmanship quality relating to installation details.
2. Installing Contractor will complete all testing for system operational compliance, and test to ensure all equipment is working fully to published specifications.
3. Results will be recorded and submitted to the Owner. Installing Contractor's commissioning submittal will serve to allow 7-days for the Owner to perform an Owners System commissioning.
4. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Installing Contractor submittals.
5. The operation of all system equipment shall be demonstrated by the Installing Contractor.
6. Both subjective and objective tests will be required to determine compliance with the specifications.
  - a. The Installing Contractor shall be responsible for providing test equipment for these tests.
  - b. The Installing Contractor shall be responsible for providing qualified personnel to run the tests, make adjustments, and answer system questions for as long as required to accomplish the tests and setup satisfactorily.



7. The Installing Contractor shall be responsible for providing the personnel that accomplished all programming for the system; this includes the control system and any DSP software. This person will be available to run requested demonstration, make adjustments, and answer system programming questions for as long as required to accomplish the demonstration satisfactorily.
8. In the event there is required rework, large scale readjustments, or defective equipment that must be repaired or replaced, tests may be suspended or continued at the option of the Owner. Owner will advise if training can commence while any further cleanup is being done before Final System Checkout.

### 3.8 TRAINING

- .1 The Installing Contractor shall provide on-the-job training by a qualified instructor, to personnel designated by the Owner, to instruct them in the operation and routine maintenance of the systems.
  1. All training shall take place after the systems are operational, but before the acceptance tests.
  2. Operational Training:
    - a. There shall be a minimum of   2   hours of end-user training included in this specification for this activity.
    - b. In the event the Installing Contractor does not have qualified instructors on staff for certain sophisticated equipment, the Installing Contractor, at no additional cost to Owner, will provide a manufacturer's representative for such instruction to the Owner.
    - c. Training Materials Supplied:
      - (a) System operational manual (not equipment operation manuals) that explains how to fully operate the system; from start-up to shut-down, and all operational steps in-between, in a step by step description, with pictures and other visuals to help convey information.
  3. Maintenance Training:
    - a. A session with Owner's designated technical personnel for routine and preventive maintenance will be given.
      - (a) This training is for scheduled preventative maintenance for such items as filter and lens cleaning, minor equipment checks and "user" adjustments.
        - (i) This training is not meant to teach Owner's representatives how to use commercial test equipment and/or do sophisticated equipment/system alignment.
    - b. There shall be a minimum of   2   hours of end-user training included in this specification for this activity.
    - c. Training Materials Supplied:
      - (a) Utilizing the equipment manuals and flow diagrams of the required in contract closeout submittals supply a listing with suggested preventative maintenance schedule of the system equipment.

### 3.9 FINAL CHECKOUT

- .1 Final Checkout will not be performed until the Installing Contractor's Full System Commissioning has been successfully completed (including all "punch-list" items) and the test results have been reviewed by the Owner.
  1. Installing Contractor's test submittal will serve to allow 7-days for the Owner to make arrangements to do Final Checkout

.2 The Final Checkout with the Owner will consist of the following:

1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents and subsequent Installing Contractor submittals.
2. The operation of all system equipment shall be demonstrated by the Installing Contractor.
3. Both subjective and objective tests will be required to determine compliance with the specifications. The Installing Contractor shall be responsible for providing test equipment and qualified personnel for these tests.
4. All final, "as-built" drawings, run sheets, manuals, and other required documents shall be on hand.
  - a. Two complete sets of these documents shall be delivered to Parks Canada at this time.

**END OF SECTION**