

SYSTEM COORDINATION, VERIFICATION AND TESTING 26 08 05

1 GENERAL

1.1 Scope

- .1 The Division 26 contractor shall retain and pay for the services of an Independent Testing Organization ("ITO") to provide System Co-ordination Study, In-plant Inspection, Verification and On-Site Commissioning Service in accordance with the details specified herein.
- .2 The Division 26 Contractor shall include in the Bid Amount the cost for the services of tradesmen to handle equipment, make temporary connections, operate equipment and make repairs and adjustments and assist the testing organization's on-site specialists during the on-site pre-service inspection, testing, calibration, on-site witness testing and supplementary Commissioning phase of the work and as required by the Consultant until the equipment and systems are accepted by the Owner.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 14 Bus Duct
 - .2 26 24 13 Low Voltage Switchboards
 - .3 26 05 27 Grounding - Secondary
 - .4 26 32 13 Power Generation Diesel
 - .5 26 36 23 Automatic Transfer Switches

1.3 Independent Testing Organization

- .1 In order to ensure the requirement for independence, the ITO must be retained directly by the Division 26 contractor. The ITO must not be retained by an equipment manufacturer or their distributor as part of an equipment package.

1.4 Bidding Instructions to Vendors

The Bidders for Division 26 work shall advise all equipment suppliers bidding for the equipment supply for this project prior to Tender close of the requirement for comprehensive factory and on-site testing and commissioning and the requirement for on-site services of technical representatives during the testing and extensive commissioning phase and ensure the services and associated costs are included in the suppliers' quotations for the equipment for the project and in the Bidder's Tender Price.

Approved Testing Organizations

Standard of Acceptance

- Haronitis & Associates Limited
- AC Tesla
- Pelikan
- Eaton Electric / Cutler Hammer Service
- Schneider Canada Service
- Siemens Service
- G. T. Woods
- K-Tek Electro-Service Industries
- Rondar
- Brosz and Associates

- Enkompass

2 PRODUCTS

2.1 Not Used

3 EXECUTION

3.1 Preliminary Co-ordination Study

- .1 Immediately upon award of Contract liaison with the Supply Authority for information on relays and other protective devices installed on their system and substations which affect the co-ordination of this system.
- .2 Include liaison with the equipment manufacturers to obtain appropriate information and to recommend appropriate devices to obtain co-ordination of the system, immediately after award of Contract.
- .3 Prepare preliminary high voltage phase and ground curves and recommend fuse and/or sensor sizes for the main high voltage switchboards.
- .4 For the 600 V Normal, Emergency and APS systems investigate the long time overcurrent settings and determine the correct CT (sensor) size. If multitap CT's are available on the ACB's, select a CT's where the long time setting is middle of the range.
- .5 The recommended relays, sensors and CT's should be documented in a report format and submitted as a shop drawing (8 copies) for review by the Consultant within 2 weeks of award of Contract. The purpose of this report is to allow switchboards to be released to production. Attend all necessary meetings as required by the Supply Authority, Consultant and manufacturer to resolve co-ordination details.

3.2 Detailed Co-ordination Study

- .1 Prepare a detailed co-ordination study of the electrical system and submit 8 copies as a shop drawing for review.
- .2 The co-ordination study shall include the preparation of time-current characteristic curves of the protective devices in the system drawn on special Log-Log graphs with .01 to 10,000 seconds on the Time co-ordinate and 5 ranges on the Current co-ordinate paper. The system shall be sub-divided into portions so that the curve for each device clearly shows its relationship to associated upstream and downstream devices and shall be submitted as per Article "Shop Drawings". Each set of curves on a single graph for the portion of the system involved shall include or show the following:
 - .3 Appropriate sections of single line diagram.
 - .4 Electrical equipment and conductor damage curves and transformer inrush, damage and overload curves
 - .5 Phase and ground time current curves characteristics on different graphs.
 - .6 Three phase and ground fault levels when operating with normal utility power. Generator decrement curves for the main emergency switchboard.
 - .7 Each protective device identified with a distinctive code matching the ones on the Contract Drawings or alternatively matching ones on a riser especially prepared for the study..
 - .8 Separate curves for each different setting of feeder breakers supplying panelboards at each voltage level and on each system, i.e normal power, and emergency power
 - .9 Largest downstream non-adjustable device (ie. Moulded case breaker or fuse).

- .10 The co-ordination study shall be submitted in a formal report document as a "Shop Drawing". It shall optimize the setting and selection of protective devices. It shall also identify areas of deviation and note areas of acceptable industry practice.
- .11 The co-ordination study shall include:
- .12 The protective devices on the Supply Authority system
- .13 Main high voltage switchboards.
- .14 Damage curves on cables and transformers
- .15 Distribution equipment at all voltage levels.
- .16 Emergency system and the main distribution related to it.
- .17 Largest protective devices on each power and distribution panels and motor control centres.
- .18 Protection equipment on motors 75 kW (100 HP) and larger.

3.3 Substation Ground Resistivity Study

- .1 Immediately upon award of Contract conduct ground resistivity measurements at the proposed location of the outdoor high voltage substation. In conjunction with the substation drawings, prepare a report for submission to the ESA indicating station ground resistance, ground potential rise, mesh voltage, step voltage, and touch voltage inside and outside the station area. Make recommendations on modifying the substation grounding design where necessary to achieve acceptable grounding system characteristics.
- .2 Verify completed installation as follows:
- .3 Dynamic ground resistance measurements at the high voltage substation using the drop of potential method as described in ANSI/IEEE 81, using a three point (or four point) Fall of Potential multi function tester.
- .4 Dynamic bonding verification of the high voltage switchgear, power transformers, substation enclosure, and associated apparatus using 60 Hz AC excitation current method.
- .5 Buried Grounding System Test

3.4 Lightning Protection and Building Grounding System Testing

- .1 Buried Grounding System Test
 - .1 Perform electrical measurement testing of the installed combination electrical and lightning protection system buried grounding grid installation to verify the effectiveness of the installation.
 - .2 Test using the fall of potential method as described in ANSI/IEEE 81, using a three point (or four point) Fall of Potential multi function tester.
 - .3 Inject AC current of non standard (non 60 Hz and non 60Hz harmonics) frequency into the grounding system via an accessible ground lead connection.
 - .4 Insert current probe into soil at 10 foot intervals ranging from 0 - 400 feet away from the building, and record resistance.
- .2 Connector Contact Resistance Testing
 - .1 Perform contact resistance measurements of the following Lightning Protection System connections
 - (a) Each roof mounted LPS air terminal connection to the perimeter roof loop conductor (measure from air terminal to loop conductor)
 - (b) Resistance of bonding connection from each item of equipment on the roof to the roof LPS grid
 - (c) Roof perimeter loop conductor to each LPS down conductor

- (d) Roof perimeter loop conductor to each roof cross grid conductor
- (e) Each LPS down conductor bonding connection to the electrical room perimeter ground bars (at each floor level) and to the buried grid stub up conductor
- (f) Each LPS down conductor joint
- .2 Contact resistance to be measured using digital micro-ohmmeter
 - (a) 0 - 10A or 0 - 100A as required
 - (b) 4 terminal Kelvin measurement type
- .3 Record each measurement in micro-ohms in a chart format identifying each connection type and location
- .3 Connections to Buried Grid
 - .1 Throughout the perimeter of the ground floor electrical/mechanical plant area, grounding connections between the perimeter copper ground buses and the below grade buried grounding grid are in place.
 - .2 Similarly, the LPS down conductors in the computer room areas of the building are routed down the perimeter walls from roof to buried grid
 - .3 Measure the effective resistance of each of these connections between the buried grid and the above grade portion by utilizing a two clamp on current transformer measurement technique. One current transformer when clamped around the stub up conductor is to induce a 128 Hz voltage on the conductor, while the second current transformer measures the actual current flowing through the conductor, in order to determine the effective resistance of the connection to the buried grid. The recommended testing instrument for this test is the Fluke / LEM GEO Earth Ground Tester.
- .4 Roof Down Conductor Resistance Measurement
 - .1 Using the same technique as described above, measure the effective resistance of each LPS down conductor at the roof level, using the Fluke / LEM GEO tester.

3.5 Factory Witness Testing

- .1 Provide in-plant inspection and factory witness testing at various manufacturing plants where the equipment and materials are made and/or assembled prior to shipment to the job-site.
- .2 Certification shall be made that all required tests have been completed and that equipment conforms to standards, specifications and shop drawings and is suitable for shipment.
- .3 Factory witness tests of equipment and HV cables shall be done after equipment have passed standard production tests and is free and clear of deficiencies and in the opinion of the manufacturers, the equipment is deemed suitable for shipment to the job-site.
- .4 The supplementary factory witness tests by the Independent Testing Organization are required to certify on behalf of the contractor and owner that the equipment is compliant and free and clear of deficiencies and suitable for shipment to the job-site.
- .5 The following is an outline of the minimum requirements for the factory witness tests.
 - .1 High voltage cables:
 - (a) High voltage cables:
 - (b) Insulation resistance
 - (c) Compliance with CSA (insulation thickness compliance)
 - .2 High voltage switchgear
 - (a) Physical Inspection
 - (b) Corona Tests

- (c) Verification of relaying, protection, control and metering schemes.
- (d) Verification of mechanical and electrical interlocking schemes.
- (e) Verification of conformity to Ontario Hydro and Supply Authority requirements.
- .3 Main power transformers
 - (a) Physical inspection of tank, core and coils, (before tanking)
 - (b) BIL tests on all units
 - (c) Heat run tests on all units
 - (d) Ratio, polarity, and phase angle tests
 - (e) Compliance with Specs and Standards.
 - (f) Correctness of upstream and downstream interfaces
 - (g) Proper operation of fan controls and safeties
- .4 Diesel generators
 - (a) Physical inspection of assemblies.
 - (b) Load tests, per unit and per system
 - (c) Verification of operating performance, protection, relaying, control, metering and load management schemes with ATS simulation.
- .5 Low voltage switchboards
 - (a) Physical Inspection and compliance with HH Angus specifications and Standards
 - (b) AC Hi-pot tests
 - (c) Verification of protective device functions, ratings and settings in accordance with the approved Co-ordination Study
 - (d) Verification of the proper operation of protection, relaying, control, metering and interlocking schemes.
 - (e) Verification of the auto transfer controls
- .6 Automatic Transfer Switches
 - (a) Physical inspection and compliance with specifications
 - (b) verification of the proper operation of control and interlocking system
- .7 UPS modules and batteries
 - (a) System tests as per UPS specification documents, to be conducted by manufacturer, including heat runs, transients, operating performance, harmonics.
 - (b) Physical inspection and compliance with H. H. Angus specifications
 - (c) Verification of protective device functions, protection, relaying, control, metering, and interlocking schemes.
- .6 Provide a test report for each equipment item in each of above sections. Notify Consultant of failed tests/noncompliance

3.6 Pre-service On-site Inspection, Testing of Equipment and Devices

- .1 Upon Completion of the installation and prior to energization of components and systems, perform a complete inspection and testing to verify phase and polarity match of feeders with equipment and the tightness of power wiring terminations.
- .2 In addition perform the following tests and functions:
 - .1 High voltage cables
 - (a) Phase verification
 - (b) Grounding verification

- (c) DC Hi-pot
- (d) DC Hi-pot
- .2 High voltage switchgear
 - (a) Physical inspection, verification of wiring and interconnections
 - (b) Dynamic contact resistance on bus connections
 - (c) DC hi-pot
- .3 Power Transformers
 - (a) Thorough physical inspection
 - (b) Verify operation of temperature controls and fan operation
 - (c) Ratio, polarity and phase angle test
 - (d) Insulation power factor and polarization index tests
 - (e) Insulation power factor and polarization index tests
 - (f) Oil samples and oil analysis report for contaminants and insulation quality
- .4 Emergency Power System including ATS's
 - (a) Diesel generator system
 - (b) Diesel generator system
 - (c) Polarity and rotation tests of power terminations
 - (d) Dynamic contact resistance test on breakers and batteries
 - (e) Infra-red scan on terminations during heat run tests
 - (f) System tests as per specification documents, to be conducted by manufacturer's technical representative.
 - (g) Calibration of protective devices
 - (h) Calibration of protective devices
- .5 Low voltage switchboards
 - (a) Thorough physical inspection, verification of wiring and interconnections.
 - (b) Dynamic contact resistance on breakers and bus connections.
 - (c) Mechanical operation of breakers including racking-in and out of housing
 - (d) Calibration of relays, tests and record "as left" condition.
- .6 Power Feeders
 - (a) Thorough physical inspection
 - (b) Insulation resistance of all feeders
 - (c) Polarity and rotation tests of power terminations
- .7 UPS module, battery, static switchboards:
 - (a) System tests as per UPS specification documents, to be conducted by manufacturer, including heat runs, transients, operating performance, harmonics.
 - (b) Physical inspection and compliance with H. H. Angus specifications
 - (c) Verification of protective device functions, protection, relaying, control, metering, and interlocking schemes.
 - (d) Dynamic contact resistance on breakers and bus connections
 - (e) Mechanical operation of breakers including racking in and out of housing
 - (f) Calibration of relays, tests, and record as left condition

- (g) Thorough physical examination
 - (h) Dynamic contact resistance on battery cell connections
 - (i) Voltage measurements on all cells
 - (j) Infra-red scan of internal power components during on-site heat runs on module
 - (k) Battery capacity test, each string
 - (l) harmonic testing of input and output.
- .8 Potential transformers (throughout all components and systems)
 - (a) Ratio, polarity and phase angle tests
 - (b) Insulation resistance tests
 - .9 Current transformers (throughout all components and systems)
 - (a) AC excitation test, (produce saturation curves)
 - (b) Polarity ratio and insulation resistance tests
 - .10 Metering and Instruments throughout all components and systems
 - (a) Verify correctness of wiring and operation
 - .11 Key Interlocking schemes
 - (a) Verify proper operation and identification of all key interlocking systems throughout all switchboards and panelboards

3.7 Testing, Adjusting and Verification

- .1 Provide factory witness testing to suit delivery schedule of manufacturers. Include a contingency allowance in the cost to re-visit the manufacturers' plants and re-witness Factory Witness tests, should the initial tests fail and repairs and modifications cannot be done to correct deficiencies during the initial testing program.
- .2 Provide necessary test equipment, material, labour and miscellaneous services during the testing, adjusting, verification and commissioning procedure.
- .3 Work normal to the electrical trade such as providing temporary feeders, jumpers and connections, and handling equipment shall be done by the contractor under Division 26.
- .4 Work and technical supervision by manufacturers' technical representatives in the verification, testing and commissioning phase shall be provided and all costs for tradesmen and representatives shall be included in the tender price.
- .5 Verify that all protective device schemes function properly. Conduct circuit breaker trip tests. Apply correct voltage and current to protective devices.
- .6 Verify the performance of the ground fault alarm and protection systems
- .7 Provide cross wattmeter readings or equivalent or any differential and/or directional relay schemes. Verify metering schemes.
- .8 During the testing and verification procedure, conduct supplementary spot checks on selected protective devices in company with representative of the Owner and/or Consultant to adjust and re-test protective devices so that final settings will result in performance in accordance with approved issue of respective co-ordination curve.

3.8 UPS Battery Preparation

- .1 Measure and record all intercell battery connector resistances after installation. The Electrical Contractor is to remove and reinstall any connectors with deficient readings at no additional cost to Owner.

- .2 Arrange for the UPS supplier to equalize charge battery strings in accordance with manufacturer's recommendations.
- .3 Measure and record specific gravity readings for each battery cell one week after equalize charge.
- .4 Measure and record individual cell voltages and half cell voltages for each battery cell one week after equalize charge.
- .5 Measure and record electrolyte temperatures for each battery cell and record room temperature.
- .6 Check electrolyte level for each battery cell and adjust as necessary.
- .7 Verify all interrack, intertier and output cable connections.
- .8 Check all bolts in battery racks for tightness.

3.9 On-site Testing of UPS and Batteries

- .1 The UPS Supplier will conduct an acceptance test in presence of and to satisfaction of the Independent Testing Agent and the Consultant, after completion of installation, but before UPS System is permanently put into service.
- .2 Tests shall include operation of breakers manually and electrically, racking in and out, and checking that meters and relays function properly.
- .3 In addition to above, include work associated with field testing, cleaning and calibration of new relays and trip devices in Bid cost.

3.10 Preliminary On-Site Testing - UPS & Batteries

- .1 After connections have been completed, checkout of all components and preliminary tests have been completed and all deficiencies have been corrected, the Contractor and UPS vendor are to conduct a heat run on the module and system bypass, in the presence of the Independent Testing Agent, and the Consultant.
- .2 The heat run on the module shall be run for 4 hours at full module load using the building test load bank.
- .3 The equipment shall have passed all preliminary and heat run tests before final witness tests in the presence of the Contractor's testing organization and the Owner's Engineer can be conducted. Notify the Consultant when all of the above has been completed. Failure to complete a heat run shall result in a complete retest, once failed components have been replaced.
- .4 Conduct Witness Tests in accordance with the Consultant's test program.

3.11 On-Site Witness Tests and Commissioning Program - UPS & Batteries

- .1 After connections have been completed and preliminary tests have been made, conduct an On-site Witness Tests to the satisfaction of the Consultant. Once these test have proved satisfactory, provide the services of a licensed electrician to participate in the Owner's and Engineer's Commissioning program. The testing and demonstrations required during the Commissioning program will be conducted at a time suitable to the Owner to be on-site during the Commissioning program.
- .2 The UPS Vendor will demonstrate the capabilities of the UPS equipment to provide continuous uninterruptible power under the various power supply conditions claimed by the manufacturer and in particular the following specific conditions:
 - .1 Normal start-up sequence and ability to come on line and share load with a full rated test load, verify modules share load to within $\pm 5\%$.
 - .2 Ability to fine tune the system for float voltage control.
 - .3 The ability of the UPS to supply acceptable power to the critical bus when the incoming power from the utility and emergency system has been disconnected and reconnected rapidly. Record

the electrical parameters of the system, i.e. Battery voltage, load voltage, load amps, power factor.

- .4 Verify input harmonic performance of the UPS system when connected to the Hydro supply and when connected to the various combinations of available generator sources. Verify total harmonic current distortion does not exceed 10%. Monitor input voltage distortion and trap current and voltage throughout the tests and record data. Tests shall be done when connected to hydro and diesel generator. During input harmonic testing, a BMI harmonic analyzer will be supplied by the UPS vendor to perform harmonic current and voltage testing. Filter trap current and voltage shall be monitored to ensure filter is operating within safe limits. In the event that the testing reveals unacceptable harmonic levels or harmonic resonance conditions, manufacture shall retune filter with new components and entire test procedure will be repeated as often as necessary to obtain performance as specified and to the satisfaction of the Consultant, all at no additional cost to the Owner.
- .5 Manual transfer to and from by-pass without any interruption to the critical bus while carrying: a full system rated test load when being fed from Hydro and from the APS system. Record parameters.
- .6 Automatic transfer to by-pass without any interruption to the critical bus by overloading inverter cubicles. Record parameters.
- .7 The ease of trouble shooting and replacement of defective fuses.
- .8 Alarm and annunciator functions.
- .9 Transient performance during the various transfer tests noted above shall be monitored using a BMI monitor, with out of tolerance thresholds suitably set to record the disturbance.

3.12 Performance Verification of the Entire System

- .1 After the energization of the electrical systems have been satisfactorily completed and all testing and calibration work have been done and all reports submitted as shop drawings to the Consultant and all deficiencies noted to-dated have been corrected, the systems shall be subjected to supplementary dynamic simulation and verification of their operating performance characteristics in accordance with the Consultant's Test Plans and in the presence of the Consultant and Owner's representative.
- .2 The Contractor's forces and manufacturer's technicians shall also be present to start, stop and operate equipment and make adjustments as directed by the Consultant.
- .3 The following is an abbreviated outline of the tasks to be undertaken:
 - .1 Dynamic phasing and polarity verification of HV & LV switchboards, automatic transfer switches, and APS systems.
 - .2 Verify the start signal from each ATS is received at the respective diesel generator control panels and that the DG's start and supply power to the ATS's in the prescribed sequence.
 - .3 Verify that APS system will operate automatically. Tripping of incoming power supplies will be required
 - .4 Verify operation of APS automatic load management system by removing generating units from the system and simulating other malfunctions in the system.
 - .5 Verify operation of all manual controls on APS system
- .4 Upon completion of the Commissioning phase, prepare a comprehensive report summarizing the findings.

3.13 Reports

- .1 Prepare and submit the following reports. Simultaneously submit one copy directly to the Consultant and a further 6 copies to the contractor to be processed as a shop drawing:
 - .1 Preliminary Co-ordination Study with breaker and protective device requirements

- .2 Final Co-ordination Study
 - .3 Factory Witness test report for each item of equipment within 5 working days of the factory visit. Where deficiencies in the factory test have been noted, inform the engineer and contractor immediately to permit a decision to be made whether remedial action is required of the manufacturer prior to the equipment being accepted for shipment to site.
 - .4 Site Testing Report for each item of equipment within 5 working days of completion of site test.
 - .5 Site Performance verification report(s) to reflect each significant phase of system completion.
 - .6 Upon completion of the Commissioning phase, prepare a comprehensive report summarizing the findings.
- .2 The final report and study shall include assurance for the following items:
- .1 That the protective devices on the high voltage equipment co-ordinate with the Utility protective devices.
 - .2 That the protective devices within the parameters of the study conform to the results of the study.
 - .3 That the equipment has been tested and performs as per the settings of the approved co-ordination curves.
 - .4 That the "as left" condition of the protective devices correspond to the record documents.
- .3 Completed studies and reports shall be submitted simultaneously to the Consultant as well as part of the requirements of the Maintenance Manuals. Provide 5 copies of final reports and co-ordination study.

END OF SECTION

TRANSFER SWITCHES

26 36 23

1 GENERAL

1.1 Scope

- .1 Provide transfer switches as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 48 Vibration Isolation
 - .2 26 05 49 Seismic Restraints.
 - .3 26 08 05 System Co-ordination, Verification & Testing.
 - .4 26 32 13 Power Generation Diesel

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ANSI/NETA ATS Standard for Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - .2 CSA C282 Emergency Electrical Power Supply for Buildings,
 - .3 CSA Z32 Electrical Safety and Essential Electrical Systems in Health Care Facilities.
- .2 Product Standards:
 - .1 CSA C22.2 No. 94.1 Enclosures for Electrical Equipment, Nonenvironmental Considerations
 - .2 CSA C22.2 No. 94.2 Enclosures for Electrical Equipment, Environmental Considerations
 - .3 CSA C22 No. 178.1 Transfer Switch Equipment,
 - .4 NEMA ICS 10 AC Automatic Transfer Switches.

1.4 Manufacturer Services

- .1 Additional services are to be provided by the equipment supplier or their field service representatives and costs for this work are to be included in the Bid Amount.
- .2 Equipment manufacturer, or their supplier or field service representatives to provide the following services and associated service equipment:
 - .1 interface control wiring diagrams, schedules and wire running lists between all components,
 - .2 factory testing and supplementary acceptance testing,
 - .3 provision of information as appropriate to install and test the equipment,
 - .4 technical supervision of equipment unloading, equipment site assembly, installation of power and control cables, cable connections, and all other work normal to the electrical trade,
 - .5 on site setup of timers and controls,
 - .6 on site programming of controls and communications equipment,
 - .7 on site testing,
 - .8 technical assistance during acceptance testing,
 - .9 technical assistance during commissioning,

- .10 factory and field training of the Owner's staff in the complete operation of the system,
- .11 warranty service on a priority basis,
- .12 data book including schematic diagrams,
- .13 check out of system one month prior to expiry of warranty period,
- .14 services of a technical representative as required by the Owner to review production schedules, delivery dates, shop drawing changes, shipping details, shop and field testing and training programs.

1.5 Submittals

- .1 Shop drawings submittals:
 - .1 Product data sheets for materials specified herein.
- .2 Provide one additional set of drawings shipped with the equipment for start up use.
- .3 Operating and maintenance data:
 - .1 Installation, operating, and maintenance data and instructions to cover the equipment furnished.
 - .2 Technical data:
 - (a) schematic diagram of components, controls and relays,
 - (b) illustrated parts lists with parts catalogue numbers,
 - (c) certified copy of factory test results.
 - .3 Complete spare parts list, including parts location diagrams or drawings.
 - .4 List of priced spare parts which manufacturer recommends to be on hand during start-up and during the first two year's operation.
 - .5 A material list, listing the quantity, rating, type, and manufacturer's catalog number of all equipment on each unit.

1.6 Quality Control

- .1 Manufacturer's Production Test and Records:
 - .1 Submit certified copies of reports of manufacturer's production testing for all transfer switches.
- .2 Factory Acceptance Testing (FAT):
 - .1 Refer to Part 2 Product for requirements.
- .3 Site Acceptance Testing:
 - .1 Refer to Part 3 Execution for requirements.

1.7 Warranty

- .1 In addition to the warranty provisions of Division 01, provide a written warranty for parts, labour and services to repair or replace any part of the equipment within a period of two (2) years from date of acceptance by the Owner, against:
 - .1 faulty or inadequate design, manufacture or operation,
 - .2 defective material or workmanship, or both,
 - .3 breakage or other failure that occurs under normal and proper operation of the equipment.
- .2 Manufacturer to correct deficiencies which occur during the two year warranty period at no additional cost to the Owner. The manufacturer's technical representative to call back within one (1) hour and be available on site on a priority basis i.e. within 4 hours of being notified of a deficiency requiring repair.

2 PRODUCTS

2.1 General

- .1 Transfer switches to be provided by one manufacturer.

Standard of Acceptance

- ASCO Power Technologies 7000 series
- Russelectic
- GE
- Eaton
- Cummins
- Caterpillar

2.2 General Features

- .1 Type A without any internal trip devices.
- .2 Suitable for use as part of a code required emergency power system.
- .3 Electrically operated, mechanically held contacts.
- .4 Designed for unattended operation.
- .5 Double throw type:
 - .1 4 pole for 120/208V switches.
- .6 Rated for operation on the system shown, either:
 - .1 120/208V 3 phase, 4 wire solidly grounded, as applicable.
- .7 Suitable for operation on a high resistance grounded system without requiring a neutral connection and without introducing any load current into the ground connection.
- .8 Main contacts:
 - .1 protected by separate arcing contacts and arc chutes,
 - .2 interlocked mechanically and electrically.
- .9 Sensing and control relays:
 - .1 continuous duty,
 - .2 industrial control quality.
- .10 Pilot lights:
 - .1 LED type,
 - .2 with "Push to Test" feature.
- .11 Cable lugs:
 - .1 suitable for copper conductors,
 - .2 suitable for the cable sizes shown,
 - .3 oversized where required to suit feeders that have been oversized (eg: to meet voltage drop criteria),
 - .4 reduced sizes where required to suit feeders that are substantially smaller than the transfer switch rating (eg: due to switch oversizing to meet the specified withstand ratings).
- .12 Switch lifting yoke.

- .13 Seismically certified to withstand the ground acceleration criteria and seismic demand requirements for non-structural equipment as specified in the Building Code for the geographic location of the installation.

2.3 Automatic Transfer Switches (ATS)

- .1 Basic operation of each ATS:
 - .1 when any phase of the preferred source power at the transfer switch drops below 90% of preferred source voltage for the selected time, a relay on that transfer switch to operate to cause the Diesel engine to be started,
 - .2 when Diesel-alternator reaches rated voltage and frequency, the transfer switch to operate to transfer load to Diesel-alternator,
 - .3 when preferred source power supply is restored and voltage on all phases is 90% or more for the selected time, switch to transfer load back to preferred source power supply,
 - .4 after a preselected time delay the engine start signal is removed.
- .2 Automatic transfer switches shown connected to continuously energized preferred and alternative sources:
 - .1 controls to prevent transfer to the alternative source unless:
 - (a) the normal source fails or,
 - (b) the test switch on the respective unit has been operated.
 - .2 Selector switch to allow selection of the preferred source.
 - .3 Engine start contacts not required.
- .3 Provide in each automatic transfer switch, as indicated by "ATS" in the name, the following features:
 - .1 a microprocessor-based control panel with field accessible adjustments to such items as voltage pick-up and drop-out and timing controls,
 - .2 three phase true RMS over and under voltage sensing of both the preferred and alternative sources with programmable set points,
 - .3 over and under frequency sensing of both the preferred and alternative sources with programmable set points,
 - .4 engine start contacts,
 - .5 duplicate engine start contacts,
 - .6 time delays:
 - (a) on engine start after preferred source fails, adjustable from .5 to 6 seconds, set at 2 seconds,
 - (b) on transfer to alternative source, adjustable 0-300 seconds, set as indicated,
 - (c) on alternative source failure, adjustable from .5 to 6 seconds, set at 6 seconds,
 - (d) on transfer to preferred source after restoration of preferred source, adjustable 0-30 minutes, set as indicated,
 - (e) on transfer to preferred source following a test of the alternative source, adjustable 0-30 minutes, set at 30 seconds,
 - (f) on unloaded engine cool down, adjustable 0-60 minutes, set at 0 minutes,
 - .7 selector switches, mounted on outside of door with a guard to prevent accidental actuation:
 - (a) maintained contact type test switch:
 - i) to simulate a power failure and cause Diesel-generators to start and load to transfer,
 - ii) to cause the transfer switch to transfer back to the preferred source, following the time delay, after the test switch is manually reset,

- (b) four position selector switch for engine control. Auto / Off / Engine Test / System Test,
 - (c) reset switch for manual retransfer to preferred source with bypass of time delay,
 - (d) switch and circuitry to enable selection of the alternative source as the preferred source with override in event of failure of the alternative source,
 - (e) engine disconnect switch: two position maintained contact switch to inhibit the engine start signal from being sent when maintaining the ATS,
- .8 pilot lights:
- (a) to indicate transfer switch is in preferred source position,
 - (b) to indicate transfer switch is in alternative source position,
 - (c) to indicate preferred source power is available,
 - (d) to indicate alternative source is available,
- .9 auxiliary contacts:
- (a) contact to close when preferred source fails,
 - (b) four on main shaft, closed when on preferred source,
 - (c) four on main shaft, closed when on alternative source,
- .10 remote test circuitry,
- .11 terminal provisions for a remote customer contact to inhibit transfer to the preferred source,
- .12 terminal provisions for a remote customer contact to inhibit transfer to the alternative source,
- .13 externally-mounted quick-make quick-break operating handle on switches ≥ 600 Ampere rating,
- .14 electrical metering of the load side of the transfer switch, metering to be true RMS, 1% accuracy and to include the following:
- (a) Voltages, 3 L-L
 - (b) Frequency
 - (c) Current, 3 phases
 - (d) %unbalance, Voltage and Current
 - (e) kW
 - (f) kVA
 - (g) kVAR
 - (h) power factor
 - (i) kWh
- .15 ModBus Ethernet communications system to provide the following:
- (a) transmission of the load side metering data to the building management system and to the generator control switchboard, including:
 - i) Voltages, 3 L-L
 - ii) Frequency
 - iii) Current, 3 phases
 - iv) %unbalance, Voltage and Current
 - v) kW
 - vi) kVA
 - vii) kVAR
 - viii) power factor
 - ix) kWh

- (b) transmission of status conditions to the building management system and to the generator control switchboard, including:
 - i) Loss of preferred source
 - ii) Preferred source available
 - iii) Alternative source available
 - iv) TS connected to preferred source
 - v) TS connected to alternative source
 - vi) TS parked in neutral position (where applicable)
 - vii) TS in bypass (where applicable)
 - viii) TS under load management control (where applicable)
 - ix) TS transfer inhibit by SUPS (where applicable)

2.4 Additional Features for Selected Automatic Transfer Switches

- .1 For switches with bypass/isolation feature:
 - .1 built-in two way manual bypass/isolation system,
 - .2 to allow the active switch element to be removed from the system while the load remains energized from either the preferred source or the alternative source,
 - .3 bypass/isolation switch ratings: same as the active switch,
 - .4 load break and load make contacts,
 - .5 externally-mounted quick-make quick-break operating handle,
 - .6 safe operation as a manual transfer switch,
 - .7 auxiliary contacts to indicate when the transfer switch is in bypass mode,
 - .8 automatic shutters which close when the active element is withdrawn, to provide isolation from live bus.
- .2 For switches that supply elevator equipment:
 - .1 two selective load disconnect control contacts,
 - .2 contacts to operate prior to and/or after load transfer and retransfer (elevator pretransfer signal),
 - .3 contacts adjustable from 0 to 300 seconds, set at 20 seconds,
 - .4 engine start contacts not required.
- .3 For switches that supply SUPS equipment:
 - .1 transfer inhibit circuit to prevent a transfer in either direction upon closure of a remote contact,
 - .2 transfer to occur should the source, to which the ATS is connected, fail, regardless of the status of the remote contact.
- .4 Provide the additional features as indicated by a **v** mark in the following table:

Transfer Switch Name	Bypass/Isolation Feature	Switch Supplies Elevator Equipment	Switch Supplies SUPS Equipment
ATS-1	√	√	√
ATS-2	√	√	√

2.5 Open Transition Transfer Switches

- .1 To provide a break before make switching operation in each direction.
- .2 Preferred source and alternative source contacts mounted to a common shaft.
- .3 Single operator to provide a high speed switching operation with no intentional delay in a neutral position.
- .4 In phase monitor:
 - .1 to operate in both directions,
 - .2 to inhibit a transfer between live sources until the phase angle between the sources is at the selected angle and is decreasing,
 - .3 phase angle transfer initiation point to be adjustable from 5° to 60°.
 - .4 factory set the phase angle at 15° except where indicated otherwise,
 - .5 reset the phase angle on site to suit the characteristics of the load,
 - .6 to permit transfer when both sources are synchronized and in phase,
 - .7 to permit transfer when one source is not energized.

2.6 Automatic Transfer Switch Table

- .1 Provide automatic transfer switches of the type indicated by the √ mark in the following table:

Transfer Switch Name	Open Transition	Delayed Transition	Closed Transition	Solid State Transition
ATS-1	√			
ATS-2	√			

2.7 Ratings

- .1 Continuous duty at capacity specified without derating.
- .2 Capable of withstanding fault currents of magnitudes ≥ than the values shown, for the durations shown.
- .3 Capable of functioning in the normal manner:
 - .1 following a fault, up to the maximum level and duration specified for the withstand rating of the switch,
 - .2 after closing into a fault of a magnitude not less than that specified for the withstand rating of the switch.
- .4 The specified withstand ratings to be achieved without requiring the operation of a breaker or a fuse to protect the switch, except where shown otherwise.
- .5 Provide transfer switches as shown and in accordance with the following table:

Transfer Switch Name	Continuous Current Rating (Amperes)	30 Cycle Withstand and Closing Rating (Amperes, RMS Symmetrical @ 600V)	3 Cycle Withstand and Closing Rating (Amperes, RMS Symmetrical @ 600V)
ATS-1	1600	42KAIC	42KAIC
ATS-2	800	36KAIC	36KAIC

2.8 Settings

- .1 Factory set the TS's in accordance with the settings listed in the following table. Confirm settings prior to manufacture and reprogram on site as directed.

Transfer Switch Name	Time Delay on Transfer to the Alternative Source (seconds)	Time Delay in the Neutral Position (seconds)	Time Delay on Transfer to the Preferred Source (Seconds)
ATS-1	0	0.5	300
ATS-2	0	0.5	300

2.9 Enclosure

- .1 Enclosure:
- .1 Listed to CSA C22. 2 NO. 94.1 or 94.2 as applicable, Type 1 with drip shield except where indicated otherwise,
 - .2 suitable for installation in a sprinklered room,
 - .3 sized to accommodate the cable/bus duct feeders shown,
 - .4 doors:
 - (a) to be hinged,
 - (b) to open not less than 135°,
 - (c) equipped with a T-Handle 3 point locking system complete with lock and latch,
 - .5 instrumentation and status lights to be visible without opening doors,
 - .6 for transfer switches requiring rear access, provide three infra-red viewing ports supplied loose for field installation.
- .2 Finish:
- .1 rust-inhibiting metal treatment process,
 - .2 powder coat finish to UL50 3R,
 - .3 colour: ANSI #49 grey
- .3 Provide 2 pressurized spray cans of matching paint to touch-up small areas marred during installation.

2.10 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 01 - Electrical General Requirements.
- .2 Provide a nameplate on each TS. Nameplates to be 3 mm (c") thick, with white lettering on a red background, with bevelled edges.

- .3 Lettering to be engraved and to be 5 mm ($\frac{1}{4}$ ") high, except where indicated otherwise.
- .4 Confirm wording on nameplates prior to manufacture.
- .5 Nameplates to indicate:
 - .1 Name of the switch, eg: ATS-1 (8 mm ($\frac{1}{4}$ ") high lettering)
 - .2 System voltage, eg: 120/208V, 3 \emptyset , 3W
 - .3 Switch current rating, eg: 1600 A
 - .4 Preferred source, eg: PREFERRED SOURCE: MAIN SWBD
 - .5 Alternative source, eg: ALTERNATIVE SOURCE: GEN 2
 - .6 Load supplied, eg: SUPPLYING: SWBD-EEA
- .6 Mechanically attach nameplates with stainless steel screws.

2.11 Factory Acceptance Testing (FAT)

- .1 Provide FAT on transfer switches rated ≥ 600 Amperes.
- .2 FAT:
 - (a) to be in addition to manufacturer's standard post-production tests,
 - (b) to be witnessed by the Independent Testing Organization,
 - (c) may be witnessed by the Consultant, provide the Consultant with at least one week's notice of the FAT schedule and accommodate the Consultant's presence at the factory throughout the FAT.
- .3 As part of the FAT, perform the following inspections and tests on each switch:
 - (a) physical inspection,
 - (b) compliance with specifications,
 - (c) proper operation of all control and interlocking systems,
 - (d) dynamic transfer between two sources,
 - (e) per the NETA Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems, Section 7, #7.22.3 Emergency Systems, Automatic Transfer Switches: however, testing of "field" connections is not required,
 - (f) for closed transition transfer switches include:
 - i) waveform capture to demonstrate seamless transfer of load within 100ms,
 - ii) demonstration of protection circuitry to prevent paralleling of sources beyond 100ms,
 - iii) testing of the switch in delayed transition mode,
 - (g) for solid state transition transfer switches include:
 - i) waveform capture to demonstrate open transfer of load within specified outage duration with a load of not less than xxxkW,
 - ii) demonstration of SCR gate test board,
 - iii) demonstration of shorted SCR detection system,
 - iv) demonstration of the static switch disable switch,
- .4 Submit certified copies of the FAT reports.
- .5 Correct deficiencies prior to shipment.

2.12 Manufacturers' Service Representation on Site

- .1 Refer to Part 3 Execution for requirements.

3 EXECUTION

3.1 Installation

- .1 Install switches in accordance with the manufacturer's instructions.
- .2 Provide, under this division, a 100mm (4") reinforced concrete pad with beveled edges for each floor mounted transfer switch. Seal with paint or concrete sealer to prevent concrete dust from entering equipment.
- .3 Anchor the concrete pad to the building structure in accordance with Section 26 05 48, Vibration Isolation and Seismic Restraints.
- .4 Receive equipment at site and inspect for damage.
- .5 Provide necessary cranes and miscellaneous equipment to unload and transfer equipment into its final location.
- .6 Position transfer switches to provide:
 - .1 adequate clearance at the front, with draw-out elements in the drawn-out position,
 - .2 adequate clearance at the rear for switches requiring rear access.
- .7 Secure transfer switches to the concrete pad and/or the building structure.
- .8 Provide interconnecting, incoming and outgoing cable, bus duct, and control wiring connections as shown and as required.
- .9 Terminate power cables with two hole long barrel compression connectors equal to Burndy YA-2N.
- .10 Provide bonding of each transfer switch to perimeter ground bus with a #4/O green insulated copper conductor in PVC conduit. Terminate with Burndy YA-2N lugs.
- .11 For each transfer switch requiring rear access, install the three infra-red viewing ports supplied loose, and locate to allow for unobstructed scanning of the power connections.
- .12 For switches equipped with a quick make quick break operator attach a lamicoïd warning label adjacent to the operator, with white lettering on a red background, stating "DO NOT OPERATE WITH SWITCH ENERGIZED".
- .13 For Closed Transition Transfer Switches include:
 - .1 signs warning of closed transition transfer use, to the satisfaction of the local utility in the following locations:
 - (a) doors to main high voltage room,
 - (b) each main high voltage disconnect switch,
 - (c) each closed transition switch.
 - .2 2 #12 in EMT to the normal power breaker feeding the switch, connect to trip the breaker in the event of a fault with the transfer switch,
 - .3 a data drop to allow communication of the switch status directly to the local electric utility,
 - .4 following approval by the utility company to operate the switch in closed transition mode, the switch manufacturer to field convert the switch from delayed transition to closed transition operating mode and to re-commission the switch,
 - .5 secure inside the switch enclosure the delayed transition interlocking linkage, for future use.
- .14 For Solid State Transition Transfer Switches include:
 - .1 2 #12 in EMT to the Building Management System to indicate the static switch disable condition.
- .15 Touch up small areas marred in transit or during installation with touch up paint.

- .16 Provide rubber mats:
 - .1 3' wide 1/4" thick,
 - .2 17,000 volt rating,
 - .3 in front of each floor mounted transfer switch,
 - .4 at rear of transfer switches that require rear access,
 - .5 do not place mats until work is completed and room has been thoroughly cleaned.
- .17 Provide MICC, 2 hour fire rated interconnecting wiring between each automatic transfer switch and respective Diesel-generator control panel:
 - .1 2#12 for engine start signal,
 - .2 4#14 for ATS position (normal and emergency),
 - .3 6#14 for load management controls,
 - .4 2#12 for the remote test feature.
- .18 Provide 18 #12 in EMT from each automatic transfer switch to the Building Management System. As an alternative to #12 wires, #14 may be used if incorporated into a cable with at least 2 conductors per cable. Connect to indicate:
 - .1 alarm - preferred source failure
 - .2 status - engine start signal sent
 - .3 status - alternative source available
 - .4 status - switch connected to alternative source
 - .5 status - switch under load management control
 - .6 status - switch parked in neutral
 - .7 status - switch in bypass
 - .8 alarm - contact overlap time exceeded
 - .9 spare
- .19 Provide 12 #12 in EMT from each manual transfer switch to the Building Management System. As an alternative to #12 wires, #14 may be used if incorporated into a cable with at least 2 conductors per cable. Connect to indicate:
 - .1 alarm - preferred source failure
 - .2 status - alternative source available
 - .3 status - switch connected to alternative source
 - .4 status - switch under load management control
 - .5 status - switch parked in neutral
 - .6 spare
- .20 For each automatic transfer switch provide 16 #12 in EMT from the ATS to the Load Management Control System. As an alternative to #12 wires, #14 may be used if incorporated into a cable with at least 2 conductors per cable. Connect each pair of wires as follows:
 - .1 load management control – preferred source
 - .2 load management control – alternate source
 - .3 load management control – neutral position
 - .4 status – switch in preferred position
 - .5 status – switch in alternative position

- .6 status – switch parked in neutral position
- .7 status – switch in bypass mode
- .8 spare
- .21 For each manual transfer switch provide 14 #12 in EMT from the MTS to the Load Management Control System. As an alternate to #12 wires, #14 may be used if incorporated into a cable with at least 2 conductors per cable. Connect each pair of wires as follows:
 - .1 load management control – preferred source
 - .2 load management control – alternate source
 - .3 load management control – neutral position
 - .4 status – switch in preferred position
 - .5 status – switch in alternate position
 - .6 status – switch parked in neutral position
 - .7 spare
- .22 Provide a system compatible Ethernet cable in EMT from the communications module in each TS to the local Ethernet switch. Program the communications module as required to provide the operation specified.
- .23 From each transfer switch supplying power to fire alarm equipment, provide 2 #12 MICC fire rated cable, from an auxiliary shaft contact (closed on alternative source) to the fire alarm system and connect to indicate that the fire alarm system is on emergency power.
- .24 From each transfer switch supplying power to elevators, provide 4 #12 MICC fire rated cable, from the pre-transfer contacts in the transfer switch to the respective elevator controller and connect to initiate sequencing of the respective elevator bank during emergency power operation.
- .25 From each transfer switch supplying power to a SUPS system, provide 4 #12 in EMT, from the transfer inhibit contacts in the associated transfer switch to the respective SUPS system control cabinet and connect to inhibit transfer in the event that the critical load is on static or maintenance bypass.

3.2 Manufacturers' Service Representation on Site

- .1 Manufacturer to supply factory trained service representative to perform the following field services:
 - .1 check the installation of the equipment,
 - .2 conduct, or instruct the installation contractor in, the start-up of the equipment,
 - .3 calibrate controls,
 - .4 conduct site acceptance testing as described herein,
 - .5 participate in the commissioning program described herein,
 - .6 demonstrate the operation of safety controls to the facility operations staff,
 - .7 demonstrate the operation of the equipment over its entire performance range to the facility operations staff,
 - .8 provide training of the facility operations staff as described herein,
 - .9 repeat site visit to field convert closed transition transfer switches from delayed transition operating mode to closed transition operating mode and to re-commission the switches.
- .2 Note that multiple visits will be required due to the phased construction. Provide all necessary visits in accordance with the Contractor's procedures.
- .3 Submit copies of completed manufacturer start-up and test records prior to hand-over of equipment.

3.3 Site Acceptance Testing

- .1 After completion of installation, but before equipment is permanently placed into service, conduct Site Acceptance Testing (SAT) in the presence of and to the satisfaction of the Independent Testing Organization and the Owner's representative(s).
- .2 Conduct acceptance tests on each ATS and MTS in accordance with the reviewed test program.
- .3 Perform on site acceptance testing in accordance with the NETA Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems, Section 7, #7.22.3 Emergency Systems, Automatic Transfer Switches.
- .4 Verify engine start and control signals from each transfer switch through to the engine generator system.
- .5 Dynamically verify all signals through to:
 - .1 elevator controllers,
 - .2 fire alarm system,
 - .3 uninterruptible power systems,
 - .4 building management system,
 - .5 load management system,
 - .6 generator control panel,
 - .7 remote annunciators,
 - .8 etc.
- .6 Document test results.
- .7 Record the results of the performance testing and submit completed report.

3.4 Commissioning Program

- .1 In addition to the manufacturer's Site Acceptance Testing, installation contractor and manufacturer to provide field service personnel to participate in the commissioning of the equipment and/or system including:
 - .1 review of equipment and system commissioning procedures in addition to the manufacturer's own testing procedures,
 - .2 control of and operation of equipment during testing,
 - .3 adjusting of equipment controls as required to simulate load or fault conditions, and
 - .4 assist with record keeping of test results as directed.

3.5 Demonstration and Training

- .1 In conjunction with the manufacturer's service representative, provide training to the facility operations staff:
 - .1 in the operation and maintenance of the TS's including their interactions with the power sources, monitoring, metering and control systems,
 - .2 allow for at least 4 hour sessions,
 - .3 submit records of the training program.
- .2 Note that the training sessions may be video recorded by the Owner.

END OF SECTION

LIGHTING 26 50 00

1 GENERAL

1.1 Scope

- .1 Provide lighting fixtures as shown.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 01 01 Electrical General Requirements.
 - .2 26 05 01 Electrical Basic Materials and Methods.

1.3 Definitions and Abbreviations

- .1 The following definitions and abbreviations apply to this section.
 - .1 **Ballast**: a control device that produces a voltage sufficient to initiate the operation of the lamp and then regulates the current flow and protects the lamp from excessive temperature.
 - .2 **CIE**: Commission Internationale de l'Eclairage (International Commission on Illumination).
 - .3 **CRI**: Colour Rendering Index.
 - .4 **Driver**: a control device that converts the AC source to a DC voltage suitable for the lamp, regulates the current flow and protects the lamp from excessive temperature.
 - .5 **HO**: fluorescent lamp with a High lumen Output
 - .6 **IESNA**: the Illuminating Engineering Society of North America
 - .7 **LED**: a solid state light source using Light Emitting Diodes

1.4 Applicable Codes and Standards

- .1 Product standards:
 - .1 CSA 22.2 No. 141 Emergency Lighting Equipment
 - .2 ISO 3864-1 Graphical Symbols – Safety Colours and Safety Signs:
Part 1: Design Principles for Safety Signs in Workplaces and Public Areas.
 - .3 ISO 7010 Graphical Symbols – Safety Colours and Safety Signs:
Safety Signs Used in Workplaces and Public Areas.

1.5 Qualified Tradesperson

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using tradesperson holding applicable certificates of competency.

1.6 Submittals

- .1 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .2 Photometric data to be in accordance with IESNA testing procedures and to include:
 - .1 total input watts,
 - .2 candlepower summary,

- .3 candela distribution zonal lumen summary,
 - .4 luminaire efficacy,
 - .5 CIE type,
 - .6 coefficient of utilization,
 - .7 lamp type and lumen rating in accordance with IESNA testing procedures.
- .3 Submit samples of luminaires, which are not catalogue items, for review by Consultant. Do not manufacture additional luminaires until sample has been reviewed and all comments addressed to the satisfaction of the Consultant. Retain each reviewed sample on job site until final completion of project. Replace luminaires which do not match quality and workmanship of reviewed sample with new luminaires that do.

1.7 Shipping and Storage Requirements

- .1 Do not deliver luminaires to building or stored therein until dry and protected space is available for proper storage of luminaires.

1.8 Substitutions

- .1 Luminaires included under this Specification section are specified by manufacturer and type. Provide equipment, as specified, unless substitutions requests are approved by the Owner.
- .2 Proposed substitutions will only be considered during the bidding period.
- .3 Proposed substitutions are to conform to specification section 00 26 13 and as specified herein;
 - .1 submit proposed substitutions to the Consultant not less than two weeks prior to the tender close date and time.,
 - .2 proposed substitution submission to include:
 - (a) samples named as per the specifications,
 - (b) catalogue cuts,
 - (c) complete photometric reports,
 - (d) complete descriptive and technical data, and
 - (e) cost savings.
 - .3 Substitution submission are to be presented as an alternative price showing the amount to be deducted from or added to the base bid.
 - .4 where proposed substitutions alter functional or visual design, or change the space requirements or mounting details indicated, detail such changes in the submission and include costs for revised design and construction for trades involved.
- .4 After award of the contract, substitutions will not be considered unless compelling reasons are given such as inability to meet delivery schedule; however, this reason will not be considered if the delay is caused by the Contractor's failure to order luminaires in accordance with the project schedule. In such cases, it remains the Contractor's responsibility to provide luminaires as specified without delay to the project and without additional cost to the Owner.

2 PRODUCTS

2.1 General

- .1 Similar luminaires to be products of the same manufacturer.
- .2 Maintain finishes of luminaires, as specified in the "Luminaire List", with colours to be consistent and finishes protected from damage.

- .3 Where the description of the luminaire directs a "colour/ finish to suit Consultant" or similar language, it is to be understood that during construction the final colour/finish will be selected by Consultant at that time. The Consultant shall be permitted to make their choice from a standard colour/finish range and the selected colour to apply to all of the particular type of luminaire, unless otherwise specified.
- .4 Luminaires:
 - .1 completely assembled in factory,
 - .2 delivered to building in cartons or in palletized form, as directed.
 - .3 suitable for individual or continuous row mounting.
- .5 Recessed luminaires, to include plaster trim frame or ring and mounting brackets to match ceiling type.
- .6 Troffers: equipped with adjustable mounting brackets.
- .7 For luminaires that will be supplied with power from two sources, provide:
 - .1 separate ballasts or drivers, as appropriate for each source,
 - .2 a grounded metal barrier:
 - (a) between the two sources,
 - (b) between the ballasts/drivers fed from different sources,
 - (c) between the wiring from the ballasts/drivers, fed from different sources and the lamps,
 - .3 a warning label indicating that the luminaire is fed from multiple sources.
- .8 Ballasts and drivers to be free of polychlorinated biphenyls (PCB's).
- .9 Ballasts and drivers to have a sound rating of "A".
- .10 Ballasts to be certified in an accredited laboratory for efficiency, performance with the specified lamps, and for safety to the applicable standards.
- .11 LED Drivers:
 - .1 rated input voltage: 120V through 277V or 347V through 480V, as applicable,
 - .2 voltage input range: sustained variations of $\pm 10\%$ with no damage to the driver,
 - .3 power factor greater than 90% from 20% to 100% rated load,
 - .4 total harmonic current distortion: less than 20%, from 20% to 100% rated load,
 - .5 in-rush current limits: per NEMA 410,
 - .6 output current regulated to $\pm 5\%$ across published load range,
 - .7 output ripple current at maximum output:
 - (a) less than 15% measured (peak-average)/average,
 - (b) less than 5% low frequency content (< 120 Hz.),
 - .8 integral means of limiting surges to the LED's, per IEEE/ANSI C62.41.2 surge characteristics:
 - (a) for interior applications: common mode and differential mode surge protection of 2.5kV (100kHz, 30 Ohm ring wave),
 - (b) for exterior applications: common mode and differential mode surge protection of 3kV (1.2/50 μ s, 2 Ohm combination wave),
 - .9 able to tolerate sustained open circuit and short circuit output conditions without failure, without need for external fuses or trip devices,
 - .10 auto resetting protection,
 - .11 no visible flicker when tested with flicker wheel,
 - .12 for dimming systems: no visible flicker, when tested with flicker wheel, across the full dimming range,

- .13 operating temperature, down to and including:
 - (a) -20°C (-4°F) for interior applications,
 - (b) -40°C (-40°F) for exterior applications,
- .14 metallic heat dissipating enclosure,
- .15 integral thermal foldback to reduce driver power if case temperature exceeds rated maximum temperature,
- .16 compatible with the dimming system,
- .17 rated for UL Damp and Dry locations,
- .18 for downlights: compact enclosure with integral studs allowing the driver to be mounted on the outside of the luminaire or on a junction box, without the need for an additional enclosure,
- .19 for linear luminaires: slim profile with height ≤ 25 mm (1 inch) and width ≤ 30 mm (1.2 inch),
- .20 integral colour-coded connectors,
- .21 labelled compliant with the latest edition of the following standards:
 - (a) CSA-C22.2 No. 223, Power Supplies with Extra-Low Voltage Class 2 Outputs,
 - (b) CSA C22.2 No 250-13, Light Emitting Diode (LED) Equipment for use in Lighting Applications,
- .22 RFI and EMI: per FCC regulations, Title 47 CFR Part 15. Non-consumer,
- .23 5 year warranty.

Standard of Acceptance

- Advance
- Litetech
- Universal
- VLM (Italy)
- Lumi-Drives (UK)
- Osram
- AC Electronics
- EldoLED

2.2 Lamps

- .1 Light Emitting Diodes:
 - .1 1.2 or 3 watts per LED,
 - .2 available in 2700K, 3000K, 3500K and 4000K correlated colour temperature (CCT) packages,
 - .3 CCT tolerances to remain within a 3-step MacAdam ellipse and to maintain a CRI of ≥ 80 , and an $R_9 > 50$,
 - .4 colour temperature and lumen output for each luminaire per luminaire schedule, using IESNA LM-79 testing procedures,
 - .5 maximum temperature at the base of the "LED cap" mounted to the substrate to be controlled to ensure full lamp life,
 - .6 lumen maintenance of not less than L_{70} @ 50,000 hours, using IESNA LM-80 and LM-21 testing procedures,
 - .7 LED's of the same type to be from the same manufacturing batch,
 - .8 capable of continuous dimming, from 10-100% lumen output, flicker and noise free,
 - .9 provide certified test results for each type of LED used on the project,
 - .10 5 year warranty.

Standard of Acceptance- Lamp Acceptance:

- Cree
- Lumileds
- Nichia
- Osram
- GE
- Samsung
- Bridgelux
- Seoul Semiconductor
- Toyoda Gosei

.2 Spare Lamps

.1 Provide spare lamps of each type used on the project, as follows:

- (a) Incandescent: 15%
- (b) Fluorescent, HID & LED: 5%

2.3 Exit Signs

.1 Exit signs:

- .1 listed to CSA 22.2 No. 141,
- .2 visibility and colour requirements to conform to ISO 3864-1 for exit signs,
- .3 graphic symbol to conform to ISO 7010, type E001, E002, E005 and E006,
- .4 internally illuminated by white L.E.D. sources,
- .5 single or double face as shown,
- .6 green "running man" pictogram on each face,
- .7 directional arrows indicating the direction of egress,
- .8 white directional arrows,

3 EXECUTION

3.1 Installation

- .1 Locate and install luminaires as indicated.
- .2 Locate hangers on tile centres or intersections.
- .3 Mount recessed down lights, troffers and surface mounted luminaires in or on full tiles.
- .4 Verify quantity of luminaires before ordering.
- .5 Verify colour temperature of lamps before ordering.
- .6 Verify ceiling types with the latest revised Architectural Drawings and order luminaires to suit the correct ceiling.
- .7 Verify which luminaires are fed from two separate panels. Separate the two sources within the luminaire with a grounded metal barrier.
- .8 Check luminaires and mountings for their electrical and physical characteristics in relation to conditions due to building construction and mechanical equipment. Make necessary adjustments to luminaires or hanging arrangement without expense to Owners. Give notification at time of shop drawings and before construction if decision on necessary changes is required.
- .9 Co-operate with other trades to ensure proper installation of luminaires.

- .10 Carefully align luminaires, shown in continuous lines or rows, so that rows appear as straight lines.
- .11 Mount luminaires perfectly level or plumb.
- .12 Luminaires to fit tightly to ceiling without showing a space or light leak between frame and ceiling.
- .13 Take down any improperly installed luminaires and re-install without expense to Owner.
- .14 Standard octagonal boxes may be supplied where conduits feeding luminaires in finished areas are exposed on ceiling if hanger canopies entirely cover outlet boxes and are neatly notched for conduit. Otherwise, provide cast conduit outlet boxes with a diameter larger than canopies.
- .15 Where luminaires are suspended directly from concrete slabs, attach boxes or hickies directly to poured concrete with 6mm (¼") or larger diameter bolts and lead expansion anchors.
- .16 Where luminaires are suspended directly from precast slabs, use 8mm (5/16") or larger bolts through slabs, welded to 100mm x 100mm (4" x 4") or larger 3.5mm (10 gauge) plate located above slabs.
- .17 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidably tight locations, provide hangers to clear obstructions. Check layouts of other trades on job and plan co-operatively.
- .18 Hang luminaires in the same room at the same height.
- .19 Obtain approval before any changes are made to layouts shown.
- .20 Support luminaires mounted in or on ceilings independently of ceiling by means of chains.
- .21 Where luminaires are suspended or mounted on furred ceilings, provide continuous 12mm x 38mm (½" x 1½") channel above the ceiling, fasten each luminaire to channel with not less than two 6mm (¼") or larger diameter studs not more than 1220mm (4'- 0") on centre.
- .22 Where luminaires are installed in or on "T" bar ceilings provide each luminaire with two safety chains anchored in an approved manner to the floor slab or roof structure above. Each chain to support two corners of the luminaire. For safety chains, use #10 Tensile jack chain, installed as noted below.
- .23 Where luminaires are to be chain hung, use No. 10 Tensile jack chain, bright zinc coated, with a strength of 180 kg (400 lbs.). Make attachments using No.10 "S" hooks and close "S" hooks after installation. Caddy fasteners may be used where applicable.
- .24 Suspend industrial luminaires using 12mm (½") conduit hangers and ARB ball aligners. Select location and length of hangers to clear equipment, ducts and pipes. Metal strut (Flexibar, Unistrut, Eaton B-Line strut, T&B Superstrut) may be used for mounting of luminaires in mechanical areas and electrical rooms.

3.2 Luminaires

- .1 Luminaires:
 - .1 exactly as shown and as specified in the following schedule,
 - .2 complete with necessary accessories and lamps at time of acceptance,
 - .3 ULC or CSA certified,
 - .4 Each luminaire installed on a branch circuit operating at more than 150 volts-to-ground:
 - (a) provided with a disconnecting means integral to the luminaire,
 - (b) disconnecting means that simultaneously opens circuit conductors between the branch circuit conductors and the ballast(s)/driver(s),
 - (c) conspicuous, legible and permanent signage adjacent to the disconnecting means, identifying the specific purpose in accordance with the Electrical Code.

3.3 Lamps

- .1 Provide new lamps in luminaires.

- .2 For fluorescent luminaires with dimming ballasts, "season" the lamps by operating them at full output for 100 hours.

3.4 Exit Signs

- .1 Connect exit signs to a dedicated 120 Volt emergency power circuit and provide a lock on device on the branch circuit breaker.
- .2 In addition to the exit signs shown, provide a quantity of 20 exit signs including circuit breakers, lock on devices, junction boxes and wiring from a 120 Volt emergency power source. Signs to be installed as required by the local building authority. Turn over any signs, not required to be installed, to the Owner as spares.

3.5 Equipment Schedules

- .1 The following equipment schedules form part of this specification section.
 - .1 Schedule A: Lighting Fixtures
 - (a) luminaire types are listed in alphabetical order and not in order of preference.

SCHEDULE A – Lighting Fixtures

Title	Description	Lamp Schedule
LE1	<p>Surface mounted or suspended LED strip luminaire. Nominal 48" length. Steel housing assembly with frosted acrylic lens. Luminaire shall be suitable for suspension from slab with chain or aircraft cable. Luminaire to come complete with all necessary mounting accessories for a complete working installation.</p> <p>LED colour temperature shall be 3500K.</p> <p>Standard 0-10V (1%) dimming.</p> <p>Voltage: 120 volt</p> <p>Warranty: 5 years and meet L70, IES LM-80 and IES LM-79 testing.</p> <p>Manufacturers: Visioneering: LCOM48-LED835K044LUNV-P77 Cooper Metalux</p>	<p>LED 29W 3500K 4400 lumens 80+ CRI</p>

<p>X1</p>	<p>LED Die-Cast aluminum Edge Lit 'Running Man' or 'Pictogram' exit sign in white finish. Unit shall operate with universal 2-wire AC input voltage of 120 to 347VAC at less than 2.5W and universal 2-wire DC input voltage from 6 to 24VDC at less than 1.5W for single and double face signs.</p> <p>The housing shall be constructed of Die-Cast aluminum. The faceplate(s) shall be constructed of a clear polycarbonate panel. Each faceplate shall come standard with two legend films for pictogram and direction selection. The light source shall be white light emitting diodes (LED) and shall provide even illumination in normal and emergency operation. The pictogram exit sign in a Self-Powered configuration shall use a sealed Nickel-Cadmium battery of 2.4V nominal voltage and shall stay illuminated during emergency operation for at least two hours upon AC failure.</p> <p>When specified for surface mount, the unit shall come standard with a trip plate, trim ring, back box and canopy made of Die-Cast aluminum with white finish. The trim plate shall have a circular profile and allow for wall or ceiling mount installation. The trim ring shall allow for semi-recessed installation in walls or ceiling with cavity. The canopy shall allow for wall, end, or ceiling mount.</p> <p>When specified for recessed ceiling mount, the unit shall come standard with a flat trim plate of Die-Cast aluminum with brushed aluminum finish, a back-box of galvanized steel, and a hardware kit for back-box installation between ceiling joists, The back-box shall be provided with conduit knock-outs at the top, back and end.</p> <p>The pictogram Exit Sign shall meet CSA 22.2 No. 141, latest edition.</p> <p>Voltage: 120V</p> <p><i>Manufacturer:</i></p> <p>Beghelli lighting: CRV-RM-L-U-S-OLR Lumacell lighting AimLite Ready-Lite Submit alternates for approval</p> <p>Include in the contract an additional three (3) spare type 'X1' luminaires including installation accounting for an average of 40 meters of wire in conduit plus breaker for each additional luminaire connected to an emergency circuit. For bidding purposes, these luminaires can be added at any time during the construction process including and up to occupancy of each phase. Any luminaires not installed shall be turned over to the hospital.</p>	
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LW1	<p>Wall mounted LED luminaire. Suitable for installation in outdoor location. Nominal dimensions of 2 5/8" W x 3 3/4" H x 5 3/4" L. Refer to architectural drawings for exact lengths above stair. Luminaire shall come complete with all necessary mounting brackets, accessories, etc. for a complete working installation. Contractor to verify ceiling and lengths prior to ordering.</p> <p>LED colour temperature shall be 3000K</p> <p>Photocell control Voltage: 120 Volt</p> <p>Warranty: 5 year warranty</p> <p>B.U.G Rating: B1-U0-G0</p> <p>Cooper: XTOR2B-Y-BZ-PC1</p> <p>Axis Metalumen</p>	LED 18W 3000K 1997 Lumens 70 CRI
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END OF SECTION

CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

27 05 33

1 GENERAL

1.1 Scope

- .1 Provide conduits, backboxes, pull boxes, fastenings and fittings for communications cables.
- .2 This section applies to requirements and policies, products, and installation techniques for conduits, backboxes, pull boxes, fastenings and fittings for communications cabling and systems components.
- .3 Conform to the requirements of Specification sections 26 05 33 and 26 05 35 except/and as specified herein.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 33 Conduits, Fastenings and Fittings
 - .2 26 05 35 Outlet Boxes, Conduit Boxes and Fittings
 - .3
 - .4 27 05 53 Identifications for Communications Systems
 - .5 27 15 13 Communications Copper Horizontal Cabling

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 BICSI TDMM Telecommunications Distribution Methods Manual
- .2 Product standards:
 - .1 CSA C22.2 No. 18 Outlet Boxes, Conduit Boxes, and Fittings
 - .2 CSA C22.2 No. 83 Electrical Metallic Tubing

1.4 Submittals

- .1 Submit shop drawings including:
 - .1 product data sheets.

1.5 Quality Control

- .1 System Integration Testing ("SIT"):
 - .1 conduct visual inspections of the installation by walking through and checking conduit bend radii, nylon bushings, and box sizes. Provide site verification documentation (letter) for review.
 - .2 the Owner's representative may visually inspect or review to verify compliance;
 - (a) provide ladders, tools, and personnel to open faceplates, open ceiling tiles, open pull boxes and outlet boxes for verification.

2 PRODUCTS

2.1 Conduits

.1 Refer to Section 26 05 33 - Conduits, Fastenings and Fittings for details.

2.2 Conduit Fastenings

.1 Refer to Section 26 05 33 - Conduits, Fastenings and Fittings for details.

2.3 Conduit Fittings

.1 Refer to Section 26 05 33 - Conduits, Fastenings and Fittings for details.

2.4 Expansion Fittings

.1 Refer to Section 26 05 33 - Conduits, Fastenings and Fittings for details.

2.5 Fish Cord

.1 Refer to Section 26 05 33 - Conduits, Fastenings and Fittings for details.

2.6 Outlet Boxes

.1 Refer to Section 26 05 35 - Outlet Boxes, Conduit Boxes and Fittings.

2.7 Pull Boxes

.1 Refer to Section 26 05 35 - Outlet Boxes, Conduit Boxes and Fittings

2.8 Fittings – General

.1 Refer to Section 26 05 35 - Outlet Boxes, Conduit Boxes and Fittings

3 EXECUTION

3.1 Conduits

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Paint conduits where concealing of conduits is not possible, as required by the interior designer and/or architect.
- .3 Use electrical metallic tubing (EMT) except in cast concrete, and underground.
- .4 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .5 Mechanically bend steel conduit over 19mm (3/4") diameter.
- .6 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .7 Install pull boxes wherever necessary for proper pulling or anchoring of cables. Install so as to be accessible after installation is completed and set to come within finished lines of building.
- .8 Where conduits or cables are installed under raised floors and are required to be fastened in place, use two hole inverted "U" straps. No sharp edges or corners will be permitted which may damage PVC jackets or cables.
- .9 Install conduits and cables so as to provide maximum head room and to interfere as little as possible with free use of spaces through which they pass. They shall be installed as close to

building structure as possible such that, where concealed, necessary furring can be kept to a minimum. Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.

- .10 Pull boxes must not be used to change direction.
- .11 Where conduit runs exceed 30m, pull boxes must be installed.
- .12 Conduit changes in direction must not exceed 180 degrees between pull boxes.

3.2 Conduit Fastenings

- .1 Install one-hole steel straps to secure surface conduits 50 mm (2 in.) and smaller.
- .2 Install two-hole steel straps for conduits larger than 50 mm (2 in.).
- .3 Install beam clamps to secure conduits to exposed steel work.

3.3 Conduit Fittings

- .1 Install per industry standard and manufacturer requirements and instructions.

3.4 Expansion Fittings

- .1 Install per industry standard and manufacturer requirements and instructions.

3.5 Fish Cord

- .1 Install fish cord in empty conduits.

3.6 Outlet Boxes

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm (¼") of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.
- .5 Provide a suitable outlet box for each outlet approved for the particular area in which it is to be installed.
- .6 Locate outlet boxes mounted in hung ceiling space, such that they do not obstruct or interfere with the removal of lay-in ceiling tiles.
- .7 Offset outlet boxes, shown back-to-back in partitions, horizontally to minimize noise transmission between adjacent rooms.
- .8 For outlet boxes installed in walls with a Sound Transmission Class (STC) rating:
 - .1 apply acoustical putty pads to the outlet box,
 - .2 cover all openings and EMT, conduit and cable entrances/exits,
 - .3 install putty pads on the outside of boxes,
 - .4 provide additional layers and/or provide other sound control measures, as necessary to maintain the STC rating of the wall assembly,
 - .5 install pads and other sound control measures, if applicable, in accordance with the manufacturer's recommendations.

3.7 Pull Boxes

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 Locate pull boxes mounted in hung ceiling space, such that they do not obstruct or interfere with the removal of lay-in ceiling tiles.
- .4 Pull boxes must not be used to change direction.

3.8 Fittings – General

- .1 Install per industry standard and manufacturer requirements and instructions.

3.9 Surface Conduits

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5m (5') clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm (3") parallel to steam or hot water lines with minimum of 25 mm (1") at crossovers.

END OF SECTION

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

27 05 53

1 GENERAL

1.1 Scope

- .1 This section applies to requirements and policies, products, and installation techniques for identifying labels and signs for communications systems components.
- .2 Conform to the requirements of Specification section 26 05 53 except/and as specified herein.

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 26 05 53 Identification for Electrical Systems
 - .2 27 15 13 Communications Copper Horizontal Cabling
 - .3 27 15 43 Communications Faceplates and Connectors

1.3 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 BICSI TDMM Telecommunications Distribution Methods Manual
- .2 Product standards:
 - .1 ANSI/TIA-568.3-D Optical Fibre Cabling and Components Standard
 - .2 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure
 - .3 ANSI/TIA-607-D Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - .4 UL 969 Marking and Labeling Systems

1.4 Submittals

- .1 Submit shop drawings including:
 - .1 product data sheets,
 - .2 labeling schemes.
- .2 Submit with the maintenance and operating manuals the following:
 - .1 complete running list of all labelling schemes for review.

1.5 Quality Control

- .1 System Integration Testing ("SIT"):
 - .1 conduct visual inspections of the installation by walking through and checking off all device and equipment tagging and labelling. Provide site verification documentation (letter) for review.
 - .2 the Owner's representative may visually inspect or review to verify compliance;
 - (a) provide ladders, tools, and personnel to open faceplates, open ceiling tiles, open pull boxes and outlet boxes for verification.

2 PRODUCTS

2.1 Tags and Cable Ties

.1 General

- .1 grounding and bonding tags will meet the requirements specified in ANSI/TIA-607-D.
- .2 optical fibre safety tags will meet the requirements specified in ANSI/TIA-568.3-D.
- .3 durability: tags to last and remain legible for the life of the structured cabling system.

.2 Materials

.1 grounding and bonding tag:

(a) pre-printed green text on yellow tag:

- i) include in English "IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER",
- ii) include in French "SI CE CONNECTEUR OU CÂBLE EST DESSERRÉ OU DOIT ÊTRE RETIRÉ, VEUILLEZ APPELER LE GESTIONNAIRE DES TÉLÉCOMMUNICATIONS DU BÂTIMENT".

(b) minimum size 69.85 mm x 35.05 mm (2.75" x 1.38").

Standard of Acceptance

- Harger GRNTAG607PK10
- Panduit LTYK
- or approved equivalent

.2 optical fibre caution tag:

(a) pre-printed black text on yellow or orange background:

- i) include in English "CAUTION / FIBER OPTIC CABLE / TYPE _____ / COUNT _____".
- ii) include in French "ATTENTION / CÂBLE À FIBRE OPTIQUE / TYPE _____ / COMPTER _____"

(b) minimum size 90.42 mm x 52.32 mm (3.56" x 2.06").

Standard of Acceptance

- Panduit PST-FO
- or approved equivalent

.3 cable ties:

(a) flame retardant.

2.2 Lamacoid Nameplates

.1 General:

- .1 3 mm ($\frac{1}{8}$ ") thick laminated plastic plates with beveled edges.
- .2 Durability: nameplates to last and remain legible for the life of the structured cabling system.

.2 Materials:

.1 cabinet nameplates

- (a) background colour: Black
- (b) lettering: White

- (c) maximum plate height: 50 mm (2 in.)
- (d) plate length: as required to suit text length
- (e) letter height: 25 mm (1 in.)
- .1 rack nameplates
 - (a) background colour: Black
 - (b) lettering: White
 - (c) maximum plate height: 50 mm (2 in.)
 - (d) plate length: as required to suit text length
 - (e) letter height: 25 mm (1 in.)

2.3 Adhesive Labels

- .1 General:
 - .1 adhesive labels will meet the legibility, defacement, and adhesion requirements specified in ANSI/UL 969 (Ref. D-16). In addition, labels to meet the general exposure requirements in UL 969 for indoor use,
 - .2 Durability: labels to last and remain legible for the life of the structured cabling system.
- .2 Materials:
 - .1 conduit labels
 - (a) refer to Section 26 05 53 for details.
 - .2 pull box labels
 - (a) refer to Section 26 05 53 for details.
 - .3 building entrance terminal (BET) labels:
 - (a) self-adhesive style made of polyester with a white printing area,
 - (b) sized to suit the designated label location,
 - (c) labels printed with a minimum 6 mm (1/4 in.) high font.
 - .4 IDC termination block labels:
 - (a) self-adhesive style made of polyester with a white printing area,
 - (b) sized to suit the designated label location,
 - (c) label sized to suite a 10 pt. font height of 6 mm (1/4 in.)
 - .5 patch panel labels:
 - (a) self-adhesive style made of polyester with a white printing area,
 - (b) sized to suit the designated label location,
 - (c) label sized to suite a 10 pt. font height of 6 mm (1/4 in.)
 - .6 cable labels:
 - (a) self-laminating, vinyl with white printing area and a clear tail that self laminates the printed area when wrapped around a cable,
 - (b) sized to allow label to wrap around the cable 2.5 times minimum,
 - (c) label sized to suite a 10 pt. font height.
 - .7 patch cord labels:
 - (a) self-laminating, vinyl with white printing area and a clear tail that self laminates the printed area when wrapped around a cable,

- (b) sized to allow label to wrap around the cable 2.5 times minimum,
- (c) label sized to suite a 10 pt. font height.
- .8 faceplate labels:
 - (a) self-adhesive style made of polyester with a white printing area,
 - (b) sized to suit the designated label location
 - (c) label sized to suite a 10 pt. font height.
- .9 active equipment labels:
 - (a) self-adhesive style made of polyester with a white printing area,
 - (b) sized to suit the designated label location,
 - (c) labels printed with a minimum 6 mm (1/4 in.) high font.

Standard of Acceptance

- Brady Canada fig. products, labeler and Mark software
- Panduit fig. products, labeler and Easy-Mark software

3 EXECUTION

3.1 General

- .1 Review specific numbering scheme with Owner's representative before ordering materials.
- .2 Do not commence manufacture of nameplates and labels until numbering schemes and wording has been reviewed by the Consultant and/or Owner.
- .3 Do not apply adhesive-backed materials in locations designed for printed paper label strips.
- .4 Complete all final permanent tags, nameplates and labels prior to start of commissioning; the presence of temporary construction identifiers during commissioning is a deficiency.

3.2 Tags

- .1 Grounding and bonding tags
 - .1 Install grounding and bonding tags within 150 mm (6") of every grounding and bonding connection.
- .2 Optical fibre safety tags
 - .1 Provide optical fibre safety tags at the following locations:
 - (a) on inner duct or conduits: at 1500 mm (5 ft.) intervals,
 - (b) at junction boxes, pull boxes, and cable access locations,
 - (c) at optical fibre patch panels.

3.3 Lamacoid Nameplates

- .1 Mechanically attach with self-tapping stainless-steel screws.
- .2 Install one nameplate on the front (top) and on the back (top) of each rack and cabinet.
- .3 Labelling scheme:
 - .1 Racks:
 - (a) Room ID - R##, where:
 - i) Room ID represents the room number as identified on the floor plans or another designator as identified by the Owner,

- ii) R## represents the rack identifier plus a sequential rack number starting at '01'.
- (b) Example: T501-R01
- .2 Cabinets:
 - (a) Room ID - C##, where:
 - i) Room ID represents the room number as identified on the floor plans or another designator as identified by the Owner,
 - ii) C## represents the cabinet identifier plus a sequential cabinet number starting at '01'.
 - (b) Example: CR301-C01

3.4 Adhesive Labels

- .1 Mechanically print label content using a laser printer; hand-written labels are not acceptable.
- .2 Ensure all labels are legible, include the correct information, and compliant with the requirements.
- .3 Select label colours to conform to ANSI/TIA/EIA-606-D and TIA/EIA-568.1-E guidelines for colour coding.
- .4 Ensure surfaces are clean and dry prior to application of labels.
- .5 Ensure all labels are applied aligned with equipment lines.
- .6 Apply identifying labels to conduits, pull boxes, building entrance terminal enclosures, IDC termination blocks, patch panels, cables, patch cords, faceplates and active equipment.
- .7 Conduit
 - .1 refer to Section 26 05 53 for details.
- .8 Pull boxes
 - .1 refer to Section 26 05 53 for details.
- .9 IDC termination blocks
 - .1 Refer to "Cables" for labelling scheme.
 - .2 Label IDC termination blocks using designation strips and labels specifically manufactured for the IDC termination block being installed. Use the following colour codes:

Colour	Function
Orange	Incoming Circuits to Demarcation Point
Green	Client Connection to Incoming Circuits
White	Equipment Connections
Purple	First Level Backbone Cabling
Gray	Second Level Backbone Cabling
Blue	Horizontal Cabling
Brown	Interbuilding Backbone (Main XC to remote Intermediate XC)
Yellow	Auxiliary Circuits, Alarms, Maintenance, Security, and other Misc. Circuits
Red	Key Telephone Systems

- .10 Patch panels

- .1 Refer to "Cables" for port labelling scheme.
- .2 Labelling scheme:
 - (a) R## - RU, where:
 - i) R## represents the rack number,
 - ii) RU represents the rack unit number starting from the bottom of the rack.
 - (b) Example: R01-33

.11 Cables

- .1 To follow TBRHSC cable labelling standards. Use the following as a minimum guideline.
- .2 Apply cable labels so they are legible without opening cable bundles or removing hook and loop wraps.
- .3 Label cabling at the following locations:
 - (a) the near- end of the cable,
 - (b) the far-end of the cable,
 - (c) at outlet and faceplate,
 - (d) at patch panel or IDC termination block connection point.
- .4 Horizontal copper cabling labelling scheme:
 - (a) CCC-RP-DD, where:
 - i) CCC represents the Network closet room number where drops are aggregated and terminated for the are
 - ii) R represents the rack number in the network closet,
 - iii) P represents the patch panel that the drop is terminated to,
 - iv) DD represents the drop number on the patch panel
 - (b) Example:
F357-A5-22, where:
 - i) Network closet room F357
 - ii) Rack A
 - iii) Patch Panel 5
 - iv) Drop 22

.12 Patch cords

- .1 Label patch cords at both ends of patch cords.
- .2 Labelling scheme:
 - (a) LLUU-NNN, where:
 - i) LL represents the length,
 - ii) UU represents the unit of measure feet (ft) or metres (m),
 - iii) NNN represents a unique sequential patch cord number starting at "001"
 - (b) Example: 3m-001

.13 Faceplates

- .1 Refer to "Cables" for labelling scheme.

.14 Active Equipment

- .1 Apply labels at:

- (a) the front and rear of each piece of active equipment, including network switches, routers, and local UPS,
- (b) KVM switch buttons,
- (c) servers with identification labels and by function,
- (d) each local UPS with date of installation.

3.5 Running Lists

- .1 Create and maintain running lists. The commissioning authority will verify that running list entries match the nameplates and labels. Include in the running lists the following fields for both ends of each cable:
 - .1 serial number, panel, rack, room, floor, cable type, colour code (if applicable), binder and strand (if applicable), connector type, signal or extension number (if applicable), and two blank "note" fields.

END OF SECTION

COMMUNICATIONS COPPER CABLE SPLICING AND TERMINATIONS

27 13 13.13

1 GENERAL

1.1 Scope

- .1 This section applies to the copper termination hardware in the various work areas and telecommunications spaces.
- .2 The terminations are part of complete certified and warranted system that includes:
 - .1 Copper horizontal cabling as specified under section 27 15 13
 - .2 Patch cords as specified under section 27 16 00

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 27 15 13 Communications Copper Horizontal Cabling

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 AWG – American Wire Gauge
 - .2 IDC – Insulation-Displacement Contact
 - .3 Termination. Physical connection of signaling conductor(s) at the end of a cable segment

1.4 Applicable Codes and Standards

- .1 Legislation:
 - .1 CSA-C22.2 No. 214:17 (R2021) Communications Cables (Bi-National standard with UL 444).
- .2 Installation codes and standards:
 - .1 ISO 11801 and EN50713-5 to cover optical OM4 fibre/Class EA Cat6a shielded twisted pair - current and future amendments
 - .2 ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises
 - .3 ANSI/TIA-568.1-E Commercial Building Telecommunications Infrastructure Standard, Part 1, General Requirements.
 - .4 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure
- .3 Product standards:
 - .1 ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standards

1.5 Qualified Installation Technicians

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using technicians holding applicable certificates of competency from both the selected manufacturer and industry standards organizations (eg. BICSI).

1.6 Submittals

- .1 In addition to the requirements of Section 26 01 01 Electrical General Requirements, submit the following:
 - .1 Product Information
 - (a) Manufacturer's product information data sheet or specifications sheet with the specific product number identified.

1.7 Warranty

- .1 In accordance with 26 01 01 Electrical General Requirements provide a written warranty for parts and labour to repair or replace any part of the equipment which may fail due to defective material or workmanship from date of acceptance by the Owner.
- .2 Provide a 25 year Extended Product Warranty and System Assurance Warranty for the Fiber Optic or Copper Cabling System.

2 PRODUCTS

2.1 Category 6A UTP Jack

- .1 Modular, eight-position, KeyConnect form factor,
- .2 Compatible with RJ45 and RJ11,
- .3 Compatible with T568A/B wiring schemes,
- .4 Front Flexible PCB connection for plug insert capable of minimum 750 cycles,
- .5 Rear IDC connection for horizontal cable connection capable of 20 terminations,
- .6 Allowed IDC wire gauge: 23 AWG,
- .7 Internal connectors: Metal (Copper/Nickel),
- .8 Connector body: Plastic, UL940V-0,
- .9 Colour: Blue,
- .10 Minimum performance to meet TIA Category 6A requirements.

Standard of Acceptance

- Belden

3 EXECUTION

3.1 Installation

- .1 Install termination hardware in accordance with manufacturer's instructions.
- .2 Provide quantity of jacks as per project requirements.
- .3 Provide jacks to fill all positions in modular patch panels.
- .4 Terminate all connections to T568A wiring scheme.

.5 Ensure ANSI/EIA/TIA-568 installation practices are followed.

END OF SECTION

COMMUNICATIONS COPPER HORIZONTAL CABLING

27 15 13

1 GENERAL

1.1 Scope

- .1 This section applies to the horizontal copper structured cabling system that will interconnect the various end user locations to the telecommunications spaces to provide data communication services.
- .2 The cabling is part of complete certified and warrantied system that includes:
 - .1 Terminations as specified under section 27 13 13.13
 - .2 Connectors and faceplates as specified under section 27 15 43
 - .3 Patch cords as specified under section 27 16 00

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 27 05 53 Identification of Communications Systems
 - .2
 - .3 27 13 13.13 Communications Copper Cable Splicing and Terminations
 - .4 27 15 43 Communications Faceplates and Connectors
 - .5 27 16 00 - Communications Connecting Cords, Devices, and Adapters

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section:
 - .1 PVC Polyvinyl Chloride
 - .2 PE Polyethylene
 - .3 CMP Communications Media Plenum rating
 - .4 CMR Communications Media Riser rating

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ISO/IEC 11801 and EN50713-5 to cover optical OM4 fibre/Class EA Cat6a shielded twisted pair - current and future amendments
 - .2 ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises
 - .3 ANSI/TIA-568.1-E Commercial Building Telecommunications Infrastructure Standard, Part 1, General Requirements.
 - .4 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure
 - .5 ANSI/TIA-942-B Telecommunications Infrastructure Standard for Data Centers
 - .6 ANSI/TIA-1179-B Healthcare Facility Telecommunications Infrastructure

.2 Product standards:

- .1 ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard

1.5 **Qualified Installation Technicians**

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using technicians holding applicable certificates of competency from both the selected manufacturer and industry standards organizations (eg. BICSI).
- .2 Category 6 UTP cable to be installed by a Belden Certified Systems Vendor (CSV).

1.6 **Overview**

- .1 Refer to drawings for cabling distribution details.

1.7 **Submittals**

- .1 In addition to the requirements of Section 26 01 01 Electrical General Requirements, submit the following:
- .1 Product Information
- (a) Manufacturer's product information data sheet or specifications sheet with the specific product number identified.

1.8 **Warranty**

- .1 In accordance with 26 01 01 Electrical General Requirements provide a written warranty for parts and labour to repair or replace any part of the equipment which may fail due to defective material or workmanship from date of acceptance by the Owner.
- .2 Provide a 25 year Extended Product Warranty and System Assurance Warranty for the Copper Horizontal Cabling System.

2 PRODUCTS

2.1 **Category 6A Cabling**

- .1 General:
- .1 Minimum 23 AWG solid bare copper
- .2 Four-pair, unshielded, within an overall jacket
- .3 Each cable will be terminated on eight-position modular jacks to T568A pinout
- .4 FT4 (CMR) or FT6 (CMP) rated for the space where the cabling will be installed as required by the Ontario Building Code or other applicable codes and/or standards.
- .5 Equipped with jacket splitting cord
- .6 Jacket: Polyvinyl Chloride (PVC)
- .7 Colour: Blue
- .2 Performance Requirements:
- .1 Meet or exceed the performance as detailed in ANSI/TIA-568.2-D.
- .2 Rated for the environment (indoor/outdoor) for which it is installed

- .3 Maximum length of horizontal cable will not exceed 90m
- .4 Cable bandwidth: 500 MHz
- .5 Meet or exceed the manufacturer's guaranteed electrical performance and physical specifications.
- .6 Support IEEE PoE 802.3af and PoE+ per 802.3at-2009
- .7 Delay:
 - (a) Frequency 100 MHz
 - (b) Maximum Delay 537.6 ns/100m
 - (c) Maximum Delay Skew 45 ns/100m
 - (d) Nominal Velocity of Propagation 64%

Standard of Acceptance

- Belden

3 EXECUTION

3.1 General

3.2 Installation

- .1 Install cabling system in accordance with manufacturer's instructions.
- .2 Coordinate with other trades prior to installation.
- .3 Do not fill cable raceways greater than the maximum fill by the applicable electrical code for the particular raceway type.
- .4 Place a pull string along with cables where run in conduit. Tie off ends of the pull string.
- .5 Install cables in continuous lengths from origin to destination (no splices).
- .6 Do not exceed the cable's minimum bend radius of 4 times the cable diameter and maximum pulling tension of 25 lbs.
- .7 Support horizontal copper cabling continuously in conduit or cable tray.
- .8 Cables shall not be attached to ceiling grid, lighting support wires, piping or other ceiling mounted services.
- .9 If a J-hook or trapeze system is used, horizontal cables to be supported at a maximum of 1.2m (4ft) intervals – at no point shall cable(s) rest on acoustic ceiling grids or panels.
- .10 Bundle horizontal distribution cables in groups no greater than those recommended by the manufacturer in order to prevent deformation of the bottom cables within the bundle.
- .11 Do not block access to any valves, support infrastructure or control devices from other services with the installation of the cabling system and supporting hardware.
- .12 Apply cable wraparound label behind the faceplate on a section of cable that can be accessed by removing the faceplate.
- .13 Neatly bundle, Velcro and route together like cables. Secure cable bundles to vertical and horizontal supports and neatly fasten to plywood backboards or termination racks when routing to termination panels.
- .14 Place and suspend cables in a manner to protect them from physical interferences or damage. Replace cables if damaged during installation at no cost to the project or Owner.

- .15 Feed each panel or block by an individual bundle separated and dressed back to the point of cable entrance into the cabinet, rack or frame.
- .16 For typical work area outlets, provide minimum 300mm slack cable at the outlet and minimum 1m slack cable in the TR.
- .17 For ceiling hosted devices such as wireless access points or security cameras provide minimum 3m slack cable at the outlet and minimum 3m slack cable in the TR.
- .18 Label cables as per section 27 05 53.
- .19 Maintain the cable jacket as close as possible to the termination point.
- .20 Clearly label each cable on the cable jacket behind the patch panel at a consistent location that can be viewed without removing the bundle support ties.
- .21 Ensure cable labels are visible after installation and testing.
- .22 Do not paint cabling for any length. Replace any cables that are painted at no cost to the owner/project.
- .23 Comply with electrical code and TIA rules for separating unshielded copper communication cables from potential EMI sources, including electrical power lines and equipment.

3.3 **Site Acceptance Testing**

- .1 Conduct Site Acceptance Testing (SAT) in presence of and to the satisfaction of the Owner. After completion of installation, but before equipment is permanently placed into service.
- .2 SAT to include:
 - .1 Thorough physical inspection and verification of the installation including, but not limited to:
 - (a) Pathways and infrastructure;
 - (b) Racks and cabinets;
 - (c) Grounding and bonding;
 - (d) Cable placement, routing and dressing;
 - (e) Terminations;
 - (f) Labeling;
 - .2 Demonstration of proper function of test equipment;
 - .3 Demonstration and acceptance of test results;
- .3 Record the results of the testing and submit completed report to the Owner.

3.4 **Testing and Commissioning**

- .1 In addition to the general requirements of Section 26 01 01 Electrical General Requirements, the following sections apply for testing and commissioning:
- .2 Test Requirements
 - .1 Test every cabling channel in the installation in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA) standard.
 - .2 Test the installed twisted pair horizontal links from the termination point in the telecommunications room to the telecommunication wall outlet in the work area against the "Channel" performance limits specification as defined in standards.
 - .3 Test 100% of the installed cabling links. Diagnose, correct and re-test any failing channel until all cabling links meet the performance requirements specified. Provide documentation indicating the final and passing result of the tests for all links as part of the test results documentation.

- .4 Tests to be performed by trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof.
 - .5 Perform testing within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
 - .6 Test equipment to be equipped with high quality interface adapters as well as testing cables that do not show excessive twisting or kinking resulting from repetitive coiling/storing of the tester interface adapters.
 - .7 The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests. Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.
 - .8 A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks.
- .3 Test Results and Documentation
- .1 Record the test results information for each channel in the memory of the field tester upon completion of the test.
 - .2 Transfer the test results records saved by the tester into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that these results are transferred to the PC unaltered, i.e., "as saved in the tester" at the end of each test.
 - .3 Store and deliver the database for the completed job on DVD-ROM including the software tools required to view, inspect, and print any selection of test reports.
 - .4 Provide a paper copy of the test results that lists all the links that have been tested with the following summary information:
 - (a) The identification of the link in accordance with the naming convention defined in the overall system documentation
 - (b) The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number
 - (c) The date and time the test results were saved in the memory of the tester
 - .5 Provide General Information in the electronic data base with the test results information for each link:
 - (a) The identification of the customer site as specified by the Owner
 - (b) The identification of the link in accordance with the naming convention defined in the overall system documentation
 - (c) The overall Pass/Fail evaluation of the link-under-test
 - (d) The name of the standard selected to execute the stored test results
 - (e) The cable type and the value of NVP used for length calculations
 - (f) The date and time the test results were saved in the memory of the tester
 - (g) The brand name, model and serial number of the tester
 - (h) The identification of the tester interface
 - (i) The revision of the tester software and the revision of the test standards database in the tester
 - .6 Test results information to contain the required test parameters that are listed and as further detailed below.

- .7 Provide the detailed test results data in the electronic database for each tested link must contain the following information:
 - (a) For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. In this case, the PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters.
 - (b) Attenuation
 - (c) Next/Fext
 - (d) ACR
 - (e) Return Loss
 - (f) ELFEXT, PSELFEXT
 - (g) Propagation Delay, Delay Skew
 - (h) PSNEXT, PSACR
 - .8 Verify labeling of all wiring at all termination points.
 - .9 Provide written verification confirming that the testing and inspection has been completed and that all cable runs have passed. Also document that all defects have been identified, corrected, and retested successfully.
 - .10 Provide manufacturer certification, certifying that the cabling system is installed in accordance to manufacturer's Category 6A standards. The certification must include a minimum of 25 years application assurance warranty, which warranties that the installed cabling system complies with standard current network applications and emerging technologies.
- .4 Demonstration and Acceptance
- .1 A representative of the Owner shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase 5 business days before testing commences.
 - .2 A representative of the Owner will select a random sample of 5% of the installed links. The representative (or his authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in Specifications. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the Owner representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

END OF SECTION

COMMUNICATIONS FACEPLATES AND CONNECTORS

27 15 43

1 GENERAL

1.1 Scope

- .1 This section applies to copper and fiber faceplates and connectors that are used as part of a certified structured cabling system.
- .2 The connectors and faceplates are part of complete certified and warranted system that includes:
 - .1 Copper terminations as specified under section 27 13 13.13
 - .2 Copper horizontal cabling as specified under section 27 15 13
 - .3 Patch cords as specified under section 27 16 00

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 27 05 53 Identification for Communications Systems
 - .2 27 13 13.13 Communications Copper Cable Splicing and Terminations
 - .3 27 15 13 Communications Copper Horizontal Cabling

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section:
 - .1 APC – Angled Polished Connector
 - .2 IDC – Insulated Displacement Connector
 - .3 UPC – Ultra Physical Contact

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ANSI/TIA-455-78-C Optical Fibres - Part 1-40: Measurement Methods and Test Procedures – Attenuation.
 - .2 ANSI/TIA-455-133-A Optical Fibres - Part 1-22: Measurement Methods and Test Procedures - Length Measurement.
 - .3 ANSI/TIA-526-7-A Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement.
 - .4 ANSI/TIA-526-14-D Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 3.1, Fiber Optic Communications Subsystem Test Procedures - Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement.
 - .5 ANSI/TIA-568.1-E Commercial Building Telecommunications Infrastructure Standard, Part 1, General Requirements.

- .6 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure.
- .7 ANSI/TIA-1152-A Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
- .2 Product Standards
 - .1 ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard.
 - .2 ANSI/TIA-568.3-E Optical Fiber Cabling and Components Standard.

1.5 Qualified Installation Technicians

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using technicians holding applicable certificates of competency from both the selected manufacturer and industry standards organizations (eg. BICSI).

1.6 Submittals

- .1 In addition to the requirements of Section 26 01 01 - Electrical General Requirements, submit the following:
 - .1 Product Information
 - (a) Provide manufacturer's product information data sheet or specifications sheet with the specific product number identified.

1.7 Warranty

- .1 In accordance with 26 01 01 - Electrical General Requirements provide a written warranty for parts and labour to repair or replace any part of the equipment which may fail due to defective material or workmanship from date of acceptance by the Owner.
- .2 The warranty period will be part of a 25 year Extended Product Warranty and System Assurance Warranty for the entire Structured Cabling System.

2 PRODUCTS

2.1 Connectors

- .1 General
 - .1 Connectors to meet or exceed the associated TIA/EIA standards.
 - .2 Chosen connectors to form part of a manufacturer's end to end solution in order to comply with Warranty requirements.
- .2 Horizontal
 - (a) Copper –Category 6A
 - Copper connectors to be 8-position/8-conductor, insulation displacement connector (IDC) and accept modular 8-position/8-conductor plugs.
 - Connectors to have a universally colour-coded wiring pattern for T568A.
 - Connector colour(s) to be coordinated with architects and Owner.
 - Connectors to meet or exceed the performance requirements of Category 6A.

Standard of Acceptance

- Belden

2.2 Wall Faceplates

- .1 Faceplates to have the following:
 - .1 Single gang form factor
 - .2 Port and plate identification labels
 - .3 Appropriate adapters and fittings as required
 - .4 Minimum 4 outlet ports for work area wall outlets
 - .5 Blank insert plates for any unused outlet positions
- .2 Non-stainless steel faceplates colours to be coordinated with the Owner and Architect prior to purchase and delivery.
- .3 Wall mounted telephone locations:
 - .1 Single outlet metal faceplate with metal telephone mounting studs

Standard of Acceptance

- Belden

2.3 Modular Furniture Outlets

- .1 Appropriate modular furniture faceplates to be determined by modular furniture manufacturer brand. Use four (4) port modular furniture faceplates to match furniture selected.
- .2 Provide faceplates in the appropriate knockouts in the furniture channel, segregated from the electrical raceway section.

2.4 Surface Raceway Mounted Outlets

- .1 Appropriate modular surface raceway (eg Wiremold) faceplates to be determined by surface raceway manufacturer brand. Use four (4) port modular surface raceway faceplates to match surface raceway selected.
- .2 Provide faceplates in the appropriate knockouts in the furniture channel, segregated from the electrical raceway section.

2.5 Floor Box Mounted Outlets

- .1 Appropriate floor box faceplates to be determined by floor box manufacturer brand. Use four (4) port modular faceplates to match floor box selected.
- .2 Provide faceplates in the appropriate knockouts and positions in the floor boxes, segregated from the electrical raceway section.

2.6 Surface Mount Boxes

- .1 Provide surface mount boxes for all furniture outlets that do not have a modular furniture knockout, exposed ceiling outlets or any location not provided with an electrical backbox.
- .2 The surface mounted box shall consist of a minimum of (1) port.

3 EXECUTION

3.1 General

- .1 Provide the correct faceplates and fittings for use in specialized mounting requirements:

- .1 Faceplates and fittings shall be manufactured specifically for the equipment that they are to be mounted to.
- .2 Faceplates and fittings shall be approved by both the equipment manufacturer and the communications cabling system manufacturer.

3.2 Installation

- .1 Install fiber and copper connectors and faceplates in accordance with manufacturer's instructions.
- .2 All category modular jacks shall be terminated using the T568A termination scheme specified in ANSI/TIA-568.0-E.
- .3 Coordinate with Architect and Owner regarding required colours and finishes.
- .4 Coordinate with all other trades prior to installation of faceplates for sequencing of finishing works.
- .5 Outlets that are not mounted in faceplates during project installation phase are to be properly protected between time of termination and time of finishing, labeling and faceplating.
- .6 Provide faceplates for outlets in the locations as shown on the Drawings.
- .7 Install faceplates flush to the wall surface without any gap.
- .8 Clean and level faceplates prior to final acceptance.
- .9 In instances where the faceplate does not cover the entirety of the outlet box hole in the wall due to poor finishing workmanship, coordinate with Owner's representative and the appropriate trade to have the wall appropriately patched and painted before installing the faceplate.
- .10 Provide blank insert plates for any unused faceplate outlet positions.
- .11 For ceiling mounted devices that require slack loops for location flexibility during installation provide standalone surface mount boxes compatible with the chosen connector and cabling solution for the project. Example devices would be wireless access points and security cameras.
- .12 Provide blank faceplates for all unused communications back boxes.
- .13 Manufacturer specified tools and termination kits to be used as required.
- .14 Connectorize all fiber strands within a cable. No 'dark' fibers are allowed unless specified on the Drawings.
- .15 Connect pigtailed to fiber utilizing fusion splicing. Mechanical splicing is not acceptable.
- .16 Fiber splice protection to be via 3M heat shrink sleeves.
- .17 Perform any re-splicing or pigtail replacement at no cost to the Owner.
- .18 No manual fusion splicing will be performed.
- .19 Do not paint any faceplates, connectors or inserts. Replace any products that are painted at no cost to the owner/project.
- .20 Label faceplates and inserts as per section 27 05 53.

END OF SECTION

COMMUNICATIONS CONNECTING CORDS, DEVICES, AND ADAPTERS

27 16 00

1 GENERAL

1.1 Scope

- .1 This section describes any cords, cross-connect wire, devices, and adapters required to connect the inside or outside plant fiber, riser, and horizontal cabling as called for in the specifications and related drawings.
- .2 The patch cords and cross-connect cabling are part of complete certified and warranted system that includes:
 - .1 Terminations as specified under section 27 13 13.13
 - .2 Horizontal cabling as specified under section 27 15 13
 - .3 Connectors and faceplates as specified under section 27 15 43

1.2 Related Sections

- .1 Without limiting the scope of work or applicability of other specification sections, the work under this section directly integrates with or refers to the following specification sections:
 - .1 27 05 53 Identification of Communications Systems
 - .2 27 13 13.13 Communications Copper Cable Splicing and Terminations
 - .3 27 15 13 Communications Copper Horizontal Cabling
 - .4 27 15 43 Communications Faceplates and Connectors

1.3 Definitions and Abbreviations

- .1 The following definitions apply to this section.
 - .1 APC Angle Physical Contact
 - .2 UPC – Ultra Physical Contact

1.4 Applicable Codes and Standards

- .1 Installation codes and standards:
 - .1 ISO/IEC 11801 and EN50713-5 to cover optical OM4 fibre/Class EA Cat6a shielded twisted pair - current and future amendments.
 - .2 ANSI/TIA-568.0-E Generic Telecommunications Cabling for Customer Premises
 - .3 ANSI/TIA-568.1-E Commercial Building Telecommunications Infrastructure Standard, Part 1, General Requirements.
 - .4 ANSI/TIA-606-D Administration Standard for Telecommunications Infrastructure
 - .5 ANSI/TIA-942-B Telecommunications Infrastructure Standard for Data Centers
 - .6 ANSI/TIA-1179-B Healthcare Facility Telecommunications Infrastructure Standard
- .2 Product standards:

- .1 ANSI/TIA-568.2-D Balanced Twisted-Pair Telecommunications Cabling and Components Standard
- .2 ANSI/TIA-568.3-D Optical Fiber Cabling and Components Standard

1.5 Qualified Installation Technicians

- .1 Work to be performed by qualified, licensed and recognized firm with an established reputation in this field, using technicians holding applicable certificates of competency from both the selected manufacturer and industry standards organizations (eg. BICSI).
- .2 Category 6 UTP cable to be installed by a Belden Certified Systems Vendor (CSV).

1.6 Submittals

- .1 In addition to the requirements of 26 01 01 - Electrical General Requirements, submit the following:
 - .1 Product Information
 - (a) Manufacturer's product information data sheet or specifications sheet with the specific product number identified.

1.7 Warranty

- .1 In accordance with 26 01 01 - Electrical General Requirements provide a written warranty for parts and labour to repair or replace any part of the equipment which may fail due to defective material or workmanship from date of acceptance by the Owner.
- .2 Provide a 25 year Extended Product Warranty and System Assurance Warranty for the Copper Horizontal Cabling System.

2 PRODUCTS

2.1 Communication Room Copper Patch Cords

- .1 General:
 - .1 Minimum 23 AWG solid bare copper
 - .2 Four-pair, unshielded, within an overall jacket
 - .3 Each cable will be terminated on eight-position modular plugs to T568A pinout
 - .4 Modular booted, plug assembly
 - .5 CMR rated
 - .6 Jacket: Polyvinyl Chloride (PVC)
 - .7 Colour: Blue
 - .8 Lengths: [To be provided by Owner]
- .2 Performance Requirements:
 - .1 Meet or exceed the performance as detailed in ANSI/TIA-568-C.2 for Category 6A.
 - .2 Rated for the environment (indoor/outdoor) for which it is installed.
 - .3 Maximum length of overall cable channel including horizontal cabling, cross-connect wire, harness cables and patch cords will not exceed 100m
 - .4 Cable bandwidth (minimum): 500 MHz (Category 6A)

- .5 Meet or exceed the manufacturer's guaranteed electrical performance and physical specifications.
- .6 Support IEEE PoE 802.3af and PoE+ per 802.3at-2009
- .7 Delay:
 - (a) Frequency 100 MHz
 - (b) Maximum Delay 537.6 ns/100m
 - (c) Maximum Delay Skew 45 ns/100m
 - (d) Nominal Velocity of Propagation 64%

Standard of Acceptance

- Belden

2.2 Work Area Copper Connecting Cords

- .1 General:
 - .1 Minimum 23 AWG solid bare copper
 - .2 Four-pair, unshielded, within an overall jacket
 - .3 Each cable will be terminated on eight-position modular plugs to T568A pinout
 - .4 Modular booted, plug assembly
 - .5 CMR rated
 - .6 Jacket: Polyvinyl Chloride (PVC)
 - .7 Colour: Blue
 - .8 Lengths: [To be provided by Owner]
- .2 Performance Requirements:
 - .1 Meet or exceed the performance as detailed in ANSI/TIA-568.2-D for Category 6A.
 - .2 Rated for the environment (indoor/outdoor) for which it is installed.
 - .3 Maximum length of overall cable channel including horizontal cabling, cross-connect wire, harness cables and patch cords will not exceed 100m
 - .4 Cable bandwidth (minimum): 500 MHz (Category 6A)
 - .5 Meet or exceed the manufacturer's guaranteed electrical performance and physical specifications.
 - .6 Support IEEE PoE 802.3af and PoE+ per 802.3at-2009
 - .7 Delay:
 - (a) Frequency 100 MHz
 - (b) Maximum Delay 537.6 ns/100m
 - (c) Maximum Delay Skew 45 ns/100m
 - (d) Nominal Velocity of Propagation 64%

Standard of Acceptance

- Belden

2.3 Voice Cross-Connect Wire

- .1 General:

- .1 23 AWG solid tinned copper
- .2 Single pair, unshielded Category 3
- .3 CMR rated
- .4 Conductors will be insulated with semi-rigid PVC
- .5 One insulated conductor in a pair will be white and the other in visibly distinct solid colour

Standard of Acceptance

- ° Belden

3 EXECUTION

3.1 General

3.2 Installation

- .1 Provide two patch cords per horizontal cable. In the case of an IDC termination block based solution, one of the patch cords will be open-ended (ie. harness cable).
- .2 Provide enough fiber patch cords to patch 50% of the strands of backbone fiber cable links.
- .3 Properly route patch cords (fiber or copper) through supplied cable management.
- .4 Properly dress patch cords with Velcro ties where required.
- .5 Properly seat patch cord ends in bulkheads or jacks as required.
- .6 Ensure manufacturer bending radii are respected for entire length of patch cords.
- .7 Ensure project fill rate limitations are respected in cable management pathways to prevent pinching/crushing of patch cords.
- .8 Provide protective innerduct for any fiber patch cords that are routed in a combined (copper and fiber) cable management pathways.
- .9 Patch equipment from patch panels to equipment as required and in the methodology as specified by the Owner's representative.
- .10 Label any patch cords or harness cables as required by Owner standards or section 27 05 53.

3.3 Testing and Commissioning

- .1 In addition to the general requirements of Section 26 01 01 Electrical General Requirements, the following sections apply for testing and commissioning:
- .2 Provide accurate and complete patching and cross-connect records in electronic database format.

END OF SECTION

ACCESS CONTROL SYSTEM

28 23 10

1. GENERAL

1.1 General Requirements

- .1 Conform to Sections of Division 1 as applicable.
- .2 Conform to Section 26 01 01, Electrical General Requirements.
- .3 Materials and equipment described in each Section of the Specification are designed to establish standards of construction and workmanship.
 - .1 Where manufacturers or manufacturer's products are identified in lists with phrase "Standard of Acceptance", these are manufacturers and/or products which meet standards with regard to performance, quality of material and workmanship.
 - .2 Manufacturers and or products used are to be chosen from these lists.
 - .3 Where the Specification states "to match existing Hospital Standards" it is mandatory that the existing Standard be maintained and that the product must be as manufactured the identified manufacturer and must be the product identified.

1.2 Work Included

- .1 Expand the existing Security and Access Control system as required to support devices indicated on drawing package.
 - .2 Existing security system is by Trent Security Systems LTD – (705) 743 – 9774.
 - .3 Relocated existing security devices and components are required and indicated on drawings.
 - .4 Work to be done under this Section shall include furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete Access Control, Security Systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.
 - .5 Low voltage power supplies to be provided by Door Hardware Division, installed and wire by Division 26.
-
- .1 Provide suitable low voltage power and connect signal wiring to suit manufacturers' recommendations.
 - .2 Provide and test for proper operation.

1.3 Quality Assurance

- .1 The Access Control, Security Systems shall be designed in accordance with and conform to the requirements of:
 - .1 Canadian Standards Association (CSA)
 - .2 Ontario Electrical Safety Code (ESA)
 - .3 Ontario Building Code (OBC)
 - .4 Provincial and local bylaws and regulations
- .2 All Security related components including controls, modules, contacts and detectors must be listed by Underwriters' Laboratories of Canada (ULC).

- .3 Provide a detailed transition plan for implementing new components into the existing system. Implementation must be seamless and require a minimum end-user involvement.

1.4 Submittals

- .1 Submittals shall be of adequate depth to define fully the system offered.

1.5 Shop Drawings

- .1 Submit shop drawings of all components of the systems. Shop drawings shall include copies of dimensional drawings completely describing installation that shall be performed with relation to the space available for installation.

1.6 Manufacturer's Data

- .1 Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.

1.7 Maintenance Data

- .1 Submit copies of parts, lists and preventive maintenance requirements for systems to be installed.

1.8 System Training Configuration

- .1 System provider to review system configuration with CMH Security Manager and adjust as required.

1.9 Deviations

- .1 The approval of shop drawings by the Consultant shall not relieve the installer from responsibility for deviation from drawings or the specifications unless he has called attention in writing to such deviations at the time of submission and has obtained the approval of the Consultant thereon. When such deviations are called to the Consultants attention, and no mention is made of extra cost, it will be assumed that any proposed change will be made at no extra cost to the Owner.

1.10 Substitutions

- .1 The intent of these Specifications is to establish the quality of the materials and/or workmanship desired for this project. Substitutions shall be in conformance with the requirements as indicated.

1.11 As-Built Drawings

- .1 The Contractor shall maintain a separate set of drawings, elementary diagrams and wiring diagrams of the Access Control System to be used for as-built drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the Access Control System and shall be delivered to the Owners

1.12 Product Installation And Handling

- .1 Before and during installation care must be exercised to prevent damage to the sensitive parts and components of the system and be responsible for the storage and handling of all components until acceptance of the completed installation.

1.13 Warranty

- .1 Systems shall include a five (5) year warranty on parts forming part of this installation and a two (2) year warranty on labour. Any required system repairs which occur between the date of acceptance by the owners and the one year anniversary shall be provided without cost.
 - .1 Parts required to facilitate repairs in year two (2) through year five (5) shall be provided to the facility without cost.
 - .2 The necessary labour required to troubleshoot and remedy system problems which occur in years three (3) through year five (5) will be chargeable at a reasonable hourly rate.
 - .3 The supplier shall maintain a service department, necessary spare parts, after hours telephone answering services and call dispatching services required to implement the service standard stated below as part of this contract.

1.14 System Verification

- .1 Test and demonstrate the operation of the complete system to the Owner, the Consultant and the Commissioning Agent. This shall include, but not be limited to:
 - .1 detailed test and demonstration of each operable device
 - .2 detailed test and demonstration of overall system operation
 - .3 interfacing of various components.
- .2 On completion of the installation the manufacturer/supplier shall supply, to the Consultant and Commissioning Agent, a certificate, together with detailed inspection record sheets showing location of each device and certifying the test results per unit, confirming that the system is installed and operates in accordance with Specification.

1.15 Scope

- .1 The Access Control, Security System installation required for this installation incorporates:
 - .1 Card Readers to control entry to doors indicated.
 - .2 Door alarm contacts for connection to Central Security System.

- .3 Wire, conduit and connections to card reader, door alarms, electric strikes, electric locks, and power supplies.
- .4 Connection to Hospital Network System for connection to Central Security System.

2 PRODUCTS

2.1 General

- .1 All system hardware and software components shall be produced by manufacturers regularly engaged in the production of Access Control equipment.
- .2 All material and equipment shall be new and currently in production.
- .3 Each major component of equipment shall have the manufacturer's name address, and the model and serial number in a conspicuous place.
- .4 All equipment and devices provide shall match the existing system components and devices.
- .5 The release shall be of the failsafe type ensuring unlocking of doors for any malfunction of the security system or if the fire alarm system alarms. The arrangement shall be on the approval of the local authorities having jurisdiction.

2.2 Submittals and Instruction

- .1 The following data shall be forwarded upon award of Contract:
 - .1 Cable schematic showing card reader controllers, alarm terminals, card readers, power supply locations and all other devices and associated wiring and power.
 - .2 Technical specification data sheets of each system component and device.
 - .3 Provide complete system documentation at acceptance time, as specified herein.

3 EXECUTION

- General.1 Provide a complete operational Access Control System as shown on drawings, as specified and as intended.
- .2 Install all equipment in accordance with the manufacturer's instructions.
 - .3 Readers shall be installed at least 150mm (6") away from metal surfaces.
 - .4 Readers to be mounted at 1220mm (48") above finished floor.
 - .5 Intercom Stations to be mounted 1220mm (48") above finished floor.
 - .6 The manufacturer/supplier it to assist the Contractor in the installation and provide technical expertise required. Make final connections.
 - .7 Adjust system components as necessary to ensure complete system operation.
 - .8 Wiring
 - .1 All wiring to be installed in conduit.
 - .2 All wiring to be in accordance with manufacturer's recommendations.

- .3 All card access cables to be adequately shielded and are not to be run with power cables in same conduit.

- .9 Security System - Warranty, Maintenance, Testing and Certification
 - .1 Provide Warranty and Training as specified.
 - .2 Test all components of the system for proper operation as indicated in Specification.
 - .3 Acceptance procedures shall be in accordance with General Requirements and the following:
 - (a) Written certification shall be provided, on completion of a thoroughly tested installation, that the system has been pre-tested and is ready for acceptance testing. Written certification shall consist of a check list of operating features has been pre-tested and is functioning satisfactorily.

END OF SECTION