

BUILDING AUTOMATION SYSTEMS GENERAL 25 05 01

1 GENERAL

1.1 Scope

- .1 Extend existing hospital Building Automation System (BAS) with Direct Digital Control (DDC), and Energy Management for new mechanical systems and interface with other microprocessor based building subsystems.
 - .1 During the tender period, the contractor must perform a site inspection of the place of work and surroundings as well as, areas where access would be considered reasonable and make a thorough investigation of as-built conditions to determine the scope of work required relating to existing controls equipment and main trunk locations, prior to submitting their tender price.
 - .2 Controls contractor is to include for all upgrades required to the existing system (including software/hardware/controllers/licenses/etc) as required to interface all new points and controllers into BAS.
- .2 Provide programming and decommissioning for demolition of existing BAS headend including graphics, trends, and schedules.
- .3 Include software and hardware, wiring, computing equipment in compliance with this specification.
- .4 Products (including control devices, controllers, instrumentation, thermostats, etc...), controls strategies, and labeling scheme shall match base building standards.
- .5 Interface with other microprocessor based building subsystems.
- .6 Sequence of operations are documented on drawings.

1.2 Related Sections

- .1 Building Automation System includes Sections:
 - .1 25 14 01 B.A.S. Equipment Controllers
 - .2 25 35 01 B.A.S. Instrumentation and Actuators
 - .3 25 90 01 B.A.S. Sequence of Operations

1.3 Equipment Supplied for installation under Other Sections

- .1 Supply the following equipment for installation under other Sections of Division 20;
 - .1 automatic control valves,
 - .2 temperature wells for controllers and sensors provided under this Section,
 - .3 terminal unit controllers, actuators for volume dampers and velocity pressure sensors including transformers. Arrange and pay for shipping to terminal unit manufacturer's facility for factory installation.
 - .4 motorized dampers and actuators for motorized dampers and smoke dampers including associated end switches and relays.

1.4 Equipment Provided under Other Sections

- .1 The following equipment is provided under other Sections of Division 20;

- .1 liquid flow measuring devices
- .2 steam humidifiers with automatic control valves
- .3 unit heater and cabinet unit heater line voltage thermostats
- .4 manual dampers, fire dampers, gravity dampers, and smoke dampers
- .5 motorized dampers

1.5 Applicable standards

- .1 ANSI/ASHRAE standard 135-2001 BACnet
- .2 ANSI 709.1 Lonworks
- .3 Interfacing Standard:
 - .1 Input/output devices to use ASCII (American Standard for Communication and Information Interchange) code and standard EI (Electronic Industry Association) interfaces.
 - .2 CSA T530: Building Facilities, Design Guidelines for Telecommunications (same as EIA/TIA 569).
 - .3 IEEE 802.3 Ethernet 10Base-T LAN.

1.6 Abbreviations and definitions

- .1 The following definitions, abbreviations, and acronyms apply:
 - .1 AI Analog Input: continuously variable value, usually a sensor, referenced to a controller
 - .2 AO Analog Output: continuously variable value, usually a control signal to an actuator device, referenced to a controller.
 - .3 BI Binary (digital) Input: a two-state (On-Off) value, usually associated with a switch or state, referenced to a controller.
 - .4 BO Binary (digital) Output: a two-state (On-Off) value, usually associated with starting or stopping equipment or generating an alarm, referenced to a controller.
 - .5 BCU Building Control Unit
 - .6 ECU Equipment Control Unit
 - .7 FAS Fire Alarm System
 - .8 GUI Graphic User Interface: an LED, LCD or monitor display
 - .9 I/O Input/Output
 - .10 LAN Local Area Network
 - .11 NC Normally Closed: position of device in a de-energized state.
 - .12 NO Normally Open: position of device in a de-energized state.
 - .13 OWS Operator workstation: a PC based server or computer
 - .14 Tier 1 High level network providing communication between BCU's and workstations.
 - .15 Tier 2 Lower level network providing communications between ECU's and BCU's
 - .16 WAN Wide Area Network

1.7 Manufacturers and Installers

- .1 Provide BAS with DDC and Energy management for mechanical and electrical systems by an organization:
 - .1 specializing in design, installation, commissioning and service of open protocol DDC systems,
 - .2 having completed five (5) projects of similar size and complexity within the preceding five (5) years,
 - .3 employing certified journeymen experienced in this type of work.

Standard of Acceptance

- ° Delta

1.8 Continuity of Staff and Subcontractors

- .1 Project Manager is to be nominated at time of shop drawing submission and is to remain involved with project, from shop drawing preparation through to Acceptance, unless request for change is submitted and approved.
- .2 Subcontractors listed in preliminary design submission are to execute work defined as sublet in preliminary design document, unless request for change is submitted and approved.
- .3 Requests for changes in staff, subcontractors, or extent of work subcontracted are to be submitted for approval and such approval is not to be unreasonably withheld.

1.9 Identification of non-conforming materials and equipment.

- .1 Submit documentation at time of bid, identifying nature and extent of non-conformance and variances from specifications or referenced standards.
- .2 Failure to submit this documentation at time of bid will be interpreted as confirmation that materials, workmanship, hardware and software will be in strict accordance with specifications and standards.

1.10 Licences and Ownership

- .1 Ownership of, and licences for, hardware and software supplied or used for this project or for ongoing system operation, maintenance and modification to be registered, without restrictions, in Owner's name.
- .2 This is applicable to System Software, Workstation Application Editors, and Controller Software.
 - .1 Licensing to permit an unlimited number of users to access system without additional fees.
 - .2 As of last day of warranty period, software is to be upgraded to current version or release.
 - .3 Project-developed software and resulting documentation to be treated as part of system and subject to these same requirements for ownership and licensing. This material includes;
 - (a) Project graphic images
 - (b) CAD generated record drawings
 - (c) Project database
 - (d) Project-specific application programming code and documentation.

1.11 Shop Drawings

- .1 Submit one completely engineered and coordinated shop drawing package. Partial or incomplete submission of data and/or drawings will be returned without review.

- .2 Submit shop drawings for designed elements;
 - .1 list of materials of equipment to be used indicating manufacturer, model number, and other relevant technical data.
 - .2 BAS riser diagram showing system controllers, operator workstations, network repeaters, and network wiring.
 - .3 single-line schematics and system flow diagrams showing location of control devices.
 - .4 detailed analysis of each Sequence of Operation from design documents, ready for development of actual programming code.
 - .5 Sequence of Operations to cover normal operation and operation under various alarm conditions applicable to that system.
- .3 Submit shop drawings schedules for;
 - .1 control damper; spreadsheet type, to include separate line for each damper and columns for damper attributes.
 - .2 control valve; spreadsheet type, to include separate line for each valve and separate columns for valve attributes.
- .4 Submit catalogue cut-sheets for;
 - .1 manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for equipment and hardware items as follows;
 - (a) Controllers (BCU's and ECU'S)
 - (b) Transducers/Transmitters and Sensors with
 - accuracy data, range and scale information,
 - one sheet for each device marked with applicable options. (Where several devices of same type are to be used, submit one sheet for each device, individually marked.)
 - (c) Actuators
 - (d) Valves
 - (e) Relays/Switches
 - (f) Panels
 - (g) Power Supplies
 - (h) Batteries
 - (i) Operator Interface
 - (j) Wiring and wiring accessories
 - .2 hardware data sheets for Operator Interfaces, local panels, and portable operator terminals.
- .5 Submit supporting documentation:
 - .1 examples of graphics for Operator Interface to include;
 - (a) BAS network schematics
 - (b) typical terminal unit floor plan graphic that shows conditions on occupied floor
 - (c) typical equipment room floor plan graphic
 - (d) typical graphics for each system and terminal unit at least one sample graphic for each type of equipment,
 - (e) one sample graphic for chilled water system
 - (f) one sample graphic for hot water system
 - (g) description of techniques used for animation of information displayed on graphics].
 - .2 Software manuals for applications programs for Operator Interface, portable operator terminals, and programming devices.

- .3 Protocol Implementation Conformance (PIC) statement for BACnet devices.
- .4 Evidence that LonWork devices are LonMark approved and bear LonMark Logo.
- .5 Where interfaces occur with control or wiring diagrams of other sections, obtain reproducible copies of these diagrams and revise to show terminal numbers at interface and include diagrams as part of interconnection schematic shop drawings.

1.12 Project schedules

- .1 At time of shop drawing submission provide Gantt type Schedule of Work with;
 - .1 project broken down into discrete work items
 - .2 start date of each work item
 - .3 duration of each work item
 - .4 relationships between work items and showing constraints on work flow.
 - .5 planned delivery dates for ordered material and equipment with expected lead times.
 - .6 procedures.
- .2 During design, installation and start-up of installation provide monthly written status reports indicating work completed and revisions to expected delivery dates. Include updated Schedule of Work with each report.

1.13 Warranty

- .1 At completion of Work, submit written guarantee undertaking to remedy defects in work for period of two (2) years from date of acceptance, which includes:
 - .1 rectification of control system failures attributable to defects in workmanship, materials, hardware, and software,
 - .2 Service Technician to arrive on site within 24 hours of warranty service request, to install and debug software patches, to replace defective parts, materials or equipment, and to provide incidental supplies, and labour for remedial work,
 - .3 Technician to remain in attendance until system is returned to operating condition.
- .2 Submit similar guarantee for any part of work accepted by Owner, before completion of whole work.

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges:
 - .1 Temperature - 0° to 32.2°C (32° to 90°F)
 - .2 Relative Humidity 10% to 90% non -condensing
 - .3 Electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.
- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Equipment standard

- .1 Products and software: manufacturer/developer/supplier's catalogued current stock.

- .2 This installation is not to be used as test site for newly developed product or software, without explicit written approval.
- .3 Equipment and systems installed under this Contract to meet;
 - .1 performance specifications when subjected to VHF, UHF, FM, AM or background RFI as generated by commercial or private, portable or fixed transmitters that meet regulatory codes.
 - .2 Federal Communication Commission (FCC) Rules and Regulations, Part 15, Subpart J for computing devices.

2.3 General BAS architecture

- .1 To match existing

2.4 General functional requirements

- .1 To match existing

2.5 Performance

- .1 To match existing.

3 EXECUTION

3.1 Examination

- .1 Inspect site and thoroughly examine documents to establish locations for control devices and equipment and report discrepancies, conflicts, or omissions for resolution before starting rough-in work.
- .2 Be responsible for correction of defects caused through neglect of inspections and examinations or failure to report and resolve discrepancies.

3.2 Existing equipment

- .1 Existing equipment is not to be re-used. Cut back and remove all existing control wiring for all equipment being demolished. Remove all redundant points from B.A.S.
- .2 Demolition and removals:
 - .1 Unless specifically noted or shown otherwise, remove existing control components made redundant:
 - (a) room thermostats, controllers, auxiliary electronic devices, pneumatic controllers and relays, control valves, electronic sensors, and transmitters, to be removed and placed in storage as directed by Owner.
 - (b) local control panels; removed and placed in storage as directed by Owner.
 - .2 remove and dispose of existing conduits, wiring and tubing in exposed areas as they become redundant,
 - .3 remove existing control compressed air systems and connect to new control air system;
 - (a) existing hardwired interlocks to remain installed in systems.

- .3 in existing areas not otherwise involved in renovations, arrange and pay for holes and marks left by decommissioning and removal of control components, wiring, conduit, and tubing to be patched and refinished to match existing

3.3 Existing System Operation.

- .1 Mechanical systems to remain in operation and to maintain space conditions between hours of 6 a.m. and 9 p.m., Monday through Friday.
- .2 In these periods mechanical control system shut downs of up to 15 minutes may be permitted, after obtaining written agreement from Owner.
- .3 When time required for cut-over of controls will not meet these constraints, perform work outside of operating hours after making application; outlining areas affected; and likely length of interruption, and obtain written agreement from Owner. .
- .4 Maintain fan scheduling using existing or temporary time clocks or control systems throughout period of control system installation.
- .5 Modify existing starter control circuits to incorporate hand-off-auto control of existing starters for motors to be controlled through BAS system.

3.4 Protection

- .1 Protect work and material against damage during construction and be responsible for work and equipment until inspected, tested, and accepted.
- .2 Protect material not immediately installed and close open ends with temporary covers or plugs during storage and construction to prevent entry of foreign objects.
- .3 Protect electronic equipment from elements during construction.

3.5 Coordination

- .1 Coordinate and schedule control work with other work in same area to ensure orderly progress.
- .2 Testing and balancing:
 - .1 Supply set of tools for Testing and Balancing Technicians to interface to control system, train these technicians in use of tools and provide qualified Control Technician to assist with testing and balancing first 10 terminal units.
 - .2 Tools to be turned over to Owners on completion of testing and balancing.
- .3 Controls work by others:
 - .1 Integrate and coordinate this control work with controls and control devices provided or installed by others.
 - .2 Each supplier of control product to configure, program, start up, and test that product to satisfy requirements of Sequence of Operation regardless of where within contract documents product is specified or described.
 - .3 Resolve compatibility issues between control products provided under this section and those provided under other sections or divisions of this specification.

3.6 General Workmanship

- .1 Installation to be performed by skilled and certified technicians.
- .2 Install equipment, piping, and wiring or raceways horizontally, vertically, and parallel to building lines.
- .3 Provide sufficient slack and flexibility in connections to allow for vibration isolation between conduit, raceways, piping and equipment.
- .4 Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- .5 Install instrumentation and devices in locations providing adequate ambient conditions.
- .6 Protect components placed in areas of potentially high humidity.

3.7 Cleaning

- .1 Clean up debris, remove packaging material, collect waste and place in designated location, on a daily basis.
- .2 Keep work areas free from dust, dirt, and debris.
- .3 On completion of work, check finish of equipment provided under this section for damage and repair damaged factory-finished paint, replace deformed cabinets and enclosures with new material, and repaint to match original.

3.8 Field Quality Control

- .1 Ensure work, materials, and equipment comply with this specification and approved shop drawings.
- .2 Monitor field installation for code compliance and workmanship quality.
- .3 Arrange and pay for inspections by local or provincial authorities having jurisdiction.

3.9 Wiring

- .1 Electrical materials, equipment and installation procedures under to conform to British Columbia Electrical Safety Code as amended to date and standards established in Division 26.
- .2 Conduit:
 - .1 thin wall (EMT) conduit up to and including 32mm (1 1/4 in) size for exposed wiring up to 3 m (10 ft) above floor level,
 - .2 rigid galvanized steel conduit in locations accessible to public, subject to mechanical injury, or outdoors; and for conduit 40mm (1 1/2 in) size and larger,
 - .3 watertight compression fittings in exterior locations.
- .3 Run conduit and raceways parallel to building lines and be secured to building structure.
- .4 Wiring not to be installed in conduit to be installed parallel to building lines and be secured to building structure with clips at minimum 3m (6 ft) centres. Where possible, wiring to run above corridors and in service spaces.
- .5 Wiring in return air ceiling spaces to be plenum rated.

- .6 Where conduit leaves heated areas and enters unheated areas, seal conduit.
- .7 Provide interposing and motor control relays at local item of equipment or at associated MCC as applicable.
- .8 Provide 120 VAC wiring as needed to support operation of system networking hardware, field panels, and controllers. Refer to Section 20 05 13 for description of division of work and responsibility.
- .9 Provide control transformers for system components requiring power supply that do not have integral control transformers.
- .10 Where point schematics and specifications indicate auxiliary contact provision, provide instrumentation, wiring, conduit, power supplies and services as to integrate these points into BAS.
- .11 Mount transformers in enclosures. [

3.10 Identification of Equipment

- .1 Identify discrete items of equipment with plastic nameplates, identifying equipment and function.
- .2 Identification plates are in addition to manufacturers plates.
- .3 Manufacturers' nameplates and UL or CSA labels to be visible and legible after equipment is installed.
- .4 Identification plates:
 - .1 provided for equipment identified with number designations in schedules and equipment shop drawings.
 - .2 marked with equipment type, number and service following wording and numbering used in contract documents and shop drawings
 - .3 laminated plastic
 - .4 white face and black centre
 - .5 minimum size 75 mm x 40 mm x 3 mm (3 in x 1½ in x c in),
 - .6 engraved with 6.5 mm (1/4 in) high lettering.
 - .7 securely attached to equipment.
- .5 Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 50 mm (2 in) of termination.
- .6 Permanently label or code each point of field terminal strips to show instrument or item served.
- .7 Label each control component with permanent label. Label plug-in components so that label remains stationary during component replacement.
- .8 Label room sensors related to terminal boxes or valves with nameplates. Place labels on back of sensors.
- .9 Identify starters that are interfaced to BAS system with self adhesive labels, white letters on red background as follows;

W A R N I N G

THIS EQUIPMENT IS OPERATING UNDER AUTOMATIC CONTROL AND MAY START OR STOP AT ANY TIME WITHOUT WARNING. SWITCH DISCONNECT TO "OFF" POSITION BEFORE SERVICING.

- .10 Submit samples of labels and nameplates for review prior to installation.

3.11 Acceptance

- .1 After tests described in this specification are performed satisfactorily and checklists and reports are submitted and approved, certify acceptance of control system including:
 - .1 Control system checkout and testing
 - .2 Control system demonstration
 - .3 Training
 - .4 As-built documentation
- .2 Certification document may identify tests that cannot be performed due to extenuating circumstances such as weather conditions. Append program to certification document for rectification and completing these tests during warranty period.

3.12 Control System Checkout and Testing

- .1 Provide schedule for start-up testing.
- .2 Calibrate and prepare for service; equipment, instruments, controls, and accessories.
- .3 Start-up testing to verify substantial completion of control system before system demonstrations begin.
 - .1 Verify that control wiring is connected and free of shorts and ground faults. Verify that terminations are tight.
 - .2 Enable control systems and verify input device calibration.
 - .3 Verify that binary output devices operate and that normal positions are correct.
 - .4 Check control valves and automatic dampers for proper action and closure and adjust valve stem and damper blade travel.
 - .5 Verify that analog output devices are functional, that start and span are correct, and that direction and normal positions are correct.
 - .6 Verify that system operates according to Sequences of Operation. Simulate changes in variables by overriding and varying inputs and schedules and observe and record each operational mode response.
 - .7 Tune PID loops and control routines.
 - .8 Check each alarm with an appropriate signal at value that will trip alarm.
 - .9 Trip interlocks using field contacts to check logic and to ensure that actuators fail in proper direction.
 - .10 Test interlock actions by simulating alarm conditions to check initiating value of variable and interlock action.

- .4 Prepare and submit log documenting start-up testing of each input and output device and each control routine, with technician's initials certifying each device and each routine is functioning correctly and sensors have been calibrated. Include list of deficiencies, if any, and schedule setting out rectification program with time lines.

3.13 Control System Demonstration

- .1 Obtain approval of start-up testing log and rectification program before scheduling demonstrations.
- .2 Provide notification not less than 10 days before system demonstration begins.
- .3 Demonstration to follow previously submitted and approved procedures;
 - .1 submit checklists and report forms for each system as part of demonstration,
 - .2 lists and forms to have initials of technicians conducting demonstrations,
 - .3 date of each demonstration and signatures of Owner's representatives witnessing each demonstration section.
- .4 Prior to acceptance, perform following tests to demonstrate system operation and compliance with specification after and in addition to tests specified above in Control System Checkout and Testing.
- .5 Show field operation of;
 - .1 each Sequence of Operation.
 - .2 Operator Interface
 - .3 DDC loop response with graphical trend data output showing
 - (a) Each DDC loop response to set point change producing an actuator position change of at least 25% of full range.
 - (b) Trend sampling rate to be from 10 seconds to 3 minutes, depending on loop speed.
 - (c) Loop trend data to show set point, actuator position, and controlled variable values.
 - (d) Documentation of further tuning of any loop that displays significantly under- or over-damped control
 - .4 Demand limiting routine with trend data output showing demand-limiting algorithm action;
 - (a) trend data to document action sampled each minute over at least 30-minute period and to show building kW, demand-limiting set point, and status of set-points and other affected equipment parameters.
 - .5 Building fire alarm system interface.
 - .6 Trend logs for each system point with;
 - (a) trend data to indicate set-points, operating points, valve positions, and other data as specified in points list provided with each Sequence of Operation,
 - (b) each log to cover three 48-hour periods and to have sample frequency not less than 10 minutes,
 - (c) show that Logs are accessible through operator interface and can be retrieved for use in other software programs.
 - .7 Substantiate calibration and response of any input and output points requested.
 - .8 Provide at least two technicians equipped with two-way communication.
 - .9 Provide and operate test equipment to establish calibration and prove system operation.
- .6 Tests that fail to demonstrate system operation to be repeated after repairs and/or revisions to hardware or software is completed.

- .7 Project record Submittals.
 - .1 Submit three copies of project record documents and obtain approval during acceptance procedures.
 - .2 Submit inspection certificates.
 - .3 Certificate of Acceptance to be withheld until Submittals are approved.

3.14 Training

- .1 Materials:
 - .1 Provide course outline and materials for each class at least six weeks before first class.
 - .2 Provide training through instructor-led sessions, with computer-based, or web-based techniques.
 - .3 Instructors to be factory-trained and experienced in presenting this material.
 - .4 Perform classroom training using network of working controllers representative of installed hardware
- .2 Operating staff training:
 - .1 Provide training for Owners operating staff using abovementioned training materials in self-paced mode, web-based or computer-based mode, classroom mode, or combination of these methods.
 - .2 Allow for 3 repeat sessions for each category to cover operator shift rotation.
- .3 Training to enable students to accomplish following objectives.
 - .1 Group 1:
 - (a) Proficiently operate system
 - (b) Understand control system architecture and configuration
 - (c) Understand BAS system components
 - (d) Understand system operation, including BAS system control and optimizing routines (algorithms)
 - (e) Operate workstation and peripherals
 - (f) Log on and off system
 - (g) Access graphics, point reports, and logs
 - (h) Adjust and change system set-points, time schedules, and holiday schedules
 - (i) Recognize common HVAC system malfunctions by observing system graphics, trend graphs, and other system tools
 - (j) Understand system drawings and Operation and Maintenance manual
 - (k) Understand project layout and location of control components
 - (l) Access data from BAS controllers
 - (m) Operate portable operator's terminals
 - .2 Group 2:
 - (a) Create and change system graphics
 - (b) Create, delete, and modify alarms, including configuring alarm reactions
 - (c) Create, delete, and modify point trend logs (graphs) and multi-point trend graphs
 - (d) Configure and run reports
 - (e) Add, remove, and modify system's physical points
 - (f) Create, modify, and delete application programming
 - (g) Add operator interface stations
 - (h) Add new controller to system
 - (i) Download firmware and advanced applications programming to controller
 - (j) Configure and calibrate I/O points

- .3 Group 3:
 - (a) Maintain software and prepare backups
 - (b) Interface with job-specific, third-party operator software
 - (c) Add new users and understand password security procedures
- .4 Divide presentation of objectives into three sessions:
 - .1 Group 1: Day-to-day Operators.
 - .2 Group 2: Advanced Operators
 - .3 Group 3: System Managers and Administrator
 - .4 Participants will attend one or more of sessions, depending on knowledge and expertise level required.
 - .5 Provide each student with one copy of training material.

3.15 Submittals for Acceptance

- .1 Provide system documentation at time of acceptance.
- .2 As-built drawings;
 - .1 As-built interconnection wiring diagrams, or wire lists of field installed system with identified, ordering number of each system component and service.
 - .2 Floor plans with accurate depiction of location of system devices, controllers, and trunk wiring. Drawings to be constructed using Architectural backgrounds provided .
 - .3 Provide 2 copies on CD-ROM of above drawings in AutoCAD Release 2000 format without compression.
 - .4 Provide 5 full size hard copies of floor plan drawings.
- .3 Operation and Maintenance (O&M) Manuals:
 - .1 Provide two paper copies of material and five copies on CD-ROM in Adobe PDF format.
 - .2 Describe operation, maintenance and servicing requirements of system and associated equipment.
 - .3 Provide following information in separate sections, each with an index.
 - (a) Service and parts;
 - Names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.
 - List of recommended spare parts with part numbers and suppliers.
 - (b) System description;
 - English language outline of BAS system and system architecture
 - As-built versions of shop drawing product data.
 - Reduced size (11 in x 17 in) copies of record drawings
 - Graphic files, programs, and database on magnetic or optical media.
 - Licenses, guarantees, and warranty documents for equipment and systems.
 - (c) Technical literature for equipment, including;
 - catalogue sheets,
 - calibration, adjustments and operation instructions,
 - installation instructions,
 - hardware and software manuals, with information supplied by original product developer, on application programs and on computers and controllers supplied

- Operator's manual with procedures for operating control systems; logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set-points and variables.
- Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
- Original-issue documentation with installation and maintenance information for third-party hardware including computer equipment and sensors.
- Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- Programming manual or set of manuals with description of programming language and syntax, explanation of statements for algorithms and calculations used, procedures for point database creation and modification, documentation of techniques for program creation and modification, and instructions for use of editor.
- Documentation of programs created using custom programming language including set-points, tuning parameters, and object database. Electronic copies of programs to modify and create control logic, set-points, tuning parameters, and objects that can be viewed using programming tools.

.4 Original Software:

- .1 Furnish one original set of application and system software on original media. Disks to bear manufacturer's label. Field copies are not acceptable.
- .2 Original-issue copies of software to include operating systems, custom programming language, application generation, graphic support, maintenance support, operator workstation or web server software, and other utilities provided in support of installed system.

3.16 Correction After Completion

- .1 After start-up, testing, and commissioning phase when satisfactory and reliable operation of equipment and systems has been demonstrated, acceptance to be certified. Guarantee period to begin on date established on certificate of acceptance.
- .2 Provide (supply, install, de-bug and commission) updates and patches to resolve software deficiencies in operator workstation or web server software, project-specific software, graphic software, database software, and firmware during guarantee period.
- .3 Provide (supply, install, de-bug and commission) upgrades that improve routines and procedures of operator workstation software, web server software, project-specific software, graphic software, or database software, free of charge, during guarantee period .
- .4 Provide details of proposed changes and obtain written authorization before installation of updates, patches, or upgrades.
- .5 Include preventative maintenance, with allowance for spare parts, labour, and emergency (24 hour) service for system and equipment during guarantee period.
- .6 Equipment manufacturers to submit written undertakings to make circuit board repairs and provide spare parts, software support and patches, and technical assistance for at least five years after acceptance is certified.

END OF SECTION

B.A.S. INSTRUMENTATION AND ACTUATORS

25 35 01

1 GENERAL

1.1 Scope

- .1 Provide Instrumentation, dampers, control valves, and Actuators for Building Automation System.
- .2 Provide actuators for operating dampers provided as part of factory built air handling units.

2 PRODUCTS

2.1 General

- .1 Provide equipment which functions and meets detailed performance criteria when operating in following minimum ambient condition ranges:
 - .1 Temperature - 0°C to 32.2°C (32°F to 90°F)
 - .2 Relative Humidity 10% to 90% non -condensing
 - .3 Electrical power service of single phase, 120 VAC +/- 10%, 60 Hz nominal.
- .2 Components installed within motor control devices to be designed to operate with transient electrical fields occurring within these devices.

2.2 Power Supplies and Line Filtering

- .1 Power Supplies:
 - .1 control transformers to be UL listed,
 - .2 line voltage units to be CSA listed,
 - .3 provide over-current protection in primary and secondary circuits,
 - .4 limit connected loads to 80% of rated capacity.
- .2 DC power supplies:
 - .1 output to match equipment current and voltage requirements,
 - .2 units to be full-wave rectifier type with output ripple of 5.0 mV maximum peak-to-peak. Regulation to be 1.0% line and load combined, with 100-microsecond response time for 50% load changes,
 - .3 units to have built-in over-voltage and over-current protection and to be able to withstand 150% current overload for at least three seconds without trip-out or failure,
 - .4 units to operate between 0°C and 50°C (32°F and 120°F). EM/RF to meet FCC Class B and VDE 0871 for Class B and MILSTD 810C for shock and vibration.
- .3 Power Line Filtering:
 - .1 provide internal or external transient voltage and surge suppression for workstations and control modules,
 - .2 surge protection:
 - (a) dielectric strength of 1000 V minimum,
 - (b) response time of 10 nanoseconds or less,
 - (c) transverse mode noise attenuation of 65 dB or greater,
 - (d) common mode noise attenuation of 150 dB or greater at 40-100 Hz.

2.3 Electric/electronic actuators – air dampers

- .1 Actuators for Terminal unit dampers:
 - .1 integrated DDC controller and damper actuator,
 - .2 sized and selected in accordance with terminal box damper manufacturer's specifications,
 - .3 gear drive, direct coupled type operators mounted to shaft with universal V-bolt clamp,
 - .4 proportional type control,
 - .5 selectable / reversible rotation direction,
 - .6 input type and range as suitable for interfacing to output of terminal unit controller,
 - .7 angle of rotation adjustable between 30 to 90° with mechanical limit stops,
 - .8 damper position indication visible without cover removal,
 - .9 manual override to set damper position without power applied to actuator,
 - .10 electronic stall protection,
 - .11 general purpose dust proof enclosure,
 - .12 actuator running time of not more than 100 seconds,
 - .13 delivered to terminal unit manufacturer's factory for installation.

2.4 Control Valves

- .1 General:
 - .1 Body and trim materials selected in accordance with specification for globe valves, ball valves, or high performance butterfly valves, and in accordance with manufacturer's recommendations for design conditions and service.
 - .2 Size control valves for pressure drops and heating and cooling loads as scheduled with same pressure rating as globe valves under same service and pressure conditions.
 - .3 Size valves for two port and three port, two position service;
 - (a) line size,
 - (b) ball valves, sizes NPS 1 ½ and smaller,
 - (c) butterfly valves, sizes NPS 2 and larger.
 - .4 For two port and three port modulating service;
 - (a) use globe valves for CV rating 160 and smaller,
 - (b) use butterfly valves for CV rating above 160.
 - .5 Select butterfly valves based on CV rating at 70° rotation
 - .6 actuator and trim selected for close-off pressure ratings as follows;
 - (a) two-way modulating or two position service; 150% of pump shut off head.
 - (b) three-way modulating service; 300% of pressure differential between ports A and B at design flow or 100% of pump shut off head.
 - (c) shut off head to be based on maximum rpm when pump is fitted with VFD
 - .7 sized as follows;
 - (a) for two-position service; line size.
 - (b) for valves for radiation, terminal units and reheat coils;
 - pressure drop of 7kPa (1 psig)

2.5 Electric/electronic actuators - valves

- .1 Valve actuators for service other than radiation, radiant panel and reheat coil valve applications:
 - .1 sized and selected in accordance with manufacturer's specifications,
 - .2 electric/electronic for two position, or proportional control action, coupled to valves with linkage,
 - .3 electronic interface control board, solid state drive, reversible motor, oil immersed gear train,
 - .4 electronic overload or digital rotation sensing circuitry to protect damper operator through entire range of rotation,
 - .5 span and zero travel adjustment,
 - .6 position feedback signal on actuators used for proportional control,
 - .7 provision for manual positioning of valve when actuator is not powered,
 - .8 spring return mechanism to return valve to "normal" position on power failure (i.e. Normally Open (NO), or Normally Closed (NC)),
 - .9 control signals:
 - (a) 0 to 10VDC or 0 to 20ma,
 - (b) modulate damper position with 2 to 10VDC or 4 to 20ma input signal operating range when in proportional service.
 - (c) input type and range as suitable for interfacing to output of BAS controller
 - .10 feedback signals:
 - (a) two independent adjustable travel limit switches and wiring to BAS for indication of valve position.
 - .11 general purpose, drip proof NEMA 2 die-cast housing with corrosion resistant steel cover for indoor applications, watertight NEMA 4 enclosure for outdoor use,
 - .12 electric actuators suitable for operation down to -35°C where installed outdoors.
- .2 Valve actuators for service on radiation, radiant panel, and reheat coil valve applications:
 - .1 output shaft driven by gear train mechanism.
 - .2 reversible motor with automatic load limit,
 - .3 input type and range as suitable for interfacing to output of BAS controllers,
 - .4 adjustable span and offset travel ,
 - .5 position feedback signal on actuators used for proportional control,
 - .6 general purpose, dustproof, die-cast aluminum housing,
 - .7 actuator rotation limit.

2.6 Temperature sensors/transmitters

- .1 Sensor alternative technologies:
 - .1 Resistance temperature device (RTD) of precision thin film platinum element type;
 - (a) linear characteristics over sensor range,
 - (b) 1000 ohm, [± 20 ohms (2%)] [± 2 ohms (0.2%)] reference resistance at 0°C (32°F),
 - (c) 0/.0385ohms/ohm/°C (0.0212 ohms/ohm/°F) temperature coefficient of resistance and
 - (d) $\pm 0.36^\circ\text{C}$ at 21°C ($\pm 0.65^\circ\text{F}$ at 70°F) accuracy [] [to Din IEC 751]
 - .2 Resistance temperature device (RTD) of precision thin film nickel element type, with
 - (a) linear characteristics over sensor range,
 - (b) 1000 ohm, [± 20 ohms (2%)] [± 2 ohms (0.2%)] reference resistance at 21°C (70°F),

- (c) 5.4 ohm/°C (3.0 ohm/°F) temperature coefficient of resistance and
- (d) $\pm 0.18^{\circ}\text{C}$ at 21°C ($\pm 0.34^{\circ}\text{F}$ at 70°F) accuracy

.3 Thermistor with

- (a) non-linear negative temperature coefficient of resistance,
- (b) 10,000 ohms reference resistance at 25°C (77°F),
- (c) curve matched to $\pm 0.2^{\circ}\text{C}$ ($\pm 0.36^{\circ}\text{F}$) temperature accuracy over 0°C to 70°C (32°F to 158°F), and
- (d) long term stability of 0.025°C (0.045°F) drift per year

.2 Each sensor:

- .1 2 integral anchored lead wires
- .2 waterproof sensor to sheath seal
- .3 strain minimizing construction
- .4 standard conduit box termination with cover
- .5 pig-tail wire leads with wire nuts or screwed terminal connector block
- .6 factory calibrated and capable of end to end (sensing element to BAS) accuracy of $\pm 0.25^{\circ}\text{C}$ ($\pm 0.5^{\circ}\text{F}$) over full range of measured variable.
- .7 transducing circuit to convert output to signal compatible with equipment controller
- .8 concealed USB or serial communications port for portable PC or hand held commissioning equipment.

.3 Space temperature sensors, Type 1:

- .1 for measurement of space temperatures throughout facility
- .2 sensor operating temperature range from 4°C to 60°C (40°F to 140°F)
- .3 surface mounted plastic mono-chromatic guard with surface mounting plate and wall anchors.
- .4 guard secured to mounting plate by screws.

2.7 Electrical devices

.1 Current sensing relays:

- .1 metering transformer ranged to match load being metered,
- .2 plug in base and shorting shunt to protect current transformer when relay is removed from socket,
- .3 current transformer for single or three phase metering connected into single relay,
- .4 adjustable latch level, adjustable delay on latch and minimum differential of 10% of latch setting between latch level and release level,
- .5 discrimination between phases in three phase applications to allow worst case selection,
- .6 mounted in motor starter enclosure and fed from starter control transformer,
- .7 relay contacts capable of handling 10 amps at 240 volts.

.2 Current transducer:

- .1 output signal proportional to measured line current,
- .2 output signal in one of following ranges; 4-20 mA, 0-5 Vdc or 0-10 Vdc

.3 Control Relays:

- .1 plug-in type, UL listed, with dust cover and LED "energized" indicator.
- .2 contact rating, configuration, and coil voltage suitable for application.
- .3 NEMA 1 enclosure for relays not installed in local control panels.
- .4 Time Delay Relays:
 - .1 solid-state plug-in type, UL listed, with adjustable time delay adjustable $\pm 100\%$ from set point shown.
 - .2 contact rating, configuration, and coil voltage suitable for application.
 - .3 NEMA 1 enclosure for relays not installed in local control panels.
- .5 Override Timers:
 - .1 spring-wound line voltage, UL Listed, with contact rating and configuration by application unless implemented in control software.
 - .2 0-6 hour calibrated dial.
 - .3 flush mounted on local control panel face.
- .6 AC Current Transmitters:
 - .1 self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output.
 - .2 full-scale unit ranges of 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment.
 - .3 $\pm 1\%$ full-scale accuracy at 500 ohm maximum burden.
 - .4 UL/CSA listed and meet or exceed ANSI/ISSA 50.1 requirements.
- .7 AC Current Transformers:
 - .1 UL/CSA listed
 - .2 completely encased (except for terminals) in approved plastic material.
 - .3 selected for appropriate current ratios with $\pm 1\%$ accuracy at full-scale output.
 - .4 fixed-core transformers for new wiring installation
- .8 AC Voltage Transmitters:
 - .1 self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
 - .2 adjustable full-scale unit ranges; 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac.
 - .3 $\pm 1\%$ full-scale accuracy at 500 ohm maximum burden.
 - .4 UL/CSA listed, 600 Vac rated and conforming to ANSI/ISSA 50.1.
- .9 AC Voltage Transformers:
 - .1 UL/CSA listed, 600 Vac rated with built-in fuse protection.
 - .2 suitable for ambient temperatures of 4°C to 55°C (40°F to 130°F) and
 - .3 $\pm 0.5\%$ accuracy at 24 Vac and 5 Vac load.
 - .4 windings (except for terminals) enclosed with metal or plastic.
- .10 Power Monitors:
 - .1 three-phase type with three-phase disconnect and shorting switch assembly,

- .2 UL listed voltage transformers, and
 - .3 UL listed split-core current transformers.
 - .4 selectable output either rate pulse for kWh reading or 4-20 mA for kW reading.
 - .5 maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.
- .11 Current Switches:
- .1 self-powered, solid-state type with adjustable trip current
 - .2 integral current transformers and relays to indicate motor status
 - .3 SPDT output relay suitable for use as digital input
 - .4 field adjustable output relay trip setting, over 0-100% of range. Deadband adjustment to maximum of 10% of range
 - .5 integral zero-leakage LED's indicating sensor power and switch status
 - .6 long term setting drift of current transformer and relay combination not more than 5% full range over 6 months
 - .7 over current and over voltage protection for current transformer and relay
 - .8 operating temperature range; -10°C to 50°C (14°F to 122°F)
 - .9 operating humidity range; 5% to 90% RH non condensing
- .12 Electronic signal isolation transducers:
- .1 provided whenever;
 - (a) an analog output signal from BAS is connected to an external control system as an input (such as chiller control panel) or
 - (b) BAS is to receive an analog input signal from an external remote system.
 - .2 designed for ground plane isolation between systems.

2.8 Wiring and Raceways

- .1 Wiring, conduit, and raceways to Section 20 05 13.
- .2 Wire used for power and control:
 - .1 insulated copper conductors,
 - .2 UL listed for minimum 90°C (200°F) service.
 - .3 Power wiring minimum 12 gauge.
 - .4 Control wiring for digital functions: 18 AWG minimum with 300 Volt insulation.
 - .5 Control wiring for analog functions: 18 AWG minimum with 300 Volt insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.
 - .6 Transformer current wiring: 16 AWG minimum.
 - .7 Sensor wiring: 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware. Provide additional conductors as to support supplemental features of sensor (i.e. set-point adjustment, override, etc.)

3 EXECUTION

3.1 Installation of Sensors

.1 General:

- .1 Mount sensor assemblies and elements;
 - (a) in clean areas wherever possible,
 - (b) accessible to allow for replacement and servicing without interfering with access for adjacent equipment and personnel traffic in surrounding space,
 - (c) provide access doors where assemblies and elements are concealed.
- .2 Install transmitters, transducers, controllers, solenoid air valves and relays in NEMA2 enclosures;
 - (a) install wiring and tubing within enclosures in trays or individually clipped to back of panel with identification tags and terminal numbers visible.
- .3 Rigidly support field mounted transmitters, transducers, and sensors on pipe stands or channel brackets.
- .4 Orient sensing elements to correctly sense measured variable and to be isolated from vibrations and environmental conditions that could affect measurement or calibration.
- .5 Identify each cable and wire at every termination point.
- .6 Air seal wires attached to sensors at entry into junction box.

.2 Temperature sensors:

- .1 Install room temperature sensors on concealed junction boxes supported by wall framing.
- .2 Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in serpentine manner vertically across duct. Support each bend with capillary clip.
- .3 Install mixing plenum low-limit sensors in serpentine manner horizontally across duct. Support each bend with capillary clip. Provide sensor element length to coil area ratio of 3 m per 1 m² (1 ft per 1 sq ft).
- .4 Install pipe-mounted liquid temperature sensors in wells with heat-conducting material. Where thermowell installation necessitates shutting down of pumps or draining of pumps, coordinate with Consultant and Owner.
- .5 Cut and recover piping insulation to one foot either way for installation of strap-on temperature sensors. Provide removable insulation box over sensor and patch insulation to match existing.
- .6 Install outdoor air temperature sensors on north facing wall with sun shield.
- .7 Mount space temperature and humidity sensors 1200 mm (4 ft) above finished floor.

3.2 Actuators

.1 General:

- .1 Mount actuators and adapters according to manufacturer's recommendations.
- .2 Electric and Electronic Damper Actuators:
 - .1 Mount damper actuators directly on damper shaft or jackshaft
 - .2 Mount valve actuator directly on shaft or with linkages according to manufacturer's recommendations.
 - .3 For low-leakage dampers with seals, mount actuator with minimum 5° travel available for damper seal tightening.

- .4 To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close damper, then tighten linkage.
 - .5 Provide mounting hardware and linkages for actuator installation
- .3 Valve Actuators:
- .1 Connect actuators to valves with adapters approved by actuator manufacturer.

END OF SECTION

B.A.S. SEQUENCE OF OPERATIONS

25 90 01

1 GENERAL

1.1 Definitions

- .1 System Start: actions required at system start-up under schedule control or on re-start after power failure.
- .2 Normal Operation: normal control sequence after initial start-up requirements are satisfied.
- .3 Demand Limiting: special operation parameters during normal utility power outages (emergency generator operation)
- .4 System Stop: shut-down of system under schedule control and fail-safe position of system in event of loss of normal power.
- .5 Fire Alarm: action required in the event of a signal from the fire alarm system (FA).
- .6 Schedule: scheduled operation of system
- .7 Alarm: minimum alarm points required.
- .8 Emergency Power: control system elements to be fed from emergency power, refer to electrical drawings.

2 EXECUTION

2.1 Sequence of operation and control drawings

- .1 Control sequences that follow describe and detail suggested method of control of systems.
- .2 Control drawings listed for each control sequence illustrate required inputs and outputs for the control and monitoring of systems.
- .3 Review sequence of operation described for each system and allow for additional input and output points to achieve method of control described. Review documents to determine quantity of each piece of equipment or system.
- .4 Sequences of Operation
 - .1 CS 100 Terminal Re-heat Unit
 - .2 CS 200 Split Air Conditioner – Cooling Only

END OF SECTION

CS100 - Terminal Unit with Reheat (where applicable)

Reference: Heating Drawings

Applicable
Systems: Terminal unit with reheat (typical)

System
Start: Boxes are enabled when associated AHU system is operating. Reheat coil valve V1 is enabled with OAT > 5°C. Reheat Coil valve V1

Normal
Operation: ***Space Temperature Control***

Boxes designated as “constant volume”:

Heating Priority Control

Reheat coil has priority. At designed air flow reheat valve V1 modulates to maintain space setpoint temperature.

Unoccupied
Mode: Boxes designated as “constant volume” continue to operate as per normal operation mode.

System
Stop: On shutdown of associated AHU system, supply air damper of terminal unit boxes goes to preset (adjustable) position. Hot water valve V1 on reheat coil shall modulate to maintain room temperature.

Fire Alarm: N/A

Schedule: As per associated fan schedule.

Alarm: F1 Abnormal terminal unit air flow +/- 20-25%
T1 Space temperature out of range – high: 3°C > setpoint; low: 2°C < setpoint (only when window is closed)

CS200– Split Air Conditioner – Cooling Only

Reference: Mechanical Schematic Detail CS200 on M-2.

Applicable
Systems: FC-1, CU-1

System

Start: Operator selects lead fan coil unit. Fan coil unit start is initiated by operator command through the BAS or locally at fan coil unit. Upon signal to start fan coil, fan coil starts and associated air cooled condenser unit starts under OEM controls (ESS1,ESS2).

Normal

Operation: When Space Temperature T1 above setpoint, Space temperature sensor T1 modulates control valve to maintain setpoint temperature. In the event fan coil unit stops. This condition shall alarm at the BAS.

System

Stop: Fan coil unit stop is initiated by operator command through the BAS or locally at fan coil unit. Upon signal to stop fan coil unit, associated air cooled condenser unit stops under OEM control (ESS1,ESS2), fan coil unit stops.

Fire Alarm: N/A

Smoke
Control: N/A

Schedule: System is in operation 24/7
Monitor: Space temperature from room thermostat

Alarm: EST1 Fan Coil Unit status
T1 Space temperature out of range – high: 2°C above setpoint; low: 2°C below setpoint
HL1 Condensate pan high level float switch

Emergency
Power: Yes



**Electrical
Specification**
FOR

FSJ CT SCANNER REPLACEMENT
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Issued for: Construction
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END OF SECTION

ELECTRICAL GENERAL REQUIREMENTS 26 01 01

1 REQUIREMENTS

1.1 General Contract Documents

- .1 Comply with General Conditions of Contract, Supplementary Conditions and Division 01 - General Requirements.

1.2 Work Included

- .1 Work to be done under this section to include furnishing of labour, materials, equipment and services required for installation, testing and putting into proper operation complete Electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.

1.3 Document organization

- .1 Applicable Divisions for Electrical Work:
 - .1 Division 26 - Electrical
 - .2 Division 27 - Communications
 - .3 Division 28 - Electronic Safety and Security
- .2 For clarity, any reference in the Contract Documents to Division 26 includes Division 27 and 28.
- .3 The Specifications for these Divisions are arranged in Sections for convenience. It is not intended to recognize, set or define limits to any subcontract or to restrict Contractor in letting subcontracts.
- .4 Contractor is responsible for completion of the Work whether or not portions are sublet.

1.4 Division 26, as it applies to Division 27 and 28

- .1 Division 26 contains common work requirements that are applicable to the Work of Divisions 27 and 28 and apply as if written in full within Divisions 27 and 28.

1.5 Definitions

- .1 The words "indicated", "shown", "noted", "listed" or similar words or phrases used in these Specifications, mean that the material or item referred to is "indicated", "shown", "listed" or "noted" on the Drawings or in the Specifications.
- .2 The words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected", or similar words or phrases used in these Specifications, mean that the material or item referred to, is to be "approved by", "satisfactory to", "as directed by", "submitted to", "permitted by", "inspected by" the Consultant.
- .3 Instructions using any form of the word "provide", requires the Contractor to furnish labour, materials and services as necessary to supply and install the referenced item.
- .4 The term "building code" means the current edition of the "British Columbia Building Code".
- .5 The terms "electrical code" and "electrical safety code" mean the current edition of the "Canadian Electrical Code".

- .6 The terms “electrical authority” and “electrical safety authority” mean the “Electrical Safety Authority, ESA” The term “AHJ” means the “Authority Having Jurisdiction” and can include the local building inspector, the local fire department and the electrical safety inspector or their agents.

1.6 Language

- .1 Specifications are written as a series of instructions addressed to the Contractor, and by implication to subcontractors and to suppliers. For clarity and brevity, use is made of numbered lists and bulleted lists. Where the list follows a semi-colon (;) punctuation is for clarity, where the list follows a colon (:) punctuation is to be read as short-hand form of verb “to be” or “to have” as context requires.
- .2 It is not intended to debate with the Contractor reasons for these instructions, and words associated with justification for an instruction or restatement of anticipated performance have been omitted to avoid possible ambiguities.

1.7 Examination

- .1 Examine any existing buildings and services, local conditions, building site, Specifications, and Drawings and report any condition, defect or interference that would prevent execution of the Work.
- .2 Examine work of other Divisions before commencing the Work, and report any defect or interference.
- .3 No allowance will be made for any expense incurred through failure to make these examinations of the site and documents prior to Tender or on account of any conditions on site or any growth or item existing there which was visible or known to exist at time of Tender.

1.8 Design Services

- .1 Provide design services for elements of the Work where specified. Instruments of this service to be sealed by a professional engineer licensed in the applicable jurisdiction.

1.9 Standard of Material and Equipment

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Material and Equipment.
- .2 Materials and equipment:
- .1 new and of uniform pattern throughout the Work,
 - .2 of Canadian manufacture where obtainable,
 - .3 labelled or listed by Code and/or Inspection Authorities, CSA certified and CMB listed; where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Safety Authority,
 - .4 standard products of approved manufacture,
 - .5 in compliance with Standards and Regulations with respect to;
 - (a) chemical and physical properties of materials,
 - (b) design,
 - (c) performance characteristics, and
 - (d) methods of construction and installation,
 - .6 identical units of equipment to be of same manufacture,
 - .7 within any unit of equipment, identical component parts to be of same manufacture, but various component parts comprising the unit need not be from one manufacturer.

- .3 Materials and equipment are described to establish standards of construction and workmanship.
 - .1 Where manufacturers or manufacturers' 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.
- .4 Include items of material and equipment not specifically noted on Drawings or mentioned in Specifications but which are required to make a complete and operating system.
- .5 Confirm capacity or ratings of equipment being provided, when based on ratings of equipment being provided under other trade Sections, before such items are purchased.
- .6 Provide equipment marked for use with 75°C wiring or with a higher temperature rating. If equipment is not marked with a temperature rating or if the only rating available is less than 75°C, increase the associated conductor sizes accordingly, to the satisfaction of the consultant.
- .7 Factory fabricate control panels and component assemblies.
- .8 Select materials and equipment in accordance with manufacturer's recommendations and install in accordance with manufacturer's instructions.
- .9 Materials and equipment not satisfying these selection criteria will be condemned.
 - .1 Remove condemned materials from job site and provide properly selected and approved materials.

1.10 Substitutions

- .1 The use of a substitute article or material which the manufacturer represents to be of at least equal quality and of the required characteristics for the purpose intended may be permitted, subject to the following provisions;
 - .1 a substitution will not be considered for reasons of meeting the construction schedule unless the Contractor can demonstrate to the satisfaction of the Consultant that all reasonable efforts have been made to procure the specified product or material in a timely fashion,
 - .2 the manufacturer to advise the Consultant of the intention to use an alternative article or material before doing so,
 - .3 the burden of proof as to the quality and suitability of alternatives to be upon the manufacturer, the manufacturer to supply all information necessary, as required by the Consultant, at no additional costs to the contract,
 - .4 the Consultant to be the sole judge as to the quality and suitability of alternative materials and the Consultant's decision to be final,
 - .5 where use of an alternative material involves redesign or changes to other parts of the Work, the costs and the time required to effect such redesign or changes will be considered in evaluating the suitability of the alternative materials,
 - .6 no test or action relating to the approval of substitute materials to be made until the request for substitution has been made in writing by the manufacturer and has been accompanied by complete data as to the quality of the materials proposed, such request to be made in ample time to permit appropriate review without delaying the Work, taking into consideration that such a substitution request may be rejected requiring that the product or material as originally specified be provided,
 - .7 whenever classification, listing, or other certification by a recognized standards body is a part of the specifications for any material, proposals for use of substitute materials to be accompanied by

reports from the equivalent body indicating compliance with the requirements of the specifications,

- .8 the costs of testing required to prove equality of the material proposed to be borne by the manufacturer.

1.11 Owner's Special Requirements

- .1 Contractor to conform with Owner's Procedure Manual

2 SUBMITTALS

2.1 Shop Drawings and Product Data

- .1 Submit shop drawings, manufacturers and product data and samples in accordance with Section 01 33 05;
 - .1 Submit for each item of equipment.
 - .2 Submit shop drawings in the same unit of measure as used on the drawings. Both metric and imperial measures may be included.
 - .3 Submit shop drawings by email to: shopdrawings@hhangus.com
- .2 Include an H.H. Angus shop drawing cover sheet form prepared for this project, for each shop drawing (sample included at the end of this section), or, include the same information on the contractors submittal cover sheet:
 - .1 Provide the following information on each submission;
 - (a) Client/Architect name
 - (b) Project Name
 - (c) H.H. Angus project number
 - (d) Date
 - (e) Contractor name
 - (f) Contractor reference No.
 - (g) Manufacturer's name
 - (h) Product type
 - (i) Specification section number
 - (j) Contractor trade: mechanical, electrical, elevators, or general trades
 - (k) If a re-submission, the H.H. Angus reference number from the previous submission.
 - .3 Submit shop drawings in PDF format;
 - .1 If submitted in hardcopy format, submit in 11 x 17, black and white originals of graphic quality suitable for photocopying. Allow one additional week for processing of shop drawings submitted in hardcopy format.
 - .4 Manufacturers' printed product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.
 - .5 Submit manufacturers' data sheets with typed schedules listing manufacturers' and suppliers' name and catalogue model numbers for such items as fire alarm system components, etc.
 - .6 For luminaires, submit bound sets of luminaire cut sheets with manufacturers' names and catalogue numbers for all luminaires to be used on the project. Identify and arrange the luminaire cut sheets and catalogue numbers in the same sequence as the Specification Luminaire List.

- .7 Shop drawings and product data to show;
 - .1 CSA or equivalent approval,
 - .2 dimensioned outlines of equipment,
 - .3 dimensioned details showing service connection points.
- .8 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.
- .9 Where applicable, include;
 - .1 wiring, single line and schematic diagrams,
 - .2 diagrams showing interconnection with work of other Sections,
 - .3 equipment elevations,
 - .4 component assemblies,
 - .5 trip settings,
 - .6 description of operation.
- .10 Each shop drawing to be checked and stamped as being correct, by trade purchasing item, before drawing is submitted. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.

2.2 Field, Fabrication, or Installation Drawings

- .1 Contractor's field, fabrication, installation, and/or sleeving drawings will not be reviewed as shop drawings. If submitted as a shop drawing, a transmittal will be returned identifying that the submitted drawings have not been reviewed.
- .2 Maintain a copy on site of such drawings for reference by the Consultant.
- .3 Upon request, provide a copy of such drawings to the Consultant for general information purposes.

3 APPLICABLE CODES AND STANDARDS

- .1 Install electrical systems in accordance with the Electrical Code (ESC).
- .2 Install underground systems in accordance with the latest edition of CSA C22.3 No.7 except where specified otherwise.
- .3 Abbreviations for electrical terms: to the latest edition of CSA Z85.
- .4 Comply with CSA Certification Standards in force at time of Tender submission.
- .5 Where requirements of this specification exceed those of the above mentioned standards, this specification to govern.
- .6 In the event of a conflict between codes, regulations, or standards, or where work shown is in conflict with these documents, obtain interpretation before proceeding. Failure to clarify any ambiguity will result in an interpretation requiring the application of the most demanding requirements.

4 CONFINED SPACES

- .1 Unless otherwise prescribed by the Constructor's/Owner's workplace safety program, treat spaces not designed and constructed for continuous human occupancy as "confined spaces", including but not limited to;
 - .1 horizontal and vertical service spaces, shafts, and tunnels,
 - .2 inside of equipment which permits entry of the head and/or whole body, and
 - .3 ceiling spaces which are identified as containing a hazardous substance.

5 PERMITS, FEES AND INSPECTIONS

- .1 Submit to Electrical Safety Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2 Pay associated fees.
- .3 Consultant will provide drawings and specifications required by Electrical Safety Authority at no cost.
- .4 Notify Consultant of changes required by Electrical Safety Authority prior to making changes.
- .5 Furnish to Consultant, Certificates of Acceptance from Electrical Safety Authority and authorities having jurisdiction, upon completion of the Work.

6 EQUIPMENT

6.1 Manufacturers Nameplates

- .1 Metal nameplate with raised or recessed lettering, mounted on each piece of equipment.
- .2 Manufacturer's nameplate to indicate equipment size, capacity, model designation, manufacturer's name, serial number, voltage, cycle, phase and power rating, and approval listings.

6.2 Finishes

- .1 Primary and final painting for Work, other than items specified as factory primed or finished, to be done under Finish Division 9.
- .2 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .3 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .4 Leave a quart can or a pressurized spray can of paint, as used with switchboards, with Owner for touch-up purposes.
- .5 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.
- .6 Store electrical materials and equipment such as switchboards, panels, transformers, bus ducts, fire alarm devices, luminaires, etc., in a dry, clean location and cover with polyethylene plastic to preserve factory finish.

- .7 Protect exposed or free standing equipment with plastic to minimize entry of dust and dirt and marring of finished surfaces during progress of work.
- .8 Schedule luminaires, lamps, diffusers and fire detectors for installation as late as possible during construction in order to minimize accumulation of dust and/or dirt on them. Clean luminaires and diffusers, not acceptable because of dust and dirt, in an approved manner in accordance with the manufacturer's instructions. Wrap surface mounted and suspended luminaires and fire detectors, installed prior to painting or dusty construction being completed in the area, in plastic to prevent dirt or paint from settling on them.
- .9 Wrap bus ducts in heavy gauge plastic to adequately prevent moisture and dirt from entering bus duct. Wrapping to remain until bus ducts are ready to be energized.

6.3 Pre-purchased Equipment, Damage and Ownership

- .1 At time of receipt of pre-purchased or pre-tendered equipment at job site by the installing electrical contractor, the manufacturer/distributor/supplier's technical representative to be present to inspect the equipment prior to unloading and report any damage to the Consultant. The technical representative to also witness the unloading and advise the Contractor on the appropriate method for handling the equipment in order to avoid damage during unloading, moving and setting in place.
- .2 In the event that the equipment or cable is found to be damaged before unloading it is to be returned immediately to the factory for repairs and/or replacement by the manufacturer/supplier.
- .3 In the event of damage occurring at any time during unloading and until the equipment is accepted by the Owner, the Contractor is responsible for repairs and/or replacement to the satisfaction of the Owner.

7 OFFICE, STORAGE & TOOLS

7.1 Office and Storage

- .1 Provide temporary office and lunchroom facilities, workshop, tools and material storage space. Facilities may be site trailers or as otherwise approved by the General Contractor/Construction Manager.
- .2 Assume responsibility for these facilities.
- .3 Provide power, heat, light, telephone and internet services.
- .4 Owner's cafeteria is off limits.

7.2 Appliances and Tools

- .1 Provide tools, equipment, scaffolding, extension cords, lamps and miscellaneous consumable materials, as required to carry out the Work.

8 COORDINATION

8.1 General

- .1 Consultant's drawings are diagrammatic and illustrate the general location of equipment, and intended routing of ductbanks, conduits, cabletrays, feeders, etc. and do not show every structural detail. In congested areas drawings at greater scale may be provided to improve interpretation of the Work. Where equipment or systems are shown as "double line", they are done so either to improve

understanding of the Work, or simply as a result of the use of a CAD drawing tool, and in either case such drawings are not represented as fabrication or installation drawings.

- .2 Lay out and coordinate the Work to avoid conflict with work under other Divisions.
- .3 Make good damage to Owner's property or to other trade's work caused by inaccurate layout or careless performance of the Work.
- .4 Where equipment provided under other Divisions connects with material or equipment supplied under this Division, confirm capacity and ratings of equipment being provided.
- .5 Take information involving accurate measurements from dimensioned Architectural Drawings or at the building.
- .6 Install services and equipment which are to be concealed, close to the building structure so that furring is kept to minimum dimensions.
- .7 Location of conduit, bus duct, raceways and equipment may be altered without extra cost provided instruction is given or approval is obtained, in advance of installation of items involved. Changes will be authorized by site instructions and are to be shown on Record Drawings.
- .8 Include incidental material and equipment not specifically noted on Drawings or mentioned in Specifications but which is needed to complete the Work as an operating installation.

8.2 Field, Fabrication, and Installation Drawings

- .1 Prepare field, fabrication, and/or installation drawings to show location of equipment and relative position of services and to demonstrate coordination with work of other trades.
 - .1 Drawing scale: minimum 1:50 (1/4"=1'-0")
- .2 Use information from manufacturer's shop drawings for each trade and figured dimensions from latest Architectural and Structural Drawings.
- .3 Layout equipment and services to provide access for repair and maintenance.
- .4 Submit drawings to other trades involved in each area and include note in drawing title block as follows;
 - .1 "This drawing was prepared and circulated for review and mark-up to related subcontractors as noted and initialed in the table below. Corrections and concerns identified through this coordination process have been addressed on this drawing. Areas that incorporate significant changes from layouts shown on Contract Drawings have been circled for Consultants' review."

8.3 Cutting and Remedial Work

- .1 For details of cutting and patching and division of Work refer to Division 1.
- .2 Assume responsibility for prompt installation of work in advance of concrete pouring, masonry, roofing, finishing and similar work. Should any cutting or repairing of either unfinished or finished work be required because such installation was not done, employ the particular trade, whose work is involved, to do such cutting and patching. Pay for any resulting costs.
- .3 Neatly cut or drill holes required in existing construction to accommodate equipment such as cables, raceways, bus ducts, cabletrays, etc.

- .4 Arrange and pay for cutting and patching as required for the Work. Before cutting, drilling, or sleeving structural load bearing elements, obtain the Consultant's approval of location and methods in writing. For weather exposed or moisture resistant elements or sight exposed surfaces, employ the original installer or an expert in finishing of the material, to perform cutting or patching.
- .5 Layout cutting of structural elements, such as floor slabs, walls, columns or beams and obtain approval before starting work. Conduct an electromagnetic scan for reinforcing rods, such as Hilti PS200 Ferrosan, and review with the Structural Engineer.
- .6 Arrange and pay for supplemental 3 dimensional ground penetrating radar scans to locate concrete reinforcement, conduits and other embedments. Submit and review scan results with the Consultant and obtain the Consultant's comments before starting work.
- .7 Relocate core drilling location if steel, conduit or other embedment is found in the proposed location and repeat procedure. Repair and reroute any circuits damaged by core drilling.

8.4 Voltage Ratings

- .1 Operating voltages: to latest edition of CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

8.5 Wiring of Mechanical Trades Motors

- .1 To limit responsibility and to specifically define the Work under this Division, use the following procedure with regard to motors provided under Mechanical Division 20.
- .2 The Contractor under Mechanical Division 20 will be responsible for installing equipment which he supplies including motors, starters, disconnect switch, Motor Control Centres, "mechanical" panelboards and miscellaneous controls of the type specified.
- .3 In every instance whether pertaining to Plumbing, Air Conditioning, Refrigeration, Heating or Ventilating equipment, wire to line side of the Motor Control Centre, panelboard, disconnect switch, or starter provided by these trades, in reasonable proximity to equipment being controlled.
- .4 From this point, unless otherwise noted, the cost of electrical material and labour will be borne by the particular trade whose work is involved. That trade will mount starter and wire from it to motor being controlled, together with control wiring, remote switches, and pilot lights.
- .5 Where individual starters and controls are grouped together, the Contractor under Mechanical Division 20 will provide a panel for mounting his equipment. Provide a feeder, main fused disconnect switch, a splitter of adequate size and capacity, individual fused disconnect switches, and wire to line side of the Division 20 starters.
- .6 In the case of unit heaters, reheat coils, electrical control devices, and cabinet unit heaters, terminate wiring in an outlet immediately adjacent to motor or device being electrically powered. Wiring from this point to starter, thermostat, or other devices will be done under Mechanical Division 20.
- .7 Provide branch circuit wiring and an outlet for each motorized damper or heating control.
- .8 Ascertain exact locations of starters, Motor Control Centres, "mechanical" panelboards and motors, from Mechanical Drawings.

- .9 Motors up to and including 0.25 kW (1/3 HP) to be 120 volt, 60 Hz, single phase.
- .10 Motors 0.37 kW (½ HP) and above to be 3 phase, 60 Hz, voltage as noted.

9 PROTECTION OF PERSONNEL, WORK, AND PROPERTY

9.1 Personnel Protection

- .1 Protect exposed live equipment during construction for personnel safety.
- .2 Shield and mark live parts "LIVE 120 VOLTS", or with appropriate voltage.
- .3 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.
- .4 Do not leave conduit, wires, cables, tools, equipment or materials in such a way that they constitute a hazard.
- .5 Provide guards around openings in the roof or floor to prevent stock or scrap from dropping down.
- .6 Remove loose equipment and tools from overhead areas before leaving each day.
- .7 Do not leave boards with protruding nails on the floor.
- .8 Cut off bolts at floor level to eliminate a possible tripping hazard.

9.2 Protection During Construction

- .1 Provide protection required to enable existing building and equipment to remain in continuous and normal operation.
- .2 Take the necessary precautions to protect equipment, existing building and service from damage during the Work. Accept responsibility for any damage and make good without cost to the Owner.
- .3 It is of vital importance, during work of this Contract, that all existing surfaces and items are not damaged in any way whatsoever by the work of all trades. Take precautions as necessary to prevent damage to walls, floors, ceilings, windows, doors, door frames, mouldings, finishes, piping, ductwork, light fixtures, etc. Provide protection, hoarding, tarpaulins, dust sleeves etc., as required. Any damage caused because of lack of adequate protection to be made good at no cost to the Owner.
- .4 Take care when working above or around switchgear as this equipment must remain in service.
- .5 Take care to eliminate dust in equipment areas.
- .6 Protect switchgear fronts from accidental breaker trips when working around or above them. Provide an extended shield constructed of 12 mm (½") fire retardant plywood a minimum of 450 mm (18") from board front to allow access to board.

9.3 Core Drilling

- .1 Wherever core drilling is required, provide temporary dust proof screens.

- .2 In areas where core drilling through a slab in an operating facility is necessary, the areas to be drilled to be marked out clearly on the underside of slab. Owner's representative to be notified at least 1 week prior to core drilling operation. Provide tarping of equipment supervised by the Owner.
- .3 During core drilling operations, station at least one person directly below the area of drilling with a large plastic container pressed to underside of slab to capture and hold core and water upon completion of operations.
- .4 A wet/dry commercial quality vacuum to be used continuously at location of drilling operation to remove all excess water from the area.

9.4 Infection Control Procedures

- .1 Conform with Specification Section 01 35 33 Infection Control Procedures.

9.5 Protection of Floors During Equipment Installation

- .1 Provide protection of floor finishes during installation or removal of equipment, and at any other time when moving or installing heavy equipment.
- .2 Install 19mm (¾") plywood over 6 mil plastic over finished floor areas when moving heavy equipment that could damage floor finish.
- .3 Repaint or re-tile any floors or walls damaged or scratched during construction.

9.6 Housekeeping

- .1 Maintain a high level of cleanliness.
- .2 Remove scrap and refuse from the work area daily.
- .3 Whenever possible, clean up immediately following completion of work.
- .4 Deposit oily and waste solvent rags in approved containers to minimize the fire hazard.
- .5 Sweep and damp mop daily.

10 WORK IN EXISTING BUILDING

10.1 General

- .1 During the tender period, perform a site inspection of the place of work and surroundings including the accessible ceiling spaces and other areas where access could be considered reasonable. Make a thorough investigation of the as built conditions to determine the scope of renovation and demolition work required prior to submitting a tender.
- .2 The Work includes changes to the existing building and changes at junction of old and new construction. Route cabling, ducts, conduits and other services to avoid interference with existing installation.
- .3 Core drilling to be done evenings after 7:00 pm., or on weekends and holidays. Coordinate with Owner.
- .4 Relocate existing pipes, ducts, conduits, bus ducts and any other equipment or services as necessary to accommodate the Work.

- .5 Maintain or relocate existing services which pass through the area of renovation or demolition, but which feed items located outside of these areas. Rewire devices to the original circuits.
- .6 Remove existing lighting fixtures, wiring, devices and equipment to suit new construction. Cut back and cap conduits and electrical outlets not being used, so that finished work presents a neat and clean appearance. Disconnect at point of electrical supply, remove obsolete wiring and conduits, and make existing systems safe. Blank off openings in panels or boxes created by the removal of cables, conduits, wireways or ducts.
- .7 Where an existing ceiling is to be removed and reinstalled or replaced under another trades scope of work, and the existing electrical items such as luminaires, fire detectors, speakers, exit signs, emergency lighting heads etc., are to be reused, provide the following regarding the electrical items:
 - .1 remove,
 - .2 store in a secure, clean, dry location,
 - .3 install in the new ceiling, extend wiring and raceways as necessary,
 - .4 provide new items to match existing where existing items have been lost or damaged,
 - .5 make connections,
 - .6 clean,
 - .7 relamp luminaires,
 - .8 test,
 - .9 verify fire alarm devices,
 - .10 replace defective items with new, then retest/reverify,
 - .11 submit test and verification reports.
- .8 Unless noted otherwise removed materials and equipment become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .9 Review removed luminaires and equipment with the Owner's representative, and if the Owner instructs they wish to keep any items, move them to a designated location on the site. Luminaires and equipment that the Owner does not want become the property of the Contractor and are to be taken from the site and disposed of appropriately.
- .10 For devices, fixtures and equipment to be relocated, provide junctions boxes, outlet boxes, wiring, plates, supports, etc., as necessary.
- .11 Revise panelboard directories accordingly if affected by the Work.
- .12 Clean and relamp relocated luminaires and replace any faulty ballasts.
- .13 On completion of relocations, confirm that relocated devices and luminaires are in proper working order.
- .14 Co-ordinate work affecting fire alarm system, fire safety, or protection systems with the Owner, Consultant, fire alarm system manufacturer and authorities having jurisdiction prior to commencing work. Retain the original fire alarm system manufacturer to verify relocated fire alarm devices, modified equipment and revised wiring. Provide temporary fire protection and/or a fire watch in all areas affected by the demolition and as required by authorities having jurisdiction.
- .15 Where the Owner wishes to take over renovated areas ahead of the project completion date and these areas are intended to be fed from the distribution systems in the new building, make temporary

connections to the existing services in these areas. Reconnect to permanent services at a later date, when the new distribution systems are available.

10.2 Continuity of Services

- .1 Keep existing buildings in operation with minimum length of shutdown periods.
- .2 Make connections to existing systems at approved times.
- .3 Obtain written approval, recording times when connections can be made.
- .4 Repair any damage caused to existing systems when making connections.
- .5 Provide premium time labour to tie-in feeders or wiring at night or on weekends.
- .6 Provide temporary feeders and connections as required to maintain systems in operation where shutdown periods will exceed 4 hours, or extend beyond the allowable time frame determined by the Owner.
- .7 Arrange the Work so that physical access to the existing buildings is not unduly interrupted.

11 MOVING AND SETTING IN PLACE OWNER'S EQUIPMENT

11.1 S.B.O. (Supplied by Owner)

- .1 Items marked SBO on drawings will be;
 - .1 purchased by Owner,
 - .2 received, checked, stored, unpacked, uncrated, assembled and located by the Contractor under Division 1
- .2 Connect electrical services to this equipment.

11.2 E.R. or Ex. Rel. (Existing Relocated) or otherwise so identified

- .1 Except as indicated below, items so marked on drawings will be moved from their present location and reinstalled by the Contractor under Division 1. Disconnect and reconnect electrical services to accommodate the relocation of this equipment.
- .2 Disconnect, remove, store as necessary, move into place, reinstall, clean and reconnect electrical items so marked, such as;
 - .1 luminaires,
 - .2 fire detectors,
 - .3 speakers,
 - .4 switches,
 - .5 receptacles,
 - .6 disconnects,
 - .7 splitters,
 - .8 transformers,
 - .9 etc.

12 FINAL CLEANING

12.1 General

- .1 Do final cleaning in accordance with Section 01 74 23.
- .2 Perform final cleaning after construction activities, that create dust, have been completed.
- .3 Clean electrical equipment and devices installed as part of this project.
- .4 Clean lighting reflectors, lenses, and other lighting surfaces that have been exposed to construction dust and dirt, including the top surface, whether exposed or in the ceiling space.
- .5 Clean switch, receptacle, and communications outlets, coverplates, and exposed surfaces.
- .6 Clean and vacuum any smoke detectors exposed to construction dust, do not use compressed air.
- .7 Electrical rooms, and electrical or communication closets:
 - .1 Thoroughly vacuum and clean interiors and buswork of switchboards, panels, cabinets and other electrical equipment of construction debris and dust prior to energization using a HEPA vacuum cleaner. Final clean using clean lint free cloths with a cleaning liquid as recommended by the manufacturer for the purpose.
 - .2 HEPA vacuum the top of switchboards, panels, cabinets, bus ducts, cable trays and conduits, and mechanical duct work in the room, followed by a thorough HEPA vacuuming of the floors. Thoroughly wash floors with wet mop and clean water. Control access to the room after cleaning. Provide temporary filter media on air supply ducts to these rooms to prevent re-contamination from other areas of construction.
 - .3 Thoroughly re-clean as necessary prior to final turn over.
 - .4 Do not lay permanent switchboard matting in electrical rooms until rooms are thoroughly re-cleaned, and floors wet mopped and dried, immediately prior to final turn over.

13 RECORD DRAWINGS

13.1 AS-built Drawings

- .1 Prior to testing, balancing and adjusting, transfer site record drawing information to AutoCad 2013 (CAD) files, to record final as-built condition. Obtain a current set of CAD files from the Consultant.
 - .1 Follow the Consultants AutoCad Standards. Do not alter drawing scales, X-refs, colours, layers or text styles.
 - .2 The Consultant's CAD files might not reflect all or any construction changes.
- .2 Where items have been deleted, moved, renumbered or otherwise changed from contract drawings, revise the CAD files to record these changes. "Bubble" these revisions, and place these annotations on a separate and easily identified drawing layer.
- .3 Show on electrical as-built drawings final locations of conduit, outlets, panels, branch wiring, system wiring, pull boxes, bus ducts, and equipment.
- .4 Show on site services as-built drawings survey information provided by the British Columbia Land Surveyor (ABCLS) monitoring the services installation.

- .5 Identify each drawing in lower right hand corner in letters at least 12 mm (1/2") high as follows "AS-BUILT DRAWINGS. This drawing has been revised to show systems as installed" (Signature of Contractor) (Date). The site services drawings are to include signature and stamp of ABCLS attached to note.
- .6 Submit one (1) set of white prints of the draft as-built CAD files for the Consultant's review.
- .7 Once "AS BUILT DRAWINGS" white prints are reviewed, transfer Consultant's comments to the CAD files. Return AutoCad drawings modified to "As Built" condition to Consultants on CD or DVD ROM.
- .8 Submit three (3) sets of white prints and three (3) copies of CAD files with Operating and Maintenance Manuals.

14 OPERATING AND MAINTENANCE INSTRUCTIONS

14.1 Operating and Maintenance Data

- .1 Provide operation and maintenance data bound in 210 mm x 300 mm x 50mm thick (8 1/2 in x 11 in x 2 in thick) size, vinyl covered, hard back, three-ring covers.
 - .1 Organize material in volumes generally grouped by Division Section;
 - (a) Power,
 - (b) Lighting,
 - (c) Low Voltage Systems,
 - (d) Fire Alarm and Security.
 - .2 Title sheet in each volume to be labeled "Operating and Maintenance Manual" and to bear;
 - (a) Project Name,
 - (b) Project Number,
 - (c) Date,
 - (d) Trade Section, and
 - (e) List of Contents.
 - .3 Provide three hard-copies to Owner.
- .2 In addition, provide Adobe PDF files for each document, produced from original direct-to-digital file creations.
 - .1 Organize documents into separate PDF files for each Division Section identified above, and apply Adobe Bookmarks to create Table of Contents.
- .3 Include in operations and maintenance data;
 - .1 details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation,
 - .2 technical data, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists; advertising or sales literature not acceptable,
 - .3 wiring and schematic diagrams and performance curves,
 - .4 names and addresses of local suppliers for items included in maintenance manuals,
 - .5 reviewed shop drawings,
 - .6 operating characteristics of the equipment supplied such as calibration curves and coordination data to allow proper co-ordination with Owner's equipment,
 - .7 description of operation of the controls and protective devices used,
 - .8 maintenance and adjustment procedures,

- .9 lifting and jacking instructions,
 - .10 fault locating guide,
 - .11 spare parts list and an itemized price list,
 - .12 name and telephone numbers of service organization and technical staff that will provide warranty service on the various items of equipment.
- .4 Approval procedure;
- .1 submit one set of first draft of Operating and Maintenance Manuals for approval,
 - .2 make corrections and resubmit as directed,
 - .3 review contents of Operating and Maintenance Manuals with Owner's operating staff or representative to ensure thorough understanding of each item of equipment and its operation,
 - .4 hand-over an additional two copies of Operating and Maintenance Manuals to Owner's operating staff and obtain written confirmation of delivery.

14.2 Operating and Maintenance Instructions

- .1 Provide instructions to Owner's operations staff to thoroughly explain operation and maintenance of each system, incorporating specialized instruction by manufacturers as described under other Sections. Include classroom instruction and hands-on instruction, delivered by competent instructors.
- .2 Develop the proposed training plan, submit an outline of the training program for review and adjustment by the Owner. Obtain approval from the Owner before commencing training.
- .3 Structure each session to start with the classroom instruction for the overall system, followed by hands-on instruction for each item of equipment, utilizing the services of the manufacturers' representative as required.
- .4 Organize and schedule each training session to deliver the required instruction in an efficient and effective manner on a schedule agreed upon with the Owner. Repeat each training session approximately one week after the original session.
- .5 Organize each pair of training sessions as follows:
 - .1 Power Distribution - Emergency Power- Division 26
 - .2 Communications – Division 27
 - .3 Electronic Safety and Security – Fire Alarm – Division 28
- .6 Complete the training as close to Substantial Performance as possible, so that the operations staff are prepared to operate the systems after Substantial Performance is certified.
- .7 Keep a record of date and duration of each instruction period together with names of persons attending. Submit signed records at completion of instruction.
- .8 For each training session, include the following topics;
 - .1 general purpose of the system (design intent),
 - .2 use of O & M manuals,
 - .3 review of single line drawings and control schematics,
 - .4 start-up, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control set-up and programming, troubleshooting and alarms,

- .5 interaction with other systems,
 - .6 adjustments and optimizing methods for energy conservation,
 - .7 maintenance requirements,
 - .8 special maintenance and replacement sources,
 - .9 health and safety issues,
 - .10 occupancy interaction issues, and
 - .11 system response to different operating conditions.
- .9 Develop and provide training material, including printed documents and electronic presentation aids (e.g. MS PowerPoint) for each session. Submit three (3) copies of materials in both hardcopy and electronic format, in accordance with article on Operating and Maintenance Manuals.
- .10 Sessions may be videotaped by the Owner as an aid to ongoing training of Owner's staff.

15 CARE, OPERATION AND START-UP

- .1 Arrange and pay for services of manufacturer's factory service technicians to supervise start-up of installation, check, adjust, balance and calibrate components.
- .2 Provide these services for such periods, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with every aspect of the operation, care and maintenance thereof.
- .3 Arrange and pay for services of applicable manufacturer's factory service engineer or certified independent testing organization to supervise initial start-up of specialized portions of installation and to check, adjust, balance and calibrate components including related wiring and controls. Provide these services for such periods, and for as many visits as may be necessary to put applicable portion of the installation in complete working order. Provide a certificate indicating that the equipment is free and clear of deficiencies.

16 TESTING

- .1 Conduct and pay for the following tests;
 - .1 power distribution system including phasing, voltage, grounding and load balancing,
 - .2 circuits originating from branch distribution panels,
 - .3 lighting and its control,
 - .4 motors, heaters and associated control equipment including sequenced operation of systems where applicable,
 - .5 systems: fire alarm system, communications,
 - .6 additional testing as specified in other Sections.
- .2 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.
- .3 Insulation resistance testing;
 - .1 megger circuits, feeders and equipment up to 350 V with a 500 V instrument,
 - .2 megger 350-600 V circuits, feeders and equipment with a 1000 V instrument,
 - .3 check resistance to ground before energizing.

- .4 Carry out tests in presence of Consultant.
- .5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .6 Submit test results for Consultant's review. Test electrical equipment to standards and function of specifications, applicable codes and standards in an approved manner. Replace defective equipment and wiring with new material and leave entire system in complete first class operating condition.

17 LOAD BALANCE

- .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes. Revise circuit labelling as appropriate.
- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Submit, at completion of work, report listing phase and neutral current on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

18 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as per equipment manufacturers' recommendations for each piece of equipment.

19 TEMPORARY AND TRIAL USAGE

19.1 General

- .1 Temporary and trial usage by Owner of any electrical device, machinery, apparatus, equipment or any other work or materials before final completion and written acceptance, is not to be construed as evidence of acceptance by the Consultant.
- .2 Owner to have the privilege of such temporary and trial usage, as soon as the Contractor claims that said work is completed and in accordance with specifications, for such reasonable length of time as is deemed to be sufficient for making a complete and thorough test of same.
- .3 No claims will be considered for damage to or failure of any parts of such work so used which may be discovered during temporary and trial usage, whether caused by weakness or inaccuracy of structural parts or by defective materials or workmanship of any kind whatsoever.

20 PRICING OF CHANGE NOTICES

- .1 The value of a proposed change in the work shall be determined in one or more of the following methods;
 - .1 by time and material,
 - .2 by unit prices set out in the Contract or subsequently agreed upon,
 - .3 by labour and material costs submitted in a detailed quotation.
- .2 In the case of changes in the Work to be paid for under the time and material or the unit price methods, the form of presentation of costs and methods of measurement shall be agreed to by the

Consultant and Contractor before proceeding with the change. Keep accurate records, as agreed upon, of quantities or costs and present an account of the cost of the change in the Work, together with vouchers, material receipts and invoices where applicable.

- .3 In the case of changes in the Work to be paid for under the time and material or the labour and material method, the material costs are to be less trade discounts. Provide a 20% discount from list price for items included in the Allpriser catalogue or Electrical Price Guide.
- .4 The detailed quotation referenced under the labour and material method is to include a summary of charges made up of three components: labour charges, material costs and fees.
 - .1 Labour Charges
 - (a) The labour hour estimates are to be based on the current NECA Column 2 manual of labour units.
 - (b) Labour costs are to include burden on wages such as taxes, worker compensation charges, CPP, EI, project insurance, safety meetings, estimating, as-built drawings, supervision, small tools, site facilities, labour warranty and clean up.
 - (c) The all inclusive hourly labour rate applicable for quotations submitted for changes to the work is 1.34 times the TOTAL PACKAGE RATE of the current Collective Agreement. The hourly labour rate for specialists not governed by union agreements (technicians or engineers) is 1.6 times the TOTAL PACKAGE RATE for electricians, plumbers or pipe fitters.
 - (d) The all inclusive hourly labour rate indicated above is to include:
 - Collective Agreement relevant to the place of work (vacation pay, RRSP, Health & Welfare, RST of Health & Welfare, Pension, Union admin fund, ECA fund (or others), Secretariat.
 - Legislation as relevant to the place of work (Emp. Health Tax, E.I., CPP, WSIB, taxes)
 - Project insurance, safety meetings, estimating, lay outs, site facilities, warranties, storage,
 - clean up, office supervision and miscellaneous charges.
 - (e) Foreman Electrician, General Foreman, Superintendent rates shall be as for the calculated Journeyman rate above plus 10.6% of the TOTAL PACKAGE RATE. A maximum of 10% of the total calculated journeymen hours on a change may be charged as overhead supervision hours at the Foreman rate.
 - (f) A maximum combined amount of 3% of the total calculated journeymen hours on a change may be charged as overhead supervision hours at the General Foreman/Superintendent rate.
 - (g) No other overhead supervision hours will be permitted.
 - .2 Material Charges
 - (a) Material costs are to be less trade discounts. Provide a 20% discount for items included in the Allpriser catalogue or Electrical Price Guide.
 - .3 Fees
 - (a) The overhead and profit fee is to include for the Contractor's head office and site office expenses, project manager, assistants, site office and storage facilities, utility charges, site security, telephone and facsimile transmission costs, as built, expendable small tools, financing costs, coffee breaks, site facilities, general clean up and disposal, security, storekeeper, and all other non-productive labour.
 - (b) The Contractor is allowed a combined overhead and profit fee of 10% for work to be performed by his own forces.
 - (c) The Contractor is allowed an overhead and profit fee of 5% for work performed by a Sub-Contractor.
 - (d) A Sub-Contractor is allowed an overhead and profit fee of 10% for work performed by a Sub-Subcontractor.

21 CONSULTANT REVIEWS

21.1 General

- .1 Consultant's attendance at site including but not limited to site meetings, demonstrations, site reviews and any resulting reports are for the sole benefit of the Owner and the local authority having jurisdiction.

21.2 Site Reviews

- .1 General reviews and progress reviews do not record deficiencies during the course of the Work until such time as a portion or all of the work is declared complete. In some instances before the work is completed, deficiencies may be recorded where the item is indicative of issues such as poor workmanship, incorrect materials or installation methods, or may be difficult to correct at a later date. Do not use any such reported items, or lack thereof, as part of the project quality assurance program nor as a change to the scope of work nor as acceptance of the quality of the work.
- .2 Deficiency reviews conducted by the Consultant are performed on a sampling basis, and any deficiency item is to be interpreted as being indicative of similar locations elsewhere in the Work, unless indicated otherwise.

21.3 Milestone Reviews

- .1 Specific milestone reviews may be conducted at key stages by the Consultant, including;
 - .1 before backfilling of buried services,
 - .2 before closing of shafts,
 - .3 before closing of walls,
 - .4 before closing of ceilings,
 - .5 equipment demonstration,
 - .6 Substantial Performance deficiency review,
 - .7 Total Performance deficiency review.
- .2 Coordinate with the Consultant the type and quantity of milestone reviews required and incorporate these requirements into the construction schedule.
- .3 Prior to Work being concealed, notify the Consultant in writing seven (7) calendar days in advance of the planned concealment to arrange a site review, where required by the Consultant. Correct noted deficiencies before concealing the Work. Failure to provide notification can result in the Work being exposed for review at the Contractor's cost.

21.4 Final Review

- .1 At project completion submit written request for final review of mechanical and electrical systems.
 - .1 Refer to section 26 08 19 Project Close-Out.
- .2 Include with the request a written certification that;
 - .1 deficiencies noted during job inspections have been completed,
 - .2 systems have been balanced and tested and are ready for operation,
 - .3 completed maintenance and operating data have been submitted and approved,

- .4 tags are in place and equipment identification is completed,
- .5 cleaning is finished in every respect,
- .6 electrical panels, switchboards, cabinets, and equipment surfaces have been touched up with matching paint, or re-finished as required,
- .7 spare parts and replacement parts specified have been provided and receipt acknowledged,
- .8 As-built and Record drawings are completed and approved,
- .9 Owner's operating personnel have been instructed in the operation and maintenance of systems,
- .10 fire alarm verification is 100% completed and Verification Certificate has been submitted and accepted.

22 CORRECTION AFTER COMPLETION

22.1 General

- .1 At completion, submit written guarantee, undertaking to remedy defects in work for a period of one year from date of substantial completion. This guarantee is not to supplant other guarantees of longer period called for on certain equipment or materials.
- .2 Guarantee to encompass replacement of defective workmanship, parts, materials or equipment, and to include incidental fluids, gaskets, lubricants, supplies, and labour for removal and reinstallation work.
- .3 Submit similar guarantee for one year from date of acceptance for any part of work accepted by Owner, before completion of whole work.

23 ATTACHEMENTS

23.1 Shop Drawing Submittal Form

- .1 Attached sample of shop drawings submittal form.



1127 Leslie Street,
Toronto, Ontario
M3C 2J6 Canada

SHOP DRAWING SUBMITTAL

***Include this cover page with each shop drawing submission.
Submissions without this form will be returned without review.
Submit one submittal form per shop drawing; do not group under one submittal sheet***

Client/Architect: [Client/Architect name]

Project Name: [Project name]

HHA Project No: [HHA Project No]

Contractor to complete the following for each submission.

Date: _____

Contractor Name: _____

Ref No: _____

Manufacturer Name: _____

Product Type: _____

Specification Section No: _____

Contractor Trade:

Mechanical

Electrical

Elevators

General Trades

If this is a resubmission, check here:

Previous submission HHA reference no.: _____

HHA distribution - for internal use only:	
Mechanical review:	[Mechanical designer name]
Electrical review:	[Electrical designer name]
Elevators review:	[Elevator designer name]

Document1

END OF SECTION

Issued For Construction

ELECTRICAL BASIC MATERIALS AND METHODS

26 05 01

1 GENERAL

1.1 Scope

- .1 Articles that are of a general nature, apply to each Section of Divisions 26, 27 and 28.

1.2 Work Included

- .1 Work to be done under this section to include furnishing of labour, materials, equipment and services required for installation, testing and putting into proper operation complete electrical systems as shown, as specified, as intended, and as otherwise required. Complete systems to be left ready for continuous and efficient satisfactory operation.

2 ACCESS DOORS

2.1 Construction:

- .1 Access doors, unless shown or specified otherwise:
 - .1 constructed from galvanized steel sheet,
 - .2 flush mounted,
 - .3 concealed hinges,
 - .4 180° opening door,
 - .5 round safety corners,
 - .6 anchor straps,
 - .7 plaster lock,
 - .8 screwdriver operated latches,
 - .9 without visible screws,
 - .10 finished prime coat only.
- .2 Door metal thickness as follows:
 - .1 up to and including 400 x400 (16" x 16"): 1.6 mm (16 gauge)
 - .2 height or width larger than 400 (16"): 2 mm (14 gauge)
- .3 Constructed of stainless steel with neoprene gasketed door where used in damp and high humidity areas.
- .4 Dish type door design to receive a tile insert where acoustic tile is applied to plaster or gypsum board ceilings.
- .5 Fire rated where installed in fire rated walls or ceilings. Fire rating to match the rating of the wall or ceiling.
- .6 With keyed cylinder locks, keyed alike, for areas subject to security risks, EG;
 - .1 public corridors,
 - .2 public washrooms,

- .3 etc.
- .7 Inside clear dimensions:
 - .1 approximately 400 mm x 400 mm (16" x 16") for hand access,
 - .2 at least 600 mm x 600 mm (24" x 24") where personnel are to enter through doors,
 - .3 larger where indicated or required.
- .8 Submit access door shop drawings for approval as soon as possible after award of contract, showing size, type and exact location of access doors.

Standard of Acceptance

- Acudor
- Cendrex (up to 400 x 400 only)
- Elmdor (up to 400 x 400 only)
- Mifab (up to 400 x 400 only)
- Nystrom
- Williams Brothers – GP

2.2 Installation

- .1 Provide access doors for locations where equipment requiring access, maintenance or adjustment is "built-in".
- .2 Submit a list of proposed access door locations and obtain approval before commencing installation.
- .3 Access doors to be installed under the Division in whose work they occur. Arrange for and pay cost of access doors and their installation.
- .4 Access doors are not required in removable acoustic panel type ceilings.
- .5 Size and locate access doors in applied tile, or in glazed or unglazed structural tile to suit tile patterns. Refer to Architectural Room Finish Schedule and details on Architectural drawings in this regard.

3 SLEEVES AND CURBS

3.1 Materials:

- .1 Sleeves for bus ducts, wireways and cable trays: minimum 3 mm (1/8") galvanized steel.
- .2 Integral flashing clamp on sleeves that pass through floors with a waterproof membrane.
- .3 Removable (non fire rated) sealing material: Duxseal or acceptable alternative.
- .4 Fire rated sealing material: per Article "Fire Stopping and Smoke Seals".

3.2 Installation

- .1 Provide sleeves for bus ducts, wireways, conduits and cable runs passing through;
 - .1 concrete walls, beams, slabs and floors,
 - .2 fire rated walls, partitions and ceilings.
- .2 Place and secure sleeves in concrete form work.

- .3 Supply sleeves to be set in concrete and masonry walls with installation detail drawings.
- .4 Terminate sleeves flush with surfaces of concrete and masonry walls.
- .5 Extend sleeves 100 mm (4") above finished floor.
- .6 Size sleeves to accommodate fire stopping materials where required.
- .7 Make watertight connections between sleeves and waterproof membranes.
- .8 Fill any spaces between sleeves and masonry walls;
 - .1 with non-shrink grout,
 - .2 with a rated fire stopping material for rated walls.
- .9 Seal spare sleeves and the space between sleeves and the through conduits, cables, wireways, bus ducts etc;
 - .1 using removable sealing material,
 - .2 using a rated fire stopping material for floors and rated walls,
 - .3 seal watertight where sleeves penetrate a floor slab.
- .10 Sleeves in existing concrete and masonry walls and floors;
 - .1 cutting and drilling of structural elements, such as floors, slabs, walls, columns, or beams to be carried out in accordance with procedure set out in Article "Cutting and Remedial Work" in Section "Electrical General Requirements",
 - .2 neatly cut or drill holes in existing construction,
 - .3 terminate sleeves flush with surfaces of concrete and masonry walls,
 - .4 extend sleeves 100 mm (4") above finished floor with flange, countersunk, and bolted down flush into floor surface,
 - .5 fill opening between sleeve and wall;
 - (a) with non-shrink grout,
 - (b) with a rated fire stopping material for rated walls.
 - .6 fill opening between sleeve and floor with rated fire stopping material with water barrier,
 - .7 seal as indicated above.
- .11 Size concrete curbs for bus ducts to provide sufficient area to adequately carry bus duct support brackets.
- .12 Size openings to accommodate fire stopping materials as required.

4 FIRE STOPPING AND SMOKE SEALS

4.1 General

- .1 Maintain the integrity of floor and wall, fire separations and smoke seals, around EMT, conduits, electrical raceways, cables, bus ducts, boxes and any other electrical equipment passing through rated floors or walls.

Materials

- .2 Materials to form ULC or cUL listed/classified assemblies.

- .3 Materials to meet requirements of CAN/ULC-S115 "Standard Method of Fire Tests of Firestop Systems".
- .4 Firestop system rating: minimum 2 hrs., higher where indicated.
- .5 Materials installed in horizontal separations to be impervious to water.
- .6 Submit shop drawings consisting of product technical data and ULC or cUL listing.

Standard of Acceptance

- Hilti Firestop Systems
 - 3M
 - A/D Fire Protection System Inc.
 - Eastern Wire + Conduit
- .7 Other manufacturers having products with explicitly similar characteristics, listings or classifications and approvals are acceptable.

4.2 Installation:

- .1 Submit a complete fire stopping and smoke seal schedule to the Consultant for review. Include details, cut sheets, system description and location for each proposed fire stopping and smoke sealing application.
- .2 Install firestopping and smoke seals in accordance with the manufacturer's recommendations and in accordance with the ULC or cUL listing.
- .3 Firestopping and smoke seals to be installed only by personnel trained by the manufacturer on the installation of such systems.
- .4 Firestop and smoke seal system manufacturer's training and inspection services:
 - .1 Provide the services of the manufacturer to provide training to trades performing the fire stopping. Create and maintain a log of those personnel who obtain training.
 - .2 Provide the services of the manufacturer to inspect the installation while in progress and a final inspection at completion of work. Provide a manufacturer's inspection report to the Owner and Engineer.
- .5 Seal space between penetrating service and sleeve or opening in fire rated floors and walls with a fire stopping and smoke sealing system.
- .6 At time of application of materials, surfaces to be clean, dry and free from dust, oil, grease, loose or flaking paint, loose concrete or masonry and foreign materials.
- .7 Wiring may penetrate a fire rated assembly provided it is enclosed in non-combustible conduit, and the passage of the conduit in turn is suitably sealed to the assembly with fire stop and smoke sealing materials.
- .8 Where wiring with a combustible covering and not enclosed in non-combustible conduit penetrates a fire resistance rated assembly, group the wiring into separate fire and smoke sealed penetrations to ensure the overall diameter of the combined wire(s) in each penetration does not exceed 25 mm.
- .9 Arrange single conductor metal sheathed cables to individually penetrate the fire rated assembly and be individually fire stopped and smoke sealed.

- .10 Where wiring is installed in cable trays and penetrates a fire rated assembly;
 - .1 terminate and independently support the cable tray on each side of the fire rated assembly, and
 - .2 provide sufficient working room to properly install and inspect the fire stopping and smoke sealing materials.
- .11 Smoke seal and fire stop electrical boxes that penetrate a fire rated wall using fire rated putty pads, install putty pads on the outside of boxes.
- .12 Smoke seals and fire stopping in horizontal separations to be watertight with sleeves terminating not less than 100mm (4") above the finished floor.
- .13 Co-ordinate installation of cast-in-place fire stopping devices with the Division responsible for the placement of concrete.

5 SPRINKLER PROTECTION

5.1 Materials

- .1 Surface panelboards, switchboards and other electrical equipment in sprinklered areas to be fitted with watertight hubs with insulated throat, for each conduit entrance.
 - Standard of Acceptance*
 - Thomas & Betts Ltd. - Series 401
 - Efcor of Canada Ltd. - Series 40-50B
- .2 Provide equipment in sprinklered areas, with hoods or shields and gasketed doors for protection against entry of sprinkler discharge, and to comply with the requirements of the electrical code, alternatively, and where indicated, provide indoor weatherproof equipment.
- .3 Ventilation openings to be overhanging drip proof type.
- .4 Indoor weatherproof equipment, where noted in the specifications and/or drawings to have CSA type 3R enclosures in accordance with the requirements of CSA Standard C22.2 No. 94.

6 EQUIPMENT SUPPORTS, AND BASES

6.1 Supports for electrical work

- .1 Equipment supplementary supports to be provided by General Trades.
- .2 Concrete housekeeping bases for electrical equipment to be provided by this Division.
- .3 Work to be done by firms specializing in these fields.

6.2 Supplementary supports and support brackets:

- .1 Fabricated from structural grade steel with anchor bolts and fastenings.
- .2 Designed in consultation with building structural consultant to transfer live loads and dead loads to building structural elements.
- .3 Constructed as frames bracketed from walls, and/or supported from building structure above, and/or floor below.

6.3 Installation - General

- .1 Locate supporting steel to permit service or repair, and to allow clear access to junction boxes and equipment.
- .2 Set equipment on supporting frames and brackets and install hangers, anchor bolts, and vibration mountings.
- .3 Install anchor bolts, and vibration mountings between equipment and housekeeping pad.
- .4 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .5 Provide anchorage, dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .6 Make field connections with bolts to CAN/CSA-S16.1, or weld.
- .7 Supply items for casting into concrete or building into masonry to appropriate trades together with setting templates.
- .8 After completion of erection, touch-up field welds, bolts and burnt or scratched surfaces with primer.
- .9 Where gratings or trench covers are cut in field or damaged, touch up with zinc rich paint.

7 GENERAL WIRING REQUIREMENTS

7.1 Wiring Terminations

- .1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.
- .2 Manufacturers' and CSA labels to be visible and legible after equipment is installed.

7.2 Location of Outlets

- .1 Locate outlets in accordance with Division 01 - General Requirements.
- .2 Do not install outlets back-to-back in wall.
- .3 Where back boxes on opposite sides of a wall occupy the same stud bay, apply acoustical putty pads to the outside of the boxes.
- .4 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm (10'), and information is given before installation.
- .5 Locate light switches on latch side of doors. Locate disconnect devices in mechanical and elevator machine rooms on latch side of door.

7.3 Mounting Heights

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

- .3 For Barrier Free areas verify the mounting heights with the authority having jurisdiction prior to rough-in.
- .4 Install electrical equipment at following heights unless indicated otherwise.

Description	General Area	Barrier Free
Local switches	1200 mm (47")	1050 mm (41")
Wall receptacles: General	300 mm (12")	450 mm (18")
Wall receptacles: Hospitals	450 mm (18")	450 mm (18")
Wall receptacles: above top of continuous baseboard heater	200 mm (8")	200 mm (8")
Wall receptacles: above top of counters or counter splash backs	175 mm (7")	175 mm (7")
Wall receptacles shown above top of counters where there is no counter: height above finished floor	1200 mm (47")	1050 mm (41")
Wall receptacles: In Mechanical rooms	1200 mm (47")	1050 mm (41")
Telephone outlets	300 mm (12")	450 mm (18")
Outlets for wall mounted telephones	1500 mm (59")	1000 mm (39")
Fire alarm pull stations	1500 mm (59")	1200 mm (47")
Fire alarm bells	2100 mm (83")	2100 mm (83")
Wall mounted speakers	2100 mm (83")	2100 mm (83")
Wall mounted door operator push pads	1000mm (39")	1000mm (39")
Wall or floor mounted, vertical panel type door operator controls	from ≤ 200 mm to ≥ 900 mm (from ≤ 7.9 " to ≥ 36 ")	from ≤ 200 mm to ≥ 900 mm (from ≤ 7.9 " to ≥ 36 ")
Clocks	2100 mm (83")	2100 mm (83")
Other controls	1200 mm (47")	1050 mm (41")
Panelboards	As required by code or as indicated	As required by code or as indicated

7.4 Conduit and Cable Installation

- .1 Install embedded conduit prior to pouring of concrete.
- .2 Arrange for holes through exterior walls and roof to be flashed and made weatherproof under Division 7.
- .3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.
- .4 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions and assistance to locate and install inserts.

- .5 Secure inserts firmly to form work before concrete is poured.
- .6 Provide insert drawings as required.

7.5 Plywood Backboards

- .1 Provide plywood backboards in electrical and telecommunications rooms and closets where indicated or specified for mounting of equipment.
- .2 Plywood to be securely attached to the building structure.
- .3 Plywood to be 19mm, void free, good one side, mounted with good side exposed.

END OF SECTION

WIRES & CABLES 0-1000 VOLTS 26 05 19

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Product Data

- .1 Submit product data in accordance with Section 26 01 01 Electrical General Requirements.

1.3 Conductor sizes

- .1 Conductor sizes are based on connected equipment having a temperature marking of 75°C or higher. Where equipment does not have a temperature marking or it has a marking lower than 75°C, increase the size of the conductors accordingly, to the satisfaction of the consultant.
- .2 For wires in conduit, conductor sizes are based on not more than 3 current carrying conductors in a conduit. Where more than 3 current carrying conductors are installed in a conduit increase the conductor size accordingly, to the satisfaction of the consultant.
- .3 Do not reduce conductor sizes, conductors may have been oversized due to voltage drop constraints.

2 PRODUCTS

2.1 Building Wires

- .1 Conductors: copper conductors: size as indicated.
- .2 Minimum wire size: No. 12 AWG.
- .3 Stranded conductors for 10 AWG and larger.
- .4 Insulation:
 - .1 chemically cross-linked thermosetting polyethylene material,
 - .2 RW90 or RWU90 to CSA C22.2 No. 38,
 - .3 1000V and 600V ratings.
- .5 Conductors to be colour coded. Conductors to have colour impregnated into insulation at time of manufacture. Phase conductors No. 8 AWG and larger, with black insulation, may be colour coded with adhesive colour coding tape.

Standard of Acceptance

- Aetna Insulated Wire
- General Cable
- Nexans Canada Inc.
- Prysmian Cables & Systems Ltd.
- Southwire

2.2 Armoured Cables

- .1 Type: AC90, 600V 90C to CSA C22.2 No 51, FT4 rated.
- .2 Conductors: copper, minimum size #12 with bare copper #12 bonding wire.
- .3 Insulation: RW90 XLPE.
- .4 Armour: interlocking type fabricated from galvanized steel or aluminum strip.

2.3 Instrumentation and Control Cabling

- .1 Control cables to CSA Standard CAN3-C2.1-M86 Control Cables - 600 Volts.
- .2 Control cables as follows:

Conductors	Quantity, arrangement and gauge shown on drawings or specified elsewhere.
Identification	Colour coded or numbered.
Insulation	XLPE
Armour	Steel (No armour required if installed in conduit or approved wireway).
Jacket	FT4 Flame Retardant

- .3 Shielded cables to provide 100% shield coverage complete with drain wire.
- .4 Multipair twisted shielded cables to have individually shielded pairs, overall shield, drain wires and overall rated jacket.

Standard of Acceptance

- General Cable (Carol)
- Belden
- Nexans Canada Inc.

3 EXECUTION

3.1 General

- .1 Conductor colour coding to be as follows:
 - Phase A - Red
 - Phase B - Black
 - Phase C - Blue
 - Neutral - White
 - Ground - Green
 - Control - Orange
- .2 Where colour coding tape is utilized, apply at least 50 mm (2") at terminations, junction boxes and pull boxes. Do not paint conductors.

- .3 Use:
 - .1 600 V insulation for 600 V, 480V and 120/208 V systems.
- .4 Wiring installed underground: RWU90.
- .5 Wiring in channel back of luminaires:
 - .1 600 volt type GTF or TEW,
 - .2 temperature rating as required by CSA and/or manufacturer requirements.
- .6 Store wire and cable in a clean, dry, well ventilated area.
- .7 Protect white insulated wire from exposure to NOx gas (eg: exhaust from propane fuelled equipment) by wrapping with shrink wrap, by locating away from sources of NOx and by maintaining adequate ventilation to minimize NOx levels.
- .8 Where white insulated wire has discoloured:
 - .1 do not install,
 - .2 dispose of the wire,
 - .3 remove and replace wire that has been installed.
- .9 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .10 Splice wires:
 - .1 Up to and including No. 6 AWG: with nylon insulated expandable spring type connectors with moulded thermoplastic body and expandable square edge design spring.
 - .2 Larger than #6 AWG: with compression sleeve connectors and heat shrink insulating sleeves, voltage rating of sleeves equal to or greater than the cable.
 - .3 Aluminum Conductors: with long barrel compression sleeve connectors approved for use with aluminum conductors and heat shrink insulating sleeves, voltage rating of sleeves equal to or greater than the cable.
- .11 Do not splice conductors used in parallel runs.

3.2 Installation of Building Wires

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 33.
 - .2 In wireways and auxiliary gutters in accordance with Section 26 05 37.
- .2 Home runs, of 15 and 20 Ampere circuits to lighting and receptacle panels, which exceed:
 - .1 25 m (75') in length: No. 10 AWG or larger,
 - .2 40 m (120') in length: No. 8 AWG or larger,
 - .3 60 m (180') in length: No. 6 AWG or larger.
- .3 Increase the size of branch circuit conductors and home runs as required so that the total voltage drop, from panelboards to loads, does not exceed 3% under load.

- .4 For branch circuit wiring provide a dedicated neutral conductor for each phase conductor except where indicated otherwise
- .5 For branch wiring, common neutral conductors may be used in the following applications:
 - .1 lighting circuits, excluding dimming circuits,
 - .2 housekeeping receptacles,
 - .3 specific purpose receptacles for equipment that does not produce harmonic currents, such as resistance heating.
- .6 Where wires are damaged or contaminated during installation, remove and dispose of wires, swab out conduits and pull in new, clean conductors.

3.3 Installation of Armoured Cables AC90(BX)

- .1 May be used for drops to surface and recessed mounted luminaires.
- .2 Do not use in patient care areas.
- .3 Terminate cables in accordance with Section 26 27 28 - Wire and Box Connectors - 0 - 1000 V.

3.4 Installation of Instrumentation, Communication and Control Cabling

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 33.
 - .2 In wireways and auxiliary gutters in accordance with Section 26 05 37.
 - .3 In open style cable trays in ceiling spaces, using FT4 rated cable where the ceiling space is not used as a return air plenum, as directed by the Consultant.
- .2 Neatly train circuit wiring in cabinets, panels, pullboxes and junction boxes and hold with nylon cable ties.
- .3 Run instrumentation, communication and control cabling point to point and terminate on terminal strips. Do not splice communication or control cabling. Where long runs make a continuous point to point installation impractical, make splices on labelled terminal blocks in an accessible labelled terminal cabinet, installed at 1200 mm (48") above floor, and indicate cabinet location, terminal and wire numbers on the As-built drawings.
- .4 Terminate control cables in equipment with suitable connectors.
- .5 Clearly identify cables at both ends, with permanent PVC wire markers, Weiland type Z or equal, indicating cable number and wire numbers.

END OF SECTION

GROUNDING AND BONDING SECONDARY 26 05 27

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Related Sections

- .1 26 05 53, Identification for Electrical Systems.

1.3 References

- .1 IEEE 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.

1.4 Submittals

- .1 Submit shop drawings and product data in accordance with Section 26 01 01 Electrical General Requirements.
- .2 Submit list of nameplates.

1.5 Applicable Codes and Standards

- .1 Latest edition of CSA C22.2 No 41 Grounding and Bonding Equipment.
- .2 Latest edition of CSA-Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

1.6 Work Included

- .1 Provide labour, materials, and equipment as required for installation, testing and putting into proper operation complete systems as shown, as specified and as otherwise required.

1.7 Operation and Maintenance Data

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 01 01 Electrical General Requirements.

2 PRODUCTS

2.1 Clamps:

- .1 conductor to water main clamps suitable for grounding connections,
- .2 type and size as required to make electrically conductive connections to underground water pipe,
- .3 non-corroding copper, bronze and/or stainless steel construction.

2.2 Conductors

- .1 Buried grounding conductors:
 - .1 bare, stranded, tinned, soft annealed copper,
 - .2 size #4/0 AWG unless indicated otherwise.
- .2 Insulated grounding and bonding conductors:
 - .1 bare, stranded, soft annealed copper,
 - .2 type RW90 green insulation.

2.3 Accessories

- .1 Accessories including but not limited to:
 - .1 grounding and bonding bushings,
 - .2 protective type clamps,
 - .3 bolted type conductor connectors,
 - .4 exothermic welded type conductor connectors,
 - .5 bonding jumpers, straps,
 - .6 pressure wire connectors,to be of non-corroding copper, bronze and/or stainless steel construction.

2.4 Raised Floor Bonding

- .1 Communication and computer room raised floor ground clamps: Burndy Uniground.

3 EXECUTION

3.1 Installation

- .1 Ground electrical systems in accordance with the Canadian Electrical Code and the latest edition of ANSI/IEEE Standard 142.
- .2 Bond electrical equipment in accordance with the Canadian Electrical Code and the latest edition of ANSI/IEEE Standard 142.
- .3 Install connectors in accordance with manufacturer's instructions.
- .4 Protect exposed grounding and bonding conductors from mechanical injury.
- .5 Make connections to conductive water main and electrodes, using copper welding by exothermic process.
- .6 Use mechanical connectors for grounding and bonding connections to equipment provided with lugs.
- .7 Soldered joints not permitted.
- .8 Provide a bonding wire for flexible conduit, connected at both ends to bonding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

- .9 Provide a separate bonding conductor in each conduit:
 - .1 sized as per Table 16 of the CEC,
 - .2 not less than #12 AWG copper,
 - .3 with one bond conductor for every three line conductors.
- .10 Bond building structural steel and metal siding to ground by welding copper to steel.
- .11 Make grounding connections in radial configuration only, with connections terminating at a single grounding point. Avoid loop connections.
- .12 Install grounding conductors outside electrical rooms and electrical closets in PVC conduit and conceal where possible. Where PVC conduit is not permitted use EMT and bond the EMT to the conductor at both ends.

3.2 System Grounding

- .1 Provide system grounding connections to neutral point of secondary systems using not less than #6 copper conductor unless indicated otherwise.
- .2 Install insulated copper grounding conductor for service raceways and service equipment as required by the electric utility company.
- .3 Install grounding conductors in PVC conduit.

3.3 Equipment Bonding

- .1 Install insulated copper bonding connections:
 - .1 sized not less than #12 AWG and not less than indicated in Table 16 of the electrical code,
 - .2 to typical equipment including, but not necessarily limited to the following list:
 - (a) transformers,
 - (b) panelboards,
 - (c) splitters,
 - (d) disconnect switches,
 - (e) junction and outlet boxes,
 - (f) receptacles,
 - (g) luminaires,
 - (h) transfer switches,
 - (i) UPS systems,
 - (j) battery enclosures,
 - (k) fire alarm systems,
 - (l) communications systems,
 - (m) control panels,
 - (n) other equipment that is supplied with electrical power.
- .2 Where applicable, run bonding conductors as part of the feeder.
- .3 Where bonding conductors are run separately, install in PVC conduit.

3.4 Communications Systems

- .1 Install bonding connections for telephone, sound, fire alarm, intercommunication systems as follows:

- .1 telephones: make telephone bonding system in accordance with telephone company's requirements,
- .2 communications system bonding: in accordance with ANSI/EIA/TIA 607, 568A, 569 standards,
- .3 sound, fire alarm, intercommunication systems: as required by the electrical code except where indicated otherwise.

3.5 Raised Floor Bonding

- .1 Install #6 bare copper bonding conductors in a grid pattern on four foot centres in each direction of the floor grid. Install Burndy Uniground clamp to raised floor pedestals on four foot centres, at each intersection of the bonding grid conductors.
- .2 Bond each item of equipment on the raised floor to the raised floor bonding grid with not less than a #6 tinned copper flat braid extra flexible bonding jumper.
- .3 Extend #6 green insulated copper ground conductor in PVC conduit from the bonding grid to the building main grounding system. Terminate using NEMA 2 hole compression connectors.

3.6 Bonding of Other Items

- .1 Install insulated copper bonding connections:
 - .1 sized not less than #6 AWG,
 - .2 run in PVC conduit,
 - .3 to typical items including, but not necessarily limited to following list:
 - (a) metallic water piping systems,
 - (b) metallic waste water piping systems,
 - (c) metallic gas piping systems,
 - (d) metallic vacuum piping systems,
 - (e) metallic compressed air piping systems,
 - (f) building steel work.
- .2 Review the design and installation of each piping system with the system installer and provide bonding jumpers where necessary to ensure that each piping system is electrically continuous.

END OF SECTION

FASTENINGS AND SUPPORTS

26 05 29

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Related Work

- .1 Fastenings and supports: Section 01 61 00 - Common Product Requirements.
- .2 Concrete bases and housekeeping pads for electrical equipment shall be provided by trade specialists under respective Carpentry, Concrete, and Painting Divisions.

1.3 Shop Drawings

- .1 Submit design drawings for custom fabricated trapeze hangers, sealed by a professional engineer licensed in the project location jurisdiction.
 - .1 Shop drawing details:
 - (a) construction detail drawings for each loading condition,
 - (b) span deflection calculations,
 - (c) building attachment load calculations and type.
 - .2 Provide services of engineer who sealed the custom trapeze hanger shop drawings to conduct a general review of the completed installation on site.

2 PRODUCTS

2.1 Support Channels

- .1 Hot dipped galvanized steel, U shape, size 41 mm x 41 mm x 2.5 mm (1 1/2" x 1 1/2" x 1/10") thick, surface mounted, suspended or set in poured concrete walls and ceilings.

2.2 Inserts

- .1 Inserts for conduits and raceway hangers, for single, double and multiple runs shall be galvanized.

Standard of Acceptance

- Unistrut Canada
- Burndy (Canada) Ltd. - Flexibar
- Pilgrim Technical Products Ltd. - Tufstrut

2.3 Hangers

- .1 Hangers for electrical conduit shall be hot dipped galvanized after fabrication.

Standard of Acceptance

- Burndy Canada Ltd.
- Canstrut
- Electrovert Ltd.

- E. Myatt & Co. Ltd
- Steel City Electric Ltd.
- Pilgrim Technical Products Ltd.

2.4 Trapeze hangers

.1 Performance:

.1 Manufactured:

(a) to product load listings.

.2 Custom fabricated:

(a) maximum deflection between supports: 1/250 (0.4%) of span

(b) minimum factor of safety : 5 times load to ultimate tensile or compressive strength.

.2 Construction:

.1 Carbon steel shapes, to suit load application:

(a) hollow steel section,

(b) equal leg EI section, or

(c) double C channel “strong-back”, with welded clips.

.2 Hanger rods:

(a) as specified above, and

(b) minimum two support rods,

(c) rods selected for minimum factor of safety of 5 times load to ultimate tensile or compressive strength of rod.

.3 Finish:

.1 hot dipped galvanized finish in mechanical rooms and outdoors.

.2 black steel finish in other areas.

Standard of Acceptance

- Anvil Fig 45, 46, 50

3 EXECUTION

3.1 Installation

.1 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions to locate and install inserts.

.2 Secure equipment to masonry, tile and plaster surfaces with lead anchors.

.3 Secure equipment to poured concrete with expandable inserts.

.4 Secure surface mounted equipment with T-bar support hanger fastened to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.

Standard of Acceptance

- Caddy model No. 512 c/w BHC clip

- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm (2") and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm (2").
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm (¼") dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm (¼") dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels.
- .9 Provide galvanized after fabrication metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Consultant.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .14 Supply and erect special structural work required for the installation of electrical equipment. Provide anchor bolts and fastenings unless noted otherwise. Mount equipment required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.
- .15 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets. Install angle or channel iron supports to bear the equipment where it is shown in or on structural tile walls, or walls that are inadequate to bear the equipment.
- .16 Provide channel iron or other metal supports where necessary to adequately support lighting fixtures. Do not use wood. Lighting fixtures shall be supported totally independent of ceiling and supported from structure above.
- .17 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members required between beams for supporting conduits.
- .18 Do not use explosive drive pins in any section of work without obtaining prior written approval.

END OF SECTION

SPLITTERS, JUNCTION AND PULL BOXES, CABINETS

26 05 32

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Shop Drawings and Product Data

- .1 Submit shop drawings and product data for cabinets in accordance with Section 26 01 01 Electrical General Requirements.

1.3 Reference

- .1 CSA C22.2 No. 76 Splitters.
- .2 CSA C22.2 No. 40 Junction and Pull Boxes.

2 PRODUCTS

2.1 Splitters

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs and connection bars to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters.
- .4 Distribution riser splitters shall be of special construction with hinged access door, copper bus bars predrilled to accept two-hole compression connectors for all incoming and outgoing cables.

2.2 Junction and Pull Boxes

- .1 Welded steel hot dipped galvanized construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm (1") minimum extension all around, for flush-mounted pull and junction boxes.

2.3 Cabinets

- .1 Type E: sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.
- .2 Type T: sheet steel cabinet, with hinged door, latch, lock, 2 keys, containing sheet steel backboard for surface or flush mounting as indicated.
- .3 Surface mounted cabinets shall be finished in ASA 61 grey.

2.4 Instrumentation and Control Terminal Cabinets

- .1 Surface mounted, gasketed, drip proof and dust tight, JIC enclosure, CEMA type 12 With hinged door, lock, 2 keys, white raised and removable internal mounting panel, diagram pocket, finished with ASA 61 grey.

Standard of Acceptance

- Hammond

- .2 Panel wiring to be contained in PVC wiring ducts complete with cover strips, minimum 50 mm x 50 mm (2" x 2"). Wireway fill to be limited to 60%. Where there are a large number of door mounted devices, door wiring harnesses shall also be contained in wiring ducts at rear door. All door wiring devices to emanate from the control panel terminal strips. Wiring to panel face mounted devices to be bundled neatly on hinge side of panel, enclosed in flexible spiral wrap, and installed such that wiring will not be damaged when opening and closing door. Ground panel door to panel with a flexible copper bonding strap. Label all wiring with permanent PVC sleeve type markers.
- .3 Phoenix contact terminal blocks with mounting rails, end covers, terminal markers, partition plates and accessories: UK 2.5 termination of wiring 22 to 12 AWG; UK 5 and UK 10 series for current transformers and other leads #10 AWG and #8 AWG; UDK or UK 5 twin for connecting two or more conductors to one terminal block; DIK 1.5 for three wire sensor device wiring; MTKD for thermocouple leads.
- .4 Provide lamacoid nameplates for all panel mounted control and indicating devices, and all internal components such as terminal strips, control transformers, control devices, relays, etc. as per 26 05 01.

3 EXECUTION

3.1 Splitter Installation

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 Junction, Pull Boxes and Cabinets Installation

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m (6'-6") above finished floor.
- .3 Install terminal block as indicated in Type T cabinets
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m (100') of conduit run between pull boxes.

3.3 Identification

- .1 Provide equipment identification in accordance with Section 26 05 01, Electrical Basics Materials and Methods.
- .2 Install size 2 identification labels indicating system name, voltage, phase and source of power.

- .3 Provide a typed directory in cabinets showing following information: Nature, actual quantities and room number of device or devices connected to each terminal, as well as signal circuit number where applicable.

END OF SECTION

CONDUITS, FASTENINGS AND FITTINGS

26 05 33

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 01 01 Electrical General Requirements.

1.3 Work Included

- .1 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 systems as shown as specified and as otherwise required.

1.4 Location of Conduit

- .1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

1.5 References

- .1 CSA C22.2 No. 45 Rigid Metal and Epoxy Coated Conduit
- .2 CSA C22.2 No. 83 Electrical Metallic Tubing
- .3 CSA C22.2 No. 136 Rigid PVC Conduit
- .4 CSA C22.2 No. 56 Flexible Metal and Liquid-Tight Flexible Metal Conduit
- .5 CSA C22.2 No 211.2 Rigid PVC Conduit
- .6 Conduit accessories, conduits and fittings to CSA C22.2 No. 18.

1.6 Wiring Methods

- .1 Install wiring in surface mounted EMT conduit unless otherwise specified. In finished areas, conceal conduit in walls and ceiling spaces.
- .2 In areas designated as Explosion Proof on Drawings, conduit and wiring shall be Class I, Group D, Division I.
- .3 Where shown on drawings, armoured cable shall be Teck 90 type. Jackets of cable shall have FT-4 rating identified. Connectors shall be equal to T&B Star Teck Type
- .4 Rigid PVC conduit with ground wire as per Electrical Safety Code Table 16 shall be used throughout below grade areas and may be used in or under slab on grade areas. It shall not be used in above grade slabs.

- .5 Runs of conduit and cables, where shown, are indicated only by general location and routing. 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.
- .6 Use EMT conduit for branch circuit and signal wiring in ceilings, furred spaces, and in hollow walls and partitions.
- .7 Use rigid galvanized steel conduit for wiring where conduits are exposed to possible mechanical damage.
- .8 Flexible steel conduit with integral insulated green ground wire is permitted for the final connection to luminaires mounted in suspended ceilings from the branch wiring junction box above, with flexible conduit length not to exceed 3 m (10'), and be neatly installed and attached to luminaire support chain.
- .9 Conduit shall be of sufficient size to permit easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.
- .10 Arrange conduits, installed in suspended ceilings, to provide minimum interference with removal of tiles.
- .11 Where existing locations of flush mounted electrical devices (switches, receptacles, etc.) correspond to new devices shown, the existing dropdown conduit and outlet box may be re-used. Provide new devices, new coverplates, new home-run conduit and complete new wire.
- .12 Vertical raceways to be provided with insulated cable support bushings or other approved method of supporting the weight of the cable, where vertical runs exceed those of Table 21 of the Electrical Code.

2 PRODUCTS

2.1 Conduits

- .1 Rigid hot dipped galvanized steel threaded conduit
- .2 Electrical metallic tubing (EMT), galvanized: with couplings.
- .3 Rigid PVC conduit.
- .4 Flexible metal conduit and liquid-tight flexible metal conduit.
- .5 Conduit shall be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

2.2 Conduit Fastenings

- .1 One hole steel straps to secure surface conduits 50 mm (2") and smaller. Two hole steel straps for conduits larger than 50 mm (2").
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 Six mm dia threaded rods to support suspended channels.

2.3 Conduit Fittings

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90E bends are required for 25 mm (1") and larger conduits
- .3 Raintight insulated throat steel compression connectors and couplings for EMT.
- .4 Threaded or compression type raintight/concrete tight insulated throat zinc plated steel connectors and couplings for rigid steel conduit.
- .5 Raintight insulated throat steel connectors at all surface panelboards, switchboards and other electrical equipment in sprinklered areas for all conduit terminations.

2.4 Expansion Fittings

- .1 Electrogalvanized steel with internal grounding for EMT suitable for 100mm linear conduit movement.

Standard of Acceptance

- ° Cooper Crouse Hinds XJG-EMT
- .2 Weatherproof expansion fittings with internal bonding assembly suitable for 100mm (4") linear expansion.
 - .3 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm (3/4") deflection in all directions.
 - .4 Concrete type, water tight, corrosion resistant for conduit installations embedded in concrete
 - .5 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 Fish Cord

- .1 Polypropylene

3 EXECUTION

3.1 Installation

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT) except: in cast concrete, underground or where installed exposed within 2.0m (6'-6") of floor.
- .4 Use rigid galvanized steel conduit where installed surface mounted within 2.0m (6'-6") of floor.
- .5 Use rigid PVC conduit in slab on grade cast concrete and underground. Do not use PVC conduits in slabs above grade. All conduits shall be surface mounted to minimize risks of future damage when core drilling during future renovations. Where localized congestion or circumstances forces the use of conduits in the floor slabs, they shall be epoxy coated rigid galvanized steel.
- .6 Provide PVC conduit with bonding conductor as per Table 16A of Ontario Electrical Safety Code.

- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment
- .8 Use explosion proof flexible connection for connection to explosion proof motors.
- .9 Install conduit sealing fittings in hazardous areas. Fill with compound.
- .10 Use raintight connectors or hubs for terminating conduits at all surface or floor mounted panelboards, switchboards, and other equipment located in sprinklered areas or where at risk of exposure to dripping liquids.
- .11 Install wiring in conduit unless otherwise specified.
- .12 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .13 Mechanically bend steel conduit over 19mm (3/4") dia.
- .14 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .15 Install fish cord in empty conduits.
- .16 Where conduits become blocked, remove and replace blocked section. Do not use liquids to clean out conduits.
- .17 Dry conduits out before installing wire.
- .18 Conduit manufacturer's touch up enamel shall be used to repair all scratches and gouges on epoxy-coated conduit.
- .19 Install junction boxes or cable anchor boxes wherever necessary for proper pulling or anchoring of cables. Install so as to be accessible after building is completed and set to come within finished lines of building.
- .20 Where EMT or rigid PVC is used, run green insulated bonding conductor in conduit, with minimum one bonding conductor per three ungrounded conductors.
- .21 Provide expansion couplings, with bonding jumper and ground clamps where raceways cross building control joints.
- .22 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.
- .23 Runs of conduit and cables, where shown, are indicated only by general location and routing. 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.

3.2 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.

3.3 Concealed Conduit

- .1 Do not install horizontal runs in masonry walls.
- .2 Do not install conduits in terrazzo or concrete toppings.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

26 05 35

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Related Work

- .1 Box connectors to Section 26 27 28.

1.3 References

- .1 CSA C22.2 No. 18.
- .2 CSA C22.1 Canadian Electrical Code, Part 1.

2 PRODUCTS

2.1 Outlet and Conduit Boxes - General

- .1 Size boxes in accordance with CSA C22.1
- .2 102 mm (4") square or larger outlet boxes as required for special devices
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Sheet Steel Outlet Boxes

- .1 Hot dipped galvanized steel single and multi-gang flush device boxes for flush installation, minimum size 76 mm x 50 mm x 38 mm (3" x 2" x 1½") or as indicated. 102 mm (4") square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .2 102 mm (4") square or octagonal outlet boxes for lighting fixture outlets.
- .3 102 mm (4") square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 Masonry Boxes

- .1 Hot dipped galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4 Concrete Boxes

- .1 Hot dipped galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 Floor Boxes

- .1 Concrete tight hot dipped galvanized sheet steel floor boxes with adjustable finishing rings to suit floor finish with brass or brushed aluminum faceplate. Device mounting plate to accommodate short or long ear duplex single or receptacles. Minimum depth: 28 mm (1¼") for receptacles; 73 mm (3") for communication equipment.
- .2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm (½") and 19 mm (¾") conduit. Minimum size: 73 mm (3") deep.

2.6 Conduit Boxes

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle, outside building and where weatherproof boxes are required.
- .2 Explosion proof boxes in areas indicated on drawings.

2.7 Fittings - General

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 32 mm (1½") and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

3 EXECUTION

3.1 Installation

- .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 light, switch, receptacle or other outlet, approved for the particular area in which it is to be installed.
- .6 Locate outlet boxes, mounted in hung ceiling space, so 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 Use gang boxes at locations where more than one device is to be mounted. Use combination boxes with suitable barriers where outlets for more than one system are shown.

- .9 Where 100 mm (4") square boxes are installed in exposed concrete or cinder block in finished areas, blocks will be cut under masonry division as instructed under this section. Openings shall be cut to provide a close fit to boxes and covers so that edges of openings are not visible after installation of plates. Mortar shall not be used to patch up openings that are cut too large or to patch ragged edges.
- .10 Where boxes are required for wiring and equipment on the underside of a steel roof deck, attach the boxes to the underside of the deck. Do not cut openings in the steel roof deck unless specifically indicated.

END OF SECTION

WIREWAYS AND AUXILIARY GUTTERS

26 05 37

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Applicable Standard

- .1 Latest version of CSA C22.2 No.26 Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

1.3 Shop Drawings and Product Data

- .1 Submit shop drawings and product data for each type and size of wireway and auxiliary gutter.
- .2 Show installation details and support systems.

1.4 Work Included

- .1 Provide labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

2 PRODUCTS

2.1 Wireways

- .1 CSA Type 1.
- .2 Manufactured to accommodate "lay-in" of cables without pulling.
- .3 Fabricated from code gauge sheet steel.
- .4 Cross-sectional dimensions as indicated.
- .5 Hinged covers secured with screws.
- .6 No knockouts or holes.
- .7 Etching and rust inhibiting process both inside and outside.
- .8 Finish:
 - .1 Powder coat finish,
 - .2 ANSI #49 or ANSI #61 grey.

2.2 Accessories

- .1 Accessories to be of same manufacture, material and finish as the wireway.
- .2 Accessories to include:

- .1 sweep elbows,
- .2 vertical elbows (inside and outside),
- .3 horizontal elbows (inside and outside),
- .4 tees,
- .5 crosses,
- .6 couplings,
- .7 reducers,
- .8 expansion fittings,
- .9 "C" type hanger brackets,
- .10 wall mount hanger brackets,
- .11 panel flanges,
- .12 end plates,
- .13 barriers,

Standard of Acceptance

- Canadian Electrical Raceways Inc.
- Cooper B-Line
- Hammond Manufacturing
- Hoffman
- Hubbell Wiegmann
- Legrand Wiremold C-Type
- Square D Company Canada Ltd.

3 EXECUTION

3.1 Installation

- .1 Provide wireways and accessories as shown and as required for a complete system.
- .2 Install wireways:
 - .1 in accordance with the manufacturer's recommendations,
 - .2 to accommodate "lay-in" of the wiring without requiring pulling,
 - .3 as a mechanically continuous system,
 - .4 as an electrically continuous system,
 - .5 with bonding jumpers at joints if necessary to maintain bonding continuity,
 - .6 with the hinged cover up,
 - .7 parallel or perpendicular to building lines. Where not possible, obtain instructions from the Consultant,
 - .8 using "C" brackets and/or wall brackets,
 - .9 with support on 1500mm (5') centres,
 - .10 with support on each side of an expansion fitting,
 - .11 with supports attached directly to the building structure,
- .3 Provide expansion fittings:
 - .1 Where wireway crosses a building expansion joint,

- .2 where required to accommodate thermal expansion.
- .4 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.
- .5 File cuts smooth.
- .6 For galvanized wireways, coat cut edges with a galvanizing compound.
- .7 For painted wireways, coat cut edges with primer and finish coat, colour to match wireway.
- .8 Lay wiring into wireways.
- .9 Replace any wiring that is damaged.
- .10 Maintain the space above the wireway clear, to allow for full opening of the cover.
- .11 Maintain at least 300mm clear in front of wireway to allow access for cable installations.
- .12 Install auxiliary gutters the full length of equipment.

END OF SECTION

SEISMIC RESTRAINT 26 05 49

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Scope

- .1 Provide seismic restraint systems to limit movement of conduit, EMT, cables, wireways and equipment under dynamic seismic force conditions.
- .2 Provide design, selection and provision of materials, installation instructions, installation and inspection of seismic restraint devices.
- .3 The requirements under this Section are in addition to the requirements for equipment, conduit, EMT, cable, and wireway supports and vibration isolation specified in other Sections.
- .4 Where specifications of materials of this Section differ from those in other Sections of Division 26, this Section governs, including, but not limited to, vibration isolation devices.

1.3 Applicable Codes and Standards

- .1 Installation standards and codes:
 - .1 SMACNA - "Seismic Restraint Manual Guidelines for Mechanical Systems", 3rd edition.
 - .2 ASHRAE - "HVAC Applications, Seismic and Wind Restraint Design".
- .2 Product standards:
 - .1 MSS SP-127 Bracing for Piping Systems: Seismic - Wind - Dynamic Design, Selection, Application.

1.4 Definitions

- .1 The following definitions apply to this Section of the specification:

Conduit – rigid galvanized steel conduit.

Longitudinal bracing - restraint(s) applied to limit motion parallel to the centreline of the conduit, PVC conduit, aluminum conduit, EMT, bus duct, busway, cable, cable tray or wireway.

Transverse bracing - restraint(s) applied to limit motion perpendicular to the centerline of the conduit, PVC conduit, aluminum conduit, EMT, bus duct, busway, cable, cable tray or wireway.

1.5 Systems Requiring Seismic Restraint

- .1 Seismically restrain the following equipment and systems:
 - .1 electrical conduit, PVC conduit, aluminum conduit and EMT: 63 mm (2½ in) I.D. and larger,
 - .2 cables: 60mm (2.4 in) diameter and larger,
 - .3 trapeze hangers for multiple runs of conduit, EMT or cable where the aggregate weight of the runs is ≥ 14.9 Kg/m,
 - .4 wireways,
 - .5 equipment:

- (a) rigidly supported equipment,
- (b) gravity supported equipment.

.2 Exemptions:

- .1 Exemption rules in the SMACNA or ASHRAE seismic standards may be used where applicable.

1.6 Seismic Analysis, Design and Inspection Services

- .1 Provide the services of a professional engineer, licensed in the Province of British Columbia and who specializes in seismic restraint of building services and equipment, for the design of seismic restraints and to provide inspection services of the completed installation. This engineer to have at least five years of seismic design experience.
- .2 Seismic design services:
 - .1 Provide the design of seismic restraint systems, including seismic restraint calculations for connections of equipment to the structure.
 - .2 Provide drawings showing locations of restraints and details of construction and attachment of restrains. Mark-ups of Consultant's drawings or Contractor's installation drawings may be used.
 - .3 Indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure.
 - .4 Detail anchoring methods, bolt diameter, embedment and/or welded length.
 - .5 Design seismic restrain devices to accept, without failure, the forces detailed herein acting through the equipment center of gravity.
- .3 Seismic inspection services:
 - .1 After completion of the installation of the seismic restraint devices, the specialist seismic engineer to inspect the installation, identify and report deficiencies (if any) which are observed, and re-inspect the installation after deficiencies have been corrected.
 - .2 Submit a final inspection report after work is completed and deficiencies have been corrected, confirming the installation conforms to the seismic design requirements.
 - .3 Prepare and submit any required declarations or similar document to this effect where required by local legislation.
- .4 Shop drawings of custom restraints, required calculations, and reports to be sealed by the specialist seismic professional engineer.

1.7 Manufacturer's Responsibility

- .1 Manufacturer of seismic control equipment to:
 - .1 determine seismic restraint sizes and locations,
 - .2 supply seismic restraints as scheduled, specified or required,
 - .3 supply calculations and materials for restraint of non-isolated equipment where required,
 - .4 supply installation instructions and drawings,
 - .5 provide training of the contractor's personnel on the required installation methods,
 - .6 provide trained field supervision to insure proper installation and performance.

1.8 Design Criteria

- .1 Design seismic restraint systems to conform to the requirements of the building code.
- .2 Design parameters to include:
 - .1 Soil Classification: Class C
 - .2 Building Importance factor: 1.5
 - .3 For suspended equipment, measure the building elevation height to the topside of the floor above the suspended equipment.
- .3 Building data:

Building Level	Approximate Height at Ceiling m	Horizontal Load Factor %V _{ph}	SMACNA SHL Class
Level 0	0.0		
Level 1	5.0		

Notes:

- .1 “%V_{ph}” is the horizontal force factor expressed as a percentage of the weight of the equipment or component.
- .2 For conduit, EMT, cable and wireway, the vertical uplift force is restrained by the systems as defined in the SMACNA standard.
- .3 For equipment, the vertical uplift force is 30% of the horizontal force.

1.9 Submittals

- .1 Submit shop drawings in accordance with Division 1 and as follows:
 - .1 Submit test certificates for each seismic restraint device, identifying maximum tested load capacities.
 - .2 Submit calculations for each piece of restrained equipment, conduit, EMT, cable, and wireway including seismic forces, restraint selection, and selection data.
 - .3 Provide a calculation analysis summary (spreadsheet is acceptable) for each piece of equipment, including the following information:
 - (a) Equipment ID
 - (b) Floor level
 - (c) Horizontal seismic force factor
 - (d) Equipment weight
 - (e) Horizontal seismic force
 - (f) Vertical uplift seismic force (where applicable)
 - (g) Equipment centre of gravity in three directions
 - (h) Design condition (worst case) overturning moment
 - (i) Number of restraint fastenings
 - (j) Pull-out tension per fastener
 - (k) Horizontal shear per fastener
 - (l) Pull-out tension load rating per fastener

- (m) Horizontal shear rating per fastener.
- .4 Include worst case combination of tension and shear loads at each snubber and restraint location.
- .5 Include:
 - (a) anchor bolt diameters,
 - (b) embedment depth,
 - (c) full welding details including type and length for field welds,
 - (d) required housekeeping base dimensions.
- .6 Calculations and designs to be sealed by a Professional Engineer licensed in the province or territory of the location of the project.
- .2 Sample Materials:
 - .1 None required.

1.10 Quality Assurance

- .1 Pre-Construction meeting:
 - .1 Request and arrange a meeting with the Consultant to review seismic restraint approach, prior to any restraint installation.
 - .2 Obtain approval from the Consultant before commencing work.
- .2 Testing and Review
 - .1 Install the first three lateral and three longitudinal braces for one (1) length each of conduit, EMT, cable, and wireway.
 - .2 Request and arrange for a review of the installation by the Consultant.
 - .3 Obtain approval of the installation before commencing remainder of the work.
- .3 Provide services of the manufacturer's technical representative to conduct site inspections of the Work in progress, and to conduct a final inspection of the work. Provide a copy of the final inspection report to the Consultant for review.
- .4 Request and arrange for a construction review, by the Consultant, of the completed seismic restraint installation, before any ceilings are installed.

2 PRODUCTS

2.1 Material

- .1 Seismic restraint products to be:
 - .1 approved by a government agency,
 - .2 indicate maximum restraint ratings,
 - .3 provided with:
 - (a) test results by an independent testing laboratory which state the maximum restraint ratings, or
 - (b) calculations (including combination tension and shear loading) to support seismic restraint designs.
- .2 Calculations to be sealed by a Professional Engineer licensed in the Province of British Columbia with at least five years of seismic design experience.

- .3 Testing and calculations to include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
- .4 Seismic restraint design and material supply:

Standard of Acceptance

- Vibron/Kinetics Noise Control Inc.
- BVA
- VMC/Korfund
- Tecoustics
- Hilti

2.2 Seismic Snubber Restraints

- .1 Type "SS1" – Single-Axis Limit Stop Snubber Assemblies:
 - .1 steel construction,
 - .2 attached to equipment structure and equipment,
 - .3 limit movement to not more than 6 mm (¼ in),
 - .4 designed to restrict movement in one axis,
 - .5 not less than 6 mm (¼ in) thick resilient neoprene pads to prevent metal-to-metal impact,
 - .6 not less than four (4) snubbers for each piece of equipment.
- .2 Type "SS2 / SS3" – Multi-Axis Limit Stop Snubber Assemblies:
 - .1 interlocking steel construction,
 - .2 attached to equipment structure and equipment,
 - .3 limit movement to not more than 6 mm (¼ in),
 - .4 designed to restrict movement in two (2) or three (3) axis,
 - .5 not less than 6 mm (¼ in) thick resilient neoprene pads to prevent metal-to-metal impact,
 - .6 not less than two (2) snubbers for each piece of equipment.

2.3 Cable Restraints

- .1 Type "SCR" – Cable Restraints:
 - .1 for suspended:
 - (a) cable,
 - (b) EMT,
 - (c) conduit,
 - (d) wireway,
 - (e) luminaires,
 - .2 manufactured system consisting of:
 - (a) cable,
 - (b) building attachments,
 - (c) vertical rod reinforcement assemblies,
 - .3 field-built assemblies are not acceptable,
 - .4 steel wire strand cables:

- (a) galvanized steel aircraft cable,
 - (b) sized for seismic load with a safety factor of 2,
 - (c) arranged for restraint in both longitudinal and transverse directions,
 - (d) rope connections: overlap wire "U" clips, or, tool-less wedge insert lock connectors,
 - (e) connector strength rating not less than 90% of cable breaking strength rating.
- .5 building and equipment attachment brackets:
- (a) designed to permit free cable movement in all directions up to a 45 degree misalignment,
 - (b) protective thimbles at sharp corners to protect against cable wear,
 - (c) selected to exceed the cable working design load by 50%,
 - (d) single sided "C" beam clamps are not acceptable,
- .6 vertical suspension rods:
- (a) braced to avoid potential for buckling due to vertical up-lift forces,
 - (b) structural steel angle or formed channel brace selected to prevent support rod buckling,
 - (c) brace attached to support rod with a series of adjustable clips, without the use of hand-tools.

2.4 Solid Braces

- .1 Type "SRR" - steel angles or channels:
- .1 sized for seismic load with a safety factor of 2,
 - .2 arranged for restraint in both longitudinal and transverse directions.

2.5 Rigidly Mounted Equipment Restraint

- .1 Undercut or heavy-duty sleeve type,
- .1 for post concrete-cure installation,
 - .2 carbon steel bolt, nut and sleeve,
 - .3 selected for concurrent shear and tension loads with a safety factor not less than 2.0 x estimated load.

3 EXECUTION

3.1 General:

- .1 Design seismic restraints to;
- .1 keep equipment in place during and after seismic events in accordance with the local building code,
 - .2 resist vertical loading simultaneously with transverse or longitudinal seismic loading.
- .2 Give special consideration to design for:
- .1 adjacent connections,
 - .2 insulation treatment,
 - .3 thermal movement,
 - .4 vibration isolation,
 - .5 relation to building seismic joints.

- .3 Select building structure attachments as follows:
 - .1 Concrete construction:
 - (a) cast in place anchor,
 - (b) drill-in wedge anchor.
 - .2 Steel construction:
 - (a) double sided beam clamp, loaded perpendicular to beam, or
 - (b) specifically designed welded or bolted connection.
 - .3 Single sided "C" type beam clamps are not acceptable as seismic restraint anchor points.
- .4 Brace installation:
 - .1 install cable restraints snug,
 - .2 install solid braces only in rigidly supported situations,
 - .3 brace hanger rods forming a part of a seismic restraint to accept resulting compressive loads,
 - .4 transverse and longitudinal braces to be no more than 45° above or below centerline of conduit, EMT, cable, and wireway.
- .5 Equipment:
 - .1 Provide resilient neoprene bushings and washers between equipment and anchor bolts where equipment is secured rigidly to wall, floor, or housekeeping pad.

3.2 Selection of Bracing Details

- .1 Select application type;
 - .1 single hanger or
 - .2 trapeze support.
- .2 Determine required force level, based on weight of equipment and specified factors.
- .3 With required force level, develop transverse and longitudinal brace spacing for single or trapeze hanger in accordance with;
 - .1 break length into separate straight runs, which are considered to be single straight section between any bends, except where bend is at an offset of less than 610 mm (2 ft),
 - .2 brace each straight run in transverse direction at both ends. Check required spacing for transverse bracing and compare it to the length of straight run. If length of straight run is greater than allowable distance for transverse bracing add transverse braces until spacing does not exceed allowable transverse brace distance,
 - .3 each straight run to have at least one longitudinal brace. Add longitudinal braces so that the spacing does not exceed allowable longitudinal brace spacing. Transverse brace may act as longitudinal brace for an adjacent run when it is located within 610 mm (2 ft) of adjacent straight run,
 - .4 where several short runs occur one after other, each straight run requires longitudinal brace when adjacent short runs exceed an offset length of 610 mm (2 ft). When adjacent short runs do not exceed maximum offset length the longitudinal braces can act as transverse braces as long as allowable transverse brace spacing is not exceeded. Multiple offsets can be treated as single run when the total offset is less than maximum offset length.
- .4 Select brace anchorage detail.
- .5 Calculate hanger rod load and select rod attachment to structure to suit.
- .6 Check if rod stiffeners are required to prevent hanger rod from buckling under compressive load.

3.3 Installation

- .1 Install seismic restraint devices in accordance with manufacturer's instructions.
- .2 Install snubber devices only after equipment is installed and operating, to ensure no metal-to-metal contact.
- .3 Conduit and cable penetrations through floors are acceptable as lateral restraints, provided sleeves and fire stopping materials are installed correctly.
- .4 Racked conduit, EMT, cable, and wireway systems may have the rack braced (laterally, longitudinally, or combination thereof), provided each element supported by the rack is restrained to the rack.
- .5 Secure each lateral or longitudinal brace to the building structure, and not any other building service.
- .6 Penetrations through masonry and poured concrete wall partitions are acceptable as a lateral restraint, provided sleeves and fire stopping materials are installed correctly.
 - .1 Do not use drywall partitions, or demountable partitions for lateral restraint.

3.4 Equipment Restraint – General

- .1 Select restraint fastening systems so that full restraint will be provided assuming one failed fastener.

3.5 Equipment Restraints - Rigidly Floor Mounted Equipment

- .1 Anchor floor mounted equipment with anchor bolts, not less than four bolts for rectangular equipment bases, and three bolts for circular equipment bases.
- .2 Provide resilient neoprene bushings and washers between equipment and anchor bolt.

3.6 Equipment Restraints - Surface Wall Mounted Equipment and Panels

- .1 Select bolts for concurrent shear dead-weight without deduction for uplift load, and tension restraint load.
- .2 In block-wall;
 - .1 for up to three bolts, each bolt rated for 2.0 times estimated restraint load, or
 - .2 for four bolts or more, each bolt rated for 1.0 times estimated restraint load.
- .3 In dry-wall;
 - .1 not less than four self-tapping screws drilled into the studs, with each screw rated for 1.0 times estimated restraint load.

3.7 Equipment Restraints - Recessed wall-mounted Equipment and Panels

- .1 Same as for surface mounted equipment, except fasten through top, bottom and sides of panels to adjacent block wall or wall studs.

3.8 Conduit, EMT, Cable, and Wireway

- .1 For conduit and EMT with up to 40% fill of copper conductors, restraints may be provided in accordance with the SMACNA guideline and manufacturers' instructions, using the following conversions to piping filled with water.

Reference Pipe Size, Schedule 40, NPS (in)	2½	3	3½	4	5	6	8
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Weight of Reference Pipe Size Filled With Water (Kg/m)	11.7	15.9	19.8	24.2	34.6	46.8	74.6
Conduit Size, I.D. (mm)	53	63	78	91	103	129	155
EMT Size, I.D. (mm)	63	78	91	103	-	-	-

- .2 For other applications such as:
 - .1 cables,
 - .2 conduit or EMT with aluminum conductors,
 restraints may be provided in accordance with the SMACNA guideline and manufacturers' instructions, by making a conversion to the water filled piping size, based on the system weight (Kg/m) in the table above, assuming 40% fill for conduit, and EMT.
- .3 For conduit, EMT, cables on trapeze hangers, restraints may be provided in accordance with the SMACNA guideline and manufacturers' instructions, based on the system weight per support, assuming 40% fill for conduit, and EMT.
- .4 Provide specifically designed systems for:
 - .1 wireway,
 - .2 systems where the SMACNA guidelines are not used or are not applicable.
- .5 Allow for:
 - .1 not less than 40% fill for conduit, and EMT,
 - .2 more than 40% fill as applicable,
 - .3 future fill of empty conduit, and EMT,
 - .4 future runs:
 - (a) on trapeze hangers,
 - (b) in cable tray.
 - (c) in wireway.
- .6 Do not mix cable restraints and rigid bar restraints on the same conduit, EMT, cable, or wireway system.

3.9 Completion

- .1 Arrange for the final inspection by the manufacturer.
- .2 Provide a copy of the manufacturer's final inspection report to the Consultant for review, including photographs of representative installations of each type of restraint used in the Work.

END OF SECTION

SPECIAL HOSPITAL WIRING 26 07 05

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 References

- .1 CSA Z32 - "Electrical Safety and Essential Electrical Systems in Health Care Facilities".

1.3 Work Included

- .1 Work to be done under this Section includes furnishing of labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.4 Description

- .1 Patient care areas are grouped in three categories, as follows:
 - .1 Basic care
 - .2 Intermediate care
 - .3 Critical care
- .2 Examples of the categories are:
 - .1 Basic care areas
 - (a) Patient care areas where body contact between a patient and medical electrical equipment is neither frequent nor usual, eg: examination rooms.
 - .2 Intermediate care areas:
 - (a) Patient bedwards (except where specifically identified as Basic Care)
 - (b) Treatment rooms
 - (c) Examination rooms (where medical electrical equipment is typically used)
 - (d) Clinics and similar areas
 - (e) Recovery Rooms
 - (f) Patient Holding Areas
 - (g) Patient Preparation Rooms
 - (h) Hydrotherapy Rooms
 - (i) Dialysis Treatment Stations
 - .3 Critical care areas:
 - (a) Anaesthetizing locations
 - (b) Intensive Care Units
 - (c) Coronary Care Units
 - (d) Special Care Units
 - (e) Cardiovascular Care Units
 - (f) Intermediate Coronary Care Units
 - (g) Renal Dialysis Units
 - (h) Angiographic Laboratories

- (i) Burn Units
- (j) Cardiac Cauterization Laboratories
- (k) Emergency Trauma Units
- (l) Resuscitation Rooms

2 PRODUCTS

2.1 Receptacles

- .1 Receptacles in patient care areas: Hospital Grade.
- .2 Receptacles connected to the emergency power system: coloured red.
- .3 Receptacles in patient care areas to have circuit identification in accordance with CSA standard Z32.
- .4 Circuit identification labels;
 - .1 permanent label incorporated into the face of the receptacle (not the cover plate), and visible with the cover plate in place, or
 - .2 a lamacoid secured to the wall above the receptacle (not to the cover plate).
- .5 Circuit identification information;
 - .1 name of panel feeding the receptacle,
 - .2 circuit number.
- .6 Lettering of circuit identification;
 - .1 not less than 6mm high, with
 - .2 black letters, on white background for normal power,
 - .3 red letters, on white background for emergency power.

3 EXECUTION

3.1 Bonding to Ground

- .1 Bond to ground receptacles and permanently wired electrical equipment in patient care areas by installing an insulated green equipment bonding conductor in the same conduit as the branch circuit conductors.
- .2 Terminate the bonding conductor at the load end of the circuit to the ground screw in the outlet box and extend to the ground screw on the device. At the source end, terminate the bonding conductor on the ground bus in the panel.
- .3 Provide a separate bonding conductor for each circuit, except that where the single phase receptacles in a patient care environment are supplied from two 2- wire branch circuits in the same conduit, a single bonding conductor may be provided for the two circuits.
- .4 Size bonding conductors equal to the branch circuit conductors.
- .5 In critical care areas provide a separate #10 bonding conductor for each circuit, from the outlet back to the panel.

- .6 Interconnect the ground busses in electrical panels which serve the same patient care areas with an insulated green copper conductor installed in PVC conduit and sized per Table 16 of the Electrical Safety Code, but not less than #6 AWG.
- .7 Bond to ground exposed metal non-current carrying parts of equipment located within 1.5 m horizontally from the nominal position of the bed and within 2.3 m vertically above the floor. Use green insulated copper bonding conductors;
- .8 Typical equipment to be bonded to ground includes;
 - .1 fixtures,
 - .2 headwall units,
 - .3 service strips,
 - .4 intercom stations,
 - .5 nurse call stations,
 - .6 view boxes,
 - .7 receptacles,
 - .8 switches,
 - .9 cover plates,
 - .10 conduits,
 - .11 outlet boxes, and
 - .12 other equipment as required by Code.

3.2 Neutral Conductors

- .1 In intermediate and critical care areas, provide a separate neutral conductor for each branch circuit phase conductor back to the panel supplying the outlet.
- .2 Where multiple circuits share a conduit, derate conductors, where required, on the basis that the neutral conductors are full current carrying conductors.

END OF SECTION

TESTING OF HOSPITAL WIRING

26 08 13

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.

1.2 References

- .1 CSA Z32 - "Electrical Safety and Essential Electrical Systems in Health Care Facilities".

1.3 Work Included

- .1 Work to be done under this Section includes furnishing of labour, materials, and equipment required for testing and putting into proper operation complete systems as shown as specified and as otherwise required.

1.4 Description

- .1 The checks and tests described in this section are additional to the normal visual and mechanical inspections and additional to the testing specified elsewhere.
- .2 Demonstrate and document that each branch circuit breaker, receptacle and circuit serving a patient care area is in compliance with the requirements of the ESC, CSA standard Z32 and the specifications. The patient care areas include;
 - .1 Basic care,
 - .2 Intermediate care,
 - .3 Critical care.
- .3 Where the requirements of the specifications, the ESC and the CSA standard differ, comply with the most stringent requirements.
- .4 Refer to CSA Standard Z32 for test circuits.
- .5 Tests and checks to be done in the presence of the Consultant.
- .6 Give timely notice to the Consultant that the work is ready for testing.
- .7 Where required, provide remedial work and retesting at no cost to the Owner until acceptable results are obtained and documented.
- .8 Do not place equipment into service until acceptable results have been obtained and reviewed by the Consultant.
- .9 The submission of acceptable test results is a pre-requisite to permitting occupancy of a patient care area.
- .10 The testing specified in this Section is to be provided by a professional independent testing organizations:

2 PRODUCTS

2.1 Reports

- .1 Include in the reports the individual test results for each test conducted on each breaker, receptacle, and circuit. Test results to include;
 - .1 measured values plus, where applicable, the calculated values,
 - .2 go/no go conditions,
 - .3 name of the patient care area,
 - .4 room number,
 - .5 circuit number,
 - .6 receptacle identification where more than one receptacle is connected to a circuit,
 - .7 specific outlet of a duplex receptacle (eg: top, bottom),
 - .8 name of the panelboard/isolated power system that feeds the circuit,
 - .9 date,
 - .10 name of the individual(s) who performed the checks and tests.
- .2 Results for each room to be on a separate page(s).
- .3 Reports to include a certificate, bearing a professional engineer's seal and signature, stating that the installation meets the requirements of the CSA Z32 standard, and is suitable for patient use.
- .4 Reports to be paper (hard copy) documents, as well as electronic documents.
- .5 Include copies of the reports in the Operating and Maintenance Manuals.

3 EXECUTION

3.1 Preliminary Checks

- .1 Confirm that the installation is complete, cleaned and ready for testing.

3.2 Tests

- .1 Perform the following tests, as applicable, on each branch breaker, circuit, receptacle and isolated power system serving a patient care area:
 - .1 Branch Circuit Breaker Mechanical Operation,
 - .2 Conductor Insulation Integrity Test (for grounded systems only),
 - .3 Receptacle Retentive Force Test,
 - .4 Receptacle Polarity Test,
 - .5 Branch Circuit Impedance Test (Voltage Drop Test – for grounded systems only),
 - .6 Ground Point Voltage Rise Test (for grounded systems only),
 - .7 Potential Difference Between Ground Points Test,

3.3 Branch Circuit Breaker Mechanical Operation

- .1 Requirements:

Issued For Construction

- .1 Each breaker to open and close.
- .2 Method:
 - .1 Confirm that no utilization equipment is connected to the system.
 - .2 Open and close each branch circuit breaker three times.
 - .3 Confirm that each branch circuit breaker operates mechanically.
 - .4 Record go/no go operation of each breaker.

3.4 Conductor Insulation Integrity Test (Grounded Systems Only)

- .1 Requirements:
 - .1 Not less than 10kΩ to ground for neutral conductors (all neutrals combined).
 - .2 Not less than 500kΩ to ground for each ungrounded conductor.
- .2 Method: .
 - .1 Use a 500V dc megohmmeter, isolate the branch circuits under test as required.
 - .2 Ensure that other circuits serving patients or sensitive equipment are not exposed to the test voltage.
 - .3 Measure the insulation resistance of each branch circuit conductor with all wiring devices connected.
 - .4 Confirm that the values for each conductor meet the requirements.
 - .5 Record the measured values.

3.5 Receptacle Retentive Force Test

- .1 Requirements:
 - .1 A force of 1.1 Newtons does not remove a test pin from the ground slot of a receptacle.
 - .2 A force of 13 Newtons does not remove a two pin test attachment plug from a receptacle.
- .2 Method:
 - .1 Use the test pins and methods specified in CSA Standard C22.2 No. 42. As an alternative, a commercially available "tension tester" complying with CSA Standard C22.22 No. 42, General Use Receptacles, Plugs and Similar Wiring Devices may be employed.
 - .2 If using the tension checker, ensure that the device is calibrated for tension (Newtons) for both single-ground pin and for multiple pin testing.
 - .3 For each outlet, check that the tension of ground pin removal meets or exceeds the requirement.
 - .4 For each outlet, check that the tension of the two pin removal meets or exceeds the requirement.
 - .5 Record go/no go tension reading for each outlet.

3.6 Receptacle Polarity Test

- .1 Requirements:
 - .1 Receptacles to be connected in accordance with configurations listed in Canadian Electrical Code CSA C22.1, latest edition Section 26.
- .2 Method:
 - .1 Utilize polarity test set, and test each receptacle.

- .2 Correct connection of receptacles where polarity indication is incorrect.
- .3 Record go/no go test results for each receptacle.

3.7 Branch Circuit Impedance Test (Voltage Drop Test – Grounded Systems Only)

.1 Requirements:

- .1 Voltage drop in branch circuit wiring from panelboards to receptacles not to exceed 3% when a load of not less than 80% of the breaker rating is applied at the receptacle.

.2 Method:

- .1 Utilize equipment approved by the Consultant. See Figure 2 in CSA standard Z32 for test circuit.
- .2 Ensure that all circuits other than the one under test are de-energized.
- .3 Record no load voltage at receptacle (V_o).
- .4 Apply current to 80% of the rating of the overcurrent device protecting the circuit under test and record voltage (V_L).
- .5 Remove load and reconfirm value of V_o .
- .6 Calculate voltage drop at receptacle by the formula:

$$\frac{V_o - V_L}{V_o} \times 100$$

- .7 Record the results.
- .8 Where the calculated voltage drop exceeds 3.3% rework the branch circuit wiring as required to reduce the voltage drop within the required value.

3.8 Ground Point Voltage Rise Test (Grounded Systems Only)

.1 Requirements:

- .1 The voltage rise at the ground point of each receptacle not to exceed 3 V when a current of not less than 80% of the rating of the overcurrent device, protecting the circuit under test, is passed through the bonding conductor.

.2 Method:

- .1 Use the test circuit of Figure 4 in CSA standard Z32.
- .2 Connect the test circuit to the outlet.
- .3 With switch SW open, record the voltage indicated by voltmeter V_1 as V_N , the neutral to ground voltage without load. If it exceeds about 2 V, determine the cause and correct the defect.
- .4 Using the low voltage supply, (nominally 5 V open circuit) apply a load of 80% of the rated current of the circuit, between the neutral and the bonding conductor for a period of from 1 to 5 s. Feed the low voltage supply from a circuit other than the one being tested. Record the current I, the voltage indicated by voltmeter V_1 as V_R , and the voltage indicated by voltmeter V_2 as V_o .
- .5 Record the results. The return path voltage rise V_o not to exceed 3 V.
- .6 Where voltage rise exceeds 3 V, rework the branch circuit bonding conductor as required to reduce the voltage rise within the required value.

3.9 Potential Difference Between Ground Points Test

.1 Requirements:

- .1 Potential difference between the grounding poles of receptacles and between these poles and all other exposed conductive non-current-carrying parts in the same patient care environment, to be less than 20 mV.
- .2 Method:
 - .1 Use the standard frequency-weighted test circuit of Figure 3 in CSA standard Z32.
 - .2 Confirm that all receptacles have been installed and that no utilization equipment, either permanently wired or cord-connected, is connected to the system.
 - .3 Energize the system.
 - .4 Select a local reference point known to be bonded to ground and record the measured voltage between this chosen reference and each receptacle ground pole and each exposed conductive non-current-carrying metal part.
 - .5 If the test leads are long, correct the readings for pickup (zero reading when the test leads are connected together).
 - .6 Record the results.

3.10 Reports

- .1 Prepare and submit reports within 5 days of the completion of testing in an area.
- .2 Submit one complete copy of reports, studies and test results directly to each of the Consultant and the Owner. Simultaneously submit a further 6 copies to be processed as a shop drawing.
- .3 Include copies of reports, studies and test results in the Maintenance Manuals.

END OF SECTION

PROJECT CLOSE-OUT ELECTRICAL
26 08 19

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.

1.2 Scope

- .1 Provide documentation deliverables at completion of the Work.

1.3 Occupancy Permit

- .1 Submit the reviewed final Life Safety and Fire Protection Commissioning report two weeks prior to application for occupancy permit.

1.4 Substantial Performance

- .1 Complete the Substantial Performance Checklist and submit with required documentation when applying for Substantial Performance of the Work.
- .2 Where the work is sub-divided into separate scopes of Work, each requiring a separate Substantial Performance application, provide a separate checklist for each application.
- .3 Prepare and submit to the Consultant a comprehensive deficiency list of items to be completed or corrected, as part of the application for a review by the Consultant to establish Substantial Performance of the Work, or for each designated portion of the Work in the case of phased Substantial Performance.
 - .1 Failure to include an item on the list does not alter the Contractor's responsibility to complete the Work.
- .4 Within five working days of the Consultant's review report which indicates that Substantial Performance of the Work has been achieved, provide a detailed schedule for completion and/or correction of the Work of all items described in the Contractors' and the Consultants' deficiency list.

1.5 Total Performance

- .1 Submit the following documentation with the application for Total Performance. Application for Total Performance cannot be submitted any earlier than the date of Alternate Season testing.
 - .1 Where documentation has already been submitted to the Owner, provide a copy of the transmittal.

SUBSTANTIAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- Contractor has compiled and submitted a detailed deficiency list, identifying work still to be completed, incomplete, or requires correction.
- Equipment start-up reports (Interim).
- Building department inspection reports.
- TSBC field inspection reports.
- Fire alarm verification certificate.
- Independent testing company, coordination study and testing reports submitted.
- Equipment and wiring identification completed
- Clean-up completed.
- Spare parts and replacement parts turned over to Owner; transmittal attached.
- Warranty certificates
- Operating and Maintenance Manuals, draft, submitted.
- As-built drawings submitted
- Training completed and attendance logs submitted.
- Commissioning reports submitted and reviewed by Consultant

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> <u>Incomplete or deficient - resubmit</u>
Signed:	
Date:	

TOTAL PERFORMANCE APPLICATION CHECKLIST	
Project Name:	
Contract:	
Contract Scope:	
Application Date:	
Signed:	

The following requirements are completed and included in this application. Where documentation has been issued directly to the Owner, a copy of the transmittal is enclosed.

- All known deficiencies have been corrected, including latent deficiencies reported by the Owner.
- Final commissioning reports submitted and accepted by Owner.
- Operating and Maintenance manuals - finalized and submitted (if final version was issued at time of Substantial Performance indicated here: .
- As-built drawings final version submitted (if final version was issued at time of Substantial Performance indicate here: Date of delivery: _____)

Consultant Review	
Status:	<input type="checkbox"/> Reviewed <input type="checkbox"/> Incomplete or deficient - resubmit
Signed:	
Date:	

END OF SECTION

WIRING DEVICES **26 27 26**

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Related Sections

- .1 Section 26 05 53, Identification for Electrical Systems.
- .2 Section 26 08 13, Testing of Hospital Wiring.

1.3 Submittals

- .1 Submit shop drawings for each type and size of device.

1.4 Applicable Codes and Standards

- .1 Latest edition of CSA C22.2 No. 111 Switches.
- .2 Latest edition of CSA C22.2 No. 42 Receptacles.

1.5 Scope

- .1 Provide labour, materials, and equipment required for installation, testing and putting into proper operation complete systems as shown as specified and as otherwise required.

2 PRODUCTS

2.1 Nameplates

- .1 Wall mounted:
 - .1 engraved laminated plastic to Section 26 05 53 Identification for Electrical Systems,
 - .2 7 mm (1/4") high letters unless indicated otherwise.
- .2 Receptacle mounted:
 - .1 permanently printed on white polyester background,
 - .2 7 mm (1/4") high letters unless indicated otherwise,
 - .3 UV resistant inks,
 - .4 clear polyester over lamination,
 - .5 pressure sensitive adhesive.
- .3 Colours:
 - .1 normal power: black lettering on white background,
 - .2 emergency power: red lettering on a white background,

.3 “NOT FOR PATIENT CARE”: white lettering on green background.

2.2 Switches

.1 Features:

- .1 20 A, 120 V, general purpose AC type,
- .2 higher ratings where indicated,
- .3 CSA listed,
- .4 fully rated for:
 - (a) tungsten filament lamps,
 - (b) fluorescent lamps,
 - (c) inductive loads,
- .5 HP rated where used in motor circuits, with rating not less than the motor HP,
- .6 industrial/specification grade,
- .7 toggle handle,
- .8 silent operation,
- .9 terminals rated for No. 10 AWG wire,
- .10 suitable for back and side wiring,
- .11 silver alloy contacts,
- .12 single pole, double pole, three-way, four-way switches as indicated.

.2 Toggle colours:

- .1 Normal power: ivory.
- .2 Emergency power: clear.

.3 Decora rocker colour: ivory.

.4 Switches of one manufacturer throughout project, unless accepted otherwise.

Standard of Acceptance

- Pass & Seymour (Legrand)
- Hubbell
- Bryant Electric
- Cooper-Eaton Wiring Devices (Arrow Hart)
- Leviton

.5 Switches controlling lights on 120 volt power circuits:

Standard of Acceptance

	Catalogue Numbers				
	Hubbell (Toggle) / (Decora)	Bryant (Toggle) / (Decora)	P & S (Toggle) / (Decora)	Cooper (Toggle) / (Decora)	Leviton (Toggle) / (Decora)
Single Pole	1221 / DS120	4901 / -	PS20AC1 / 2621	AH1221 / -	1221-2 / 5621-2
Double Pole	1222 / DS220	4902 / -	PS20AC2 / 2622	AH1222 / -	1222-2 / 5622-2

Three-Way	1223 / DS320	4903 / -	PS20AC3 / 2623	AH1223 / -	1223-2 / 5623-2
Four-Way	1224 / DS420	4904 / -	PS20AC4 / 2624	AH1224 / -	1224-2 / 5624-2

- .6 Switches controlling lights on 120 volt emergency power circuits: lighted handle, light to be on when load is off:

Standard of Acceptance

Type	Catalogue Numbers				
	Hubbell	Bryant	P & S	Cooper	Leviton
Single Pole (Toggle) (Decora)	HBL1221IL	4901GL	PS20AC1-SL	AH1221LT	1221-LH
	DS120IL	-	2625	-	5631-2
Three-Way (Toggle) (Decora)	HBL223IL	4903GB	PS20AC3-SL	AH1223LT	1223-LH
	DS320IL	-	2626	-	5633-2

2.3 Dimmer Switches

- .1 Dimmers for 0-10V LED drivers and fluorescent ballasts:

Standard of Acceptance

- Lutron Diva DVSTV
- Leviton DS710-10
- Cooper DF10P

2.4 Receptacles

- .1 Standard duplex style.
- .2 Heavy duty industrial/specification grade.
- .3 Patient care areas: hospital grade.
- .4 With the following features:
- .1 eight back wired entrances, four side wiring screws,
 - .2 suitable for no. 10 AWG for back and side wiring,
 - .3 break-off links for use as split receptacles,
 - .4 triple wipe contacts,
 - .5 riveted or integral ground contacts.
- .5 Colour coded as follows:
- .1 Normal power: ivory,
 - .2 Emergency power: red.
- .6 One manufacturer throughout the project.

Standard of Acceptance

- Pass & Seymour (Legrand)
- Hubbell
- Bryant Electric
- Cooper-Eaton Wiring Devices (Arrow Hart)
- Leviton

.7 The receptacles listed below represent the most common configurations and are not necessarily used on this project. Refer to drawings for types used.

.1 Duplex receptacle: 15 ampere, 120 volt, grounded CSA Configuration 5-15R:

Standard of Acceptance

Type	Catalogue Numbers				
	P & S	Hubbell	Bryant	Leviton	Cooper
Non-decora (Hospital grade)	5262	5262	5262	5262	AH5262
	8200	8200	BRY8200	8200	8200
Decora (Hospital grade)	26252	HBL2152	9252	16262	6262
	26262HG	2172	9200	16262-HG	8262

.2 Tamper-Resistant duplex safety Hospital grade receptacle: 15 ampere, 120 volt, grounded CSA Configuration 5-15R:

Standard of Acceptance

Type	Catalogue Numbers				
	P & S	Hubbell	Bryant	Leviton	Cooper
Non-decora	TR62H	8200-SG	BRY8200-TR	8200-SG	TR8200
Decora	TR26262HG	2172-TRA	-	16262-SG	-

.3 Duplex receptacle: 15 / 20 ampere, 120 volt, grounded CSA Configuration 5-20R:

Standard of Acceptance

Type	Catalogue Numbers				
	P & S	Hubbell	Bryant	Leviton	Cooper
Non-decora (Hospital grade)	5362	5362	5362	5362	AH5362
	8300	8300	BRY8300	8300	AH8300
Decora (Hospital grade)	26352	HBL2162	9352	16362	6362
	26362HG	HBL2182	9300	16362-HG	8362

2.5 Cover Plates

- .1 Compatible with wiring device.
- .2 Stainless steel 18-8 chrome metal alloy, Type 302, vertically brushed, 1 mm (1/32") thick cover plates for wiring devices in flush-mounted outlet boxes.
- .3 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .4 Engraving, where indicated:
 - .1 6 mm (1/4") high letters filled with red paint,
 - .2 parallel to finished floor level.
- .5 One manufacturer throughout the project.

Standard of Acceptance

- Pass & Seymour #93000 Series
- Harvey Hubbell of Canada Ltd. #93000 Series
- Bryant Electric #S600 Series
- Leviton #84000 Series
- Cooper #93000 Series

3 EXECUTION

3.1 Identification

- .1 Label receptacles with circuit identification using a lamacoid label with colour coding for normal, emergency and UPS source with label attached to the receptacle or the wall above the receptacle.
- .2 Label receptacles in patient care areas in accordance with the latest version of CSA standard Z32:
 - .1 lamacoid label secured to the wall above the receptacle,
 - .2 engraved with the panel name and circuit number from which the receptacle is fed,
 - .3 lettering not less than 6 mm (1/4") high,
 - .4 normal power: black lettering on white lamacoid,
 - .5 emergency power: red lettering on a white lamacoid.
 - .6 Provide an additional lamacoid, of matching colour, for receptacles on dedicated circuits, stating: "Dedicated Circuit".
 - .7 Identify receptacles, located within a patient care area but not intended for patient care use, with a nameplate stating "NOT FOR PATIENT CARE".
- .3 Label pilot light switches:
 - .1 lamacoid label secured to the wall above the switch,
 - .2 engraved with the name of the load controlled,
 - .3 black lettering on white background.

3.2 Installation

- .1 Switches
 - .1 Mount switches vertically so that the switch contacts are closed when the toggle is up or, in the case of Decora switches, when the top part of the rocker is depressed.

- .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Provide separate boxes where switches are supplied from different power systems (normal and emergency).
 - .4 Mount switches at heights specified in Section 26 05 01 - Electrical Basic Materials & Methods unless indicated otherwise.
 - .5 Verify the door swing and ensure easy access before installing switches.
 - .6 Switches installed adjacent to dimmers: provide switches that match appearance of dimmers.
 - .7 Pilot light switches: run a neutral conductor to the switch.
- .2 Dimmers
- .1 Where more than one dimmer is shown in the same location, mount dimmers in individual backboxes.
 - .2 Where remote dimmers are utilized, install associated components in accordance with the manufacturer's recommendations.
- .3 Receptacles
- .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Provide separate boxes where receptacles are supplied from different power systems (normal and emergency).
 - .3 Mount receptacles at heights specified in Section 26 05 01 - Electrical Basic Materials & Methods unless indicated otherwise.
 - .4 For each type of receptacle 20 ampere or larger, supply and hand to Owner two heavy duty caps.
 - .5 Connect receptacle grounding terminal to the outlet box with an insulated green bonding conductor.
 - .6 Verify exact position of service fittings to suit furniture layout.
 - .7 Do not mount receptacles directly on a column, unless column has been appropriately furred, to avoid breaking fire barrier.
- .4 Cover Plates
- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
 - .2 Install suitable common cover plates where wiring devices are grouped.
 - .3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .5 Install explosion proof wiring and devices in hazardous locations of Class, Division and Group as indicated on Drawings.
- .6 Ground fault circuit interrupters:
- .1 Mount receptacles at height indicated in Section 26 05 01 - Electrical Basic Materials & Methods unless indicated otherwise.
- .7 Outlets in Movable Partitions
- .1 Co-ordinate installation of outlet boxes and conduits with the particular trade involved.

3.3 Testing

- .1 Verify the operation of illuminated handles in switches.
- .2 Verify the operation of lights on pilot light switches.
- .3 Test each receptacle for correct polarity and ground continuity.
- .4 For receptacles in patient care areas, provide the testing per Section 26 08 13 Testing of Hospital Wiring.

END OF SECTION

WIRE AND BOX CONNECTORS 0-1000 V 26 27 28

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Applicable Codes and Standards

- .1 Latest version of CSA C22.2 No.65 Wire Connectors.
- .2 Latest version of CSA C22.2 No.188 Splicing Wire Connectors.

2 PRODUCTS

2.1 Materials

- .1 Mechanical pressure type wire connectors:
 - .1 for copper conductors: current carrying parts of copper or tin plated aluminum,
 - .2 for aluminum conductors: current carrying parts of aluminum.

Standard of Acceptance

- Burndy
- IlSCO
- Thomas & Betts

- .2 Compression type pressure wire connectors:
 - .1 long barrel
 - .2 tin plated copper for copper conductors
 - .3 aluminum for aluminum conductors

Standard of Acceptance

- Burndy
- IlSCO
- Thomas & Betts

- .3 Twist on wire connectors:
 - .1 for copper wire up to and including #6 AWG,
 - .2 "live" spring construction,
 - .3 corrosion resistant spring,
 - .4 square wire spring construction,
 - .5 polypropylene cap rated for 105°C

Standard of Acceptance

- T&B Murette
- Ideal
- 3M

- .6 For damp, wet, outdoor and submersible locations: filled with silicone gel.
- .4 Fixture type splicing connectors:
 - .1 current carrying parts of copper,
 - .2 sized to fit copper conductors 10 AWG or less,
 - .3 temperature rating of not less than 105°C

Standard of Acceptance

- Burndy
- Hubbell
- Thomas & Betts

3 EXECUTION

3.1 Installation

- .1 Provide connectors in accordance with the manufacturer's recommendation for the size, quantity and type of wires.
- .2 Install connectors in accordance with the manufacturer's recommendations.
- .3 Remove insulation carefully from ends of conductors:
 - .1 where the conductor is damaged, remove the damaged portion and strip the insulation back further as necessary,
 - .2 where the conductor is too short, replace the conductor.
- .4 For aluminum conductors, clean the conductors and immediately coat with electrical joint compound.
- .5 Tighten screws of mechanical pressure type connectors in accordance with the manufacturer's recommendations. Installation to meet secureness tests in accordance with CSA C22.2 No.65.
- .6 Install compression type connectors using the appropriate compression tool and die as recommended by the manufacturer. Make two crimps on each wire. Installation to meet secureness tests in accordance with CSA C22.2 No.65.
- .7 Remove all traces of electrical joint compound after each connection has been made.
- .8 Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS 26 28 16

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 References

- .1 CAN/CSA C22.2 No. 5.1. Moulded case circuit breakers.

1.3 Shop Drawings and Product Data

- .1 Submit shop drawings and product data in accordance with Section 26 01 01 Electrical General Requirements.
- .2 Nameplates shall be in accordance with Article "Equipment Identification".
- .3 Include time-current characteristic curves for breakers with ampacity of 200 A and over or with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.4 Work Included

- .1 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 systems as shown as specified and as otherwise required.

1.5 Operation and Maintenance Data

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 01 01 Electrical General Requirements.

1.6 Maintenance Materials

- .1 Provide maintenance materials as required and as specified in Section 26 01 01 Electrical General Requirements.

1.7 Operating and Maintenance Instructions

- .1 Provide operating and maintenance instructions as specified in Section 26 01 01 Electrical General Requirements.

2 PRODUCTS

2.1 Breakers General

- .1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation.
- .2 Common-trip breakers: with single handle for multi-pole applications.

- .3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 5 - 10 times current rating.
- .4 Circuit breakers with interchangeable trips over 150 A.
- .5 35,000 Amps symmetrical interrupting rating at 600 volts

2.2 Thermal Magnetic Breakers

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Solid State Trip Breakers

- .1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase, ground fault and short circuit protection.

2.4 Features

- .1 Include
 - .1 on-off locking device
 - .2 handle mechanism

2.5 Enclosure

- .1 Mount individually mounted breakers in CEMA 3 enclosure.

3 EXECUTION

3.1 Installation

- .1 Install circuit breakers as indicated.

END OF SECTION

LIGHTING

26 51 13

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 Work Included

- .1 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 Electrical systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation.

1.3 Shop Drawings and Product Data

- .1 Submit shop drawings in accordance with Section 26 01 01 Electrical General Requirements - Shop Drawings and Product Data.
- .2 Submit complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .3 Photometric data to include:
 - .1 Total input watts, candlepower summary, candela distribution zonal lumen summary, luminaire efficiency, CIE type, coefficient of utilization, lamp type and lumen rating in accordance with IESNA testing procedures.

1.4 Requirements

- .1 Luminaires shall not be delivered to building or stored therein until dry and protected space is available for proper storage of luminaires.
- .2 Submit samples of luminaires which are not catalogue items for approval. Additional luminaires shall not be manufactured until sample has been approved. Each approved sample shall be retained on job site until final completion of project. Luminaires which do not match quality and workmanship of standard sample will be rejected.
- .3 Finishes of luminaires, as specified in the "Luminaire List" must be maintained. Where the description of the luminaire directs a "colour/ finish to suit Architect" it is to be understood that during construction the final colour/finish will be selected. The Architect must be permitted to make their choice from a standard colour/finish range but the selected colour will apply to all of the particular type of luminaire unless otherwise specified.

1.5 Substitutions

- .1 Luminaires included under this Section are specified by approved manufacturer and type. Furnish equipment, as specified:

2 PRODUCTS

2.1 General

- .1 Similar luminaires shall be products of same manufacturer.
- .2 Luminaires shall be suitable for individual or continuous mounting.
- .3 Supply recessed luminaires, where installed in plaster or in acoustic ceilings, complete with plaster trim frame or ring and mounting brackets.
- .4 Troffers in ceiling shall be equipped with adjustable mounting brackets.
- .5 Luminaires shall be completely assembled in factory and shall be delivered to building in cartons or in palletized form, as directed.

2.2 Ballasts

- .1 LED Drivers:
 - .1 Operable from 50/60 Hz input source of 120V through 277V or 347V through 480V with sustained variations of $\pm 10\%$ (voltage) with no damage to the driver.
 - .2 Input power factor greater than 0.90 from 20% to 100% rated load.
 - .3 Input current Total Harmonic Distortion (THD) less than 20% from 20% to 100% rated load.
 - .4 Comply with NEMA 410 for in-rush current limits.
 - .5 Output current regulated to $\pm 5\%$ across published load range.
 - .6 Output ripple current at maximum output:
 - (a) less than 15% measured peak-average/average,
 - (b) less than 5% low frequency content (< 120 Hz.).
 - .7 Integral means of limiting surges to the LED's, based on 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).
 - .8 Able to tolerate sustained open circuit and short circuit output conditions without failure, without need for external fuses or trip devices. Auto resetting.
 - .9 No visible flicker when tested with flicker wheel.
 - .10 For dimming systems: no visible flicker, when tested with flicker wheel, across the full dimming range.
 - .11 Minimum operating temperature:
 - (a) -20°C (-4°F) for interior applications,
 - (b) -40°C (-40°F) for exterior applications.
 - .12 Metallic enclosure for optimal thermal performance.
 - .13 Integral thermal foldback to reduce driver power if case temperature exceeds rated maximum temperature.
 - .14 Compatible with the dimming system.
 - .15 Class A sound rating.

- .16 Rated for UL Damp and Dry locations.
- .17 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 of an additional enclosure.
- .18 For linear luminaires: slim profile with height \leq 25 mm (1 inch) and width \leq 30 mm (1.2 inch).
- .19 Integral colour-coded connectors.
- .20 Free of any Polychlorinated Biphenyls (PCBs).
- .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 Comply with applicable requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 15, for Non-Consumer equipment.
- .23 RoHS compliant.
- .24 Warranty: 5 years

Standard of Acceptance

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

2.3 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. CCT tolerances to remain within a 3-step MacAdam ellipse and to maintain a CRI of \geq 80, and an $R_9 > 50$.
 - .3 Colour temperature and lumen output for each luminaire per luminaire schedule. Comply with IESNA LM-79 testing procedures.
 - .4 Maximum temperature at the base of the "LED cap" mounted to the substrate to be controlled to ensure full lamp life.
 - .5 Minimum lumen maintenance of L_{70} @ 50,000 hours. Comply with IESNA LM-80 and LM-21 testing procedures.
 - .6 LED's of the same type to be from the same manufacturing batch.
 - .7 Capable of continuous dimming, flicker and noise free, from 10-100% lumen output.
 - .8 Provide certified test results for each type of LED used on the project.
 - .9 Warranty: 5 years

Standard of Acceptance- Lamp Acceptance:

- Cree
- Lumileds
- Nichia
- Osram

- GE
- Samsung
- Bridgelux

3 EXECUTION

3.1 Installation

- .1 Locate and install luminaires as indicated.
- .2 Locate hangers on tile centres or intersections. Mount recessed incandescents, troffers and surface mounted luminaires in or on full tiles.
- .3 Verify quantity of luminaires before placing orders.
- .4 Verify ceiling types with the latest revised Architectural Drawings and order luminaires to suit the correct ceiling.
- .5 Check lighting 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.
- .6 Co-operate with other trades to ensure proper installation of lighting luminaires.
- .7 Carefully align luminaires, shown in continuous lines or rows, so that rows appear as straight lines.
- .8 Mount luminaires perfectly level or plumb. Luminaires shall fit tightly to ceiling without showing a space or light leak between frame and ceiling.
- .9 Take down any improperly installed luminaires and re-install without expense to Owner.
- .10 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.
- .11 Attach boxes or hickies directly to poured concrete with 6mm (¼") minimum diameter bolts and lead expansion anchors where luminaires are suspended directly from concrete slabs. Use 8mm (5/16") minimum bolts through precast slabs, welded to 100mm x 100mm (4" x 4") minimum, 3.5mm (10 gauge) plate above slabs.
- .12 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. Luminaires in any room shall hang at one height. Obtain approval before any changes are made to layouts shown
- .13 All luminaires mounted in or on ceilings shall be supported independently of ceiling by means of chains.
- .14 Provide continuous 12mm x 38mm (½" x 1½") channel above the ceiling, where luminaires are suspended or mounted on furred ceilings. Fasten luminaires to channel with two 6mm (¼") minimum diameter studs with minimum 1220mm (4'- 0") on centre.

- .15 Luminaires installed in or on "T" bar ceilings shall be equipped with safety chains anchored in an approved manner to the floor slab or roof structure above. Fluorescent luminaires shall have two chains, each supporting two corners of the luminaire. Chain shall be #10 Tensile jack chain, installed as noted below.
- .16 Chain shall be No. 10 Tensile jack chain, bright zinc coated, with a strength of 180 kg (400 lbs.) where luminaires are indicated to be chain hung. Attachments shall be made using a No. 10 "S" hook. Caddy fasteners may be used where applicable. "S" hooks must be closed after installation.
- .17 Industrial luminaires where suspended shall be 12mm (1/2") conduit hangers and ARB ball aligners. Length and location shall 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 Lighting Luminaires

- .1 Provide lighting luminaires exactly as shown and as specified in the following schedule. Luminaires shall be complete with necessary accessories and lamps at time of acceptance.
- .2 All luminaires shall be ULC or CSA certified.
- .3 Each fluorescent luminaire installed on branch circuits with voltage exceeding 150 volts-to-ground shall be provided with a disconnecting means integral to the luminaire that simultaneously opens all circuit conductors between the branch circuit conductors and the supplying ballast(s) and marked in a conspicuous, legible and permanent, manner adjacent to the disconnecting means, identifying the specific purpose in accordance with the Canadian Electrical Code Part 1 Rule 30-308(4).

3.3 Luminaire List

.1 Luminaire manufacturers are listed in alphabetical order and not in order of preference.

<u>LED Section</u>		
LA	Base Building 6" Round LED downlight Manufacturers: Maxilume: HV6-LED-21W-120-DIM-FL-60K-AT-LED-6101-CL-WH	1100 Lumens 3500K 80+ CRI 21W LED
LB	Recessed 610 (2'-0") x 610mm (2'-0") recessed direct led fixture to match style of existing base building fluorescent luminaires. Fixture shall suitable for installation in t-bar ceiling and be suitable for 0-10v dimming. Voltage: 120V Manufacturers: Ledalite #33-22-D1-ST-L-830-50-A-7-D-E	5000 Lumens 3000K 80+ CRI 42W LED

END OF SECTION

TELEPHONE & DATA RACEWAYS

27 05 28

1 GENERAL

1.1 General Requirements

- .1 Conform to Section 26 01 01, Electrical General Requirements.
- .2 Conform to Section 26 05 01, Electrical Basic Materials and Methods.

1.2 System Description

- .1 Empty raceways systems shall consist of outlet boxes, cover plates, conduits, pull boxes, fish wires and service poles.
- .2 Empty conduit systems being installed shall be for installation of wiring installed at a later date by communications contractor:
 - .1 Telephone and data communications systems.

2 PRODUCTS

2.1 Material

- .1 Conduits: EMT type, to Section 26 05 33 - Conduits Fastenings and Fittings.
- .2 Junction boxes and pull boxes to Section 26 05 32 - Splitters, Junction and Pull Boxes, Cabinets.
- .3 Outlet boxes, and fittings: to Section 26 05 35 - Outlet Boxes, Conduit Boxes and Fittings.
- .4 Cover plates: to Section 26 27 26 - Wiring Devices.
- .5 Fish wire: polypropylene type

3 EXECUTION

3.1 Installation

- .1 Install empty raceway system, including fish wire, outlet boxes, pull boxes, cover plates, conduit, service poles, miscellaneous and positioning material to constitute complete system.
- .2 Verify exact location of outlets to suit furniture layout.
- .3 Fish conduit, clear blockages and outlet and clean out pull boxes at completion of installation. Leave conduit free of water or excess moisture. Install 3 mm (1/8") polypropylene pull cord continuously from outlet to outlet, through conduit and fasten at each box.
- .4 Conduit bends shall have a bending radius of not less than ten times conduit diameter. Ream out conduits and identify end with green paint.
- .5 Install additional steel pull boxes in such a manner that, throughout entire system, there shall be not more than two 90 degree or equivalent bends or more than 30 m (100') in each run, so that wire or cables may be pulled in or withdrawn with reasonable ease.

.6 Minimum space requirements in pull boxes, having one conduit each in opposite ends of box, shall be as follows:

Maximum Size of Conduit in Millimetres (Inches)	Size of Box in Millimetres (Inches)			For each Additional Conduit, Increase Width (Millimetres)Inches)
	Width	Length	Depth	
20 mm (¾")	100 mm (4")	300 mm (12")	75 mm (3")	50 mm (2")
25 mm (1")	100 mm (4")	400 mm (16")	75 mm (3")	50 mm (2")
32 mm (1¼")	150 mm (6")	500 mm (20")	75 mm (3")	75 mm (3")
38 mm (1½")	200 mm (8")	675 mm (27")	100 mm (4")	100 mm (4")
50 mm (2")	200 mm (8")	900 mm (3')	100 mm (4")	125 mm (5")

.7 Minimum space requirements in pull boxes for 90 degree pulls, shall be as follows:

Maximum Size of Conduit in Millimetres (Inches)	Size of Box in Millimetres (Inches)			For each Additional Conduit, Increase Width Millimetres (Inches)
	Width	Length	Depth	
20 mm (¾")	150 mm (6")	300 mm (12")	100 mm (4")	50 mm (2")
25 mm (1")	200 mm (8")	400 mm (16")	150 mm (6")	50 mm (2")
32 mm (1¼")	250 mm (10")	450 mm (18")	200 mm (8")	75 mm (3")
38 mm (1½")	300 mm (12")	600 mm (24")	250 mm (10")	100 mm (4")
50 mm (2")	350 mm (14")	750 mm (30")	300 mm (12")	125 mm (5")

.8 Maintain separation of communications conduits to sources of electromagnetic interference as follows:

Item	Minimum Clearance
Fluorescent ballasts	150mm (6")
Conduit and cables used for electrical distribution less than 1kV	300mm (12")
Conduit and cables used for electrical distribution greater than 1kV	1000mm (36")
Motor	1200mm (48")
Transformer	1200mm (48")

.9 The above tables provides a guideline and at all times the Consultant may advise greater clearances if the currents being carried through these devices are particularly likely to cause interference.

- .10 Interference shall be minimized by ensuring that, wherever possible, communications conductors cross sources of interference at right angles.
- .11 Install cables, conduit and cable tray, etc. along or at right angles to building lines unless impractical to do so. Verify specific cases of deviation in advance with consultant.

END OF SECTION

COMMUNICATIONS CABLING

27 15 00

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.

1.2 Work Included

- .1 Work to be done under this Section shall include furnishing of labor, materials, and equipment required for installation, testing and putting into proper operation complete Communications systems as shown, as specified and as otherwise required. Complete systems shall be left ready for continuous and efficient satisfactory operation. Provide equipment, materials, labor, and services not specifically mentioned or shown which may be necessary to complete or perfect all parts of this installation and in compliance with requirements stated or reasonably inferred by the Contract Documents.
- .2 All work shall be performed as per the schedule prepared by the General Contractor. Allow for work to be done after hours and on weekends as dictated by the schedule.

2 INSTALLATION GUIDELINES

2.1 Codes and Standards

- .1 All work performed on this project will be installed in accordance with the current edition of the Canadian Electrical Code and all local codes and ordinances, authorities having jurisdiction, and the following standards (including all sub-headings, addenda, and TSBs):
 - .1 ANSI/TIA/EIA-568-C.0, Generic Telecommunications Cabling for Customer Premises, Ed. C, Amd. 2, 08-2012.
 - .2 ANSI/TIA/EIA-568-C.1, Commercial Building Telecommunications Cabling Standard, Ed. C, Amd. 2, 05-2012.
 - .3 ANSI/TIA/EIA-568- C.2, Balanced Twisted-Pair Telecommunication Cabling and Components Standard, Ed. C, Err. 04-2014
 - .4 ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard, Ed. C, Amd. 1, 10-2011
 - .5 ANSI/TIA-568-C.4, Broadband Coaxial Cabling and Components Standard, Ed. C, 07-2011
 - .6 TIA-569-B-2004, Commercial Building Standards for Telecommunications Pathways and Spaces
 - .7 ANSI/TIA/EIA-606-B-2012, Administration Standard for Commercial Telecommunications Infrastructure
 - .8 ANSI J-STD-607-B-2011, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - .9 CSA C22.1-06, Canadian Electrical Code, Part I: Safety Standard for Electrical Installers
 - .10 CSA C22.1HB-06, CE Code Handbook
 - .11 CSA T568.1-05, Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements (adopted ANSI/TIA/EIA-568-B.1-2001)
 - .12 Building Industry Consulting Service International (BICSI) TDM Manual latest editions at the time of tender.

- .13 Manufacturers design guide.
- .14 Hospital IT standards.

- .2 The Contractor's performance of the work shall comply with applicable national, provincial and local laws, rules, and regulations. The Contractor shall give required notices, shall procure necessary governmental licenses and inspections, and shall pay without burden to the Owner, all fees and charges in connection therewith unless specifically provided otherwise. In the event of violation, The Contractor shall pay all fines and penalties, including attorney's fees, and other defense costs and expenses in connection therewith.

3 QUALIFICATION OF SYSTEM

3.1 General

- .1 Acceptable proposed system will be covered by a two part certification program provided by the single manufacturer and that manufacturer's Reseller (Vendor, Installer or similar designation).
- .2 Manufacturer shall administer a program through the Installer to provide support and service to the purchaser.
- .3 The first part is an assurance program which provides that the certified system will support the applications for which it is designed, during the lifetime of the certified system.
- .4 The second portion of the certification is a 25-year warranty provided by the Manufacturer and the Reseller on all products within the system (jacks, cables, cross-connects, baluns, etc...).
- .5 In the event that the certified system ceases to support the certified applications, whether at the time of cut over, during normal use or when upgrading, the Manufacturer and Reseller shall commit to promptly implement corrective action.
- .6 Documentation proving the cabling system's compliance to the recommendations, as listed in the Codes and Standards section shall be provided by the Reseller prior to the structured cabling system being installed.
- .7 Workmanship and installation methods used shall be equal to or better than that found in the BICSI (Building Industry Consulting Service International) TDM manual and the NeiS document "Installing Commercial Building Telecommunications Cabling".
- .8 Purchaser demands strict adherence to the performance specifications listed in the Codes and Standards section. The manufacturer shall maintain 9001 Quality Control certification for the facilities that manufacturer the product used in this cabling system.

4 MANUFACTURER

4.1 General

- .1 Manufacturer refers to the company that manufactures the components and is responsible for the design and installation guidelines used by the Reseller (Installer, Vendor, or similar designation) to complete this cabling system installation.
- .2 The manufacturer along with the Reseller is responsible for the final warranty and certification of the application assurance.

- .3 The Reseller shall show proof of a contractual relationship with the Manufacturer, and shall pass through the Manufacturer's certification to purchaser.
- .4 The cabling manufacturer shall provide an end-to-end cabling solution, including horizontal cables, backbone cables, jacks and connectors, patch panels, termination blocks, patch cords and jumpers. For this project only end-to-end solutions shall be accepted.
- .5 Where no manufacture is specified, provide products from manufactures in compliance with the listed requirements.
- .6 Standard of acceptance for communication cabling is BELDEN.

5 SUBMITTALS

5.1 Pre-construction Submittals

- .1 Submit shop drawings in accordance with Section 26 01 01 Electrical General Requirements - Shop Drawings and Product Data.
- .2 Submit the following documents for Review prior to construction:
 - (a) Cross-connect schedule for approval by the Owner.
 - (b) Shop drawings

5.2 Post-construction Submittals (Maintenance Manuals)

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 26 01 01 Electrical General Requirements.
- .2 Submission shall include:
 - (a) Manufacturer's technical documentation on all devices used in cabling system.
 - (b) Manufacturer supplied Application Guidelines for required applications.
 - (c) The Manufacturer's and Contractors Warranty and Certification
 - (d) Complete cable testing documentation in hard and soft copies. Provide licenced versions of any software required for viewing test results.
 - (e) An End User's Manual describing the essential system elements as well as the end user's responsibility for maintaining the integrity of the cabling system over time. This Manual shall include, as a minimum, guidelines for system expansion and modification (moves, additions, changes of service) as well as labelling and record keeping.
- .3 Provide maintenance materials as required and as specified in Section 26 01 01 Electrical General Requirements.

5.3 As-built Drawings

- .1 The Contractor shall keep one complete set of prints at the site office, including all addendums, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as built conditions that deviate from the original contract documents.
- .2 Within two (2) weeks of the Projects completion the Contractor shall submit a complete set of As-Built drawings including cable routing, Telecommunication Rooms layouts, riser diagrams and telecommunications outlets. The layout shall detail locations of all equipment and indicate all wiring pathways, and outlets (including cable ID numbers). This as-built information shall include Addendums, Change Orders, Clarifications, Revisions, and Site Instructions.

- .3 Upon completion the Contractor shall certify, in writing that the as built records are complete and that they accurately indicate all communication services related to the communications infrastructure. This shall include all visible and all invisible items. The information shall also correspond with all identifications applied by the Contractor to cables and termination devices in the buildings.
- .4 The Contractor shall forward a letter of certification to the Consultant for final review and as built CAD drawings to the Consultant for final review.
- .5 The contractor may obtain copies of the telecommunication contract drawings (Tender Issue) in dwg format from the Consultant on request. A drawings release form needs to be signed by the Contractor prior to releasing the drawings.
- .6 After as-built drawings have been reviewed, print four (4) full size copies of the drawings. Deliver two (2) copies to the Owner and two (2) copies to the Facilities Management (if different from the Owner).
- .7 For each Telecommunications Room provide a full-size laminated copy of the floor plans indicating which cables originate from that particular Telecommunications Room and all applicable pathways. Mount the drawing on the Telecommunications Room wall that is easily accessible to the Owner.

6 COMMUNICATIONS CONTRACTOR

6.1 Project Manager

- .1 Within ten (10) days of the date of acceptance of this Bid, the Contractor shall notify the Consultant of the appointment of a competent Project Manager, experienced in the design and installation of structured cabling systems and in the supervision of similar contract work.
- .2 The Project Manager shall be available during the entire life of the Contract to answer all questions pertaining to the contractual work, and shall be available at the site from the commencement date of equipment delivery to the commissioning completion date.
- .3 The Project Manager shall represent the Contractor and shall have authority to carry out directions given to him as the Contractor's representative.

6.2 Communications Installers

- .1 The staff selected for the installation of the structured cabling system shall conform to the following:
 - .1 An installer on site that is certified by the cable manufacturer. This installer along with the Project Manager will ultimately be responsible for the construction of this project.

7 INSTALLATION GENERAL REQUIREMENTS

7.1 General Requirements

- .1 All voice and data outlets shall be flush mounted where possible; otherwise a surface mount shall be used unless otherwise indicated on the supplied drawings.
- .2 All face plates shall match electrical face plates in the area unless otherwise noted.
- .3 Blank inserts are to be placed in to outlet ports not containing communications jacks. The blanks are to be colored to match the faceplate.
- .4 All four pairs of horizontal cables are to be terminated. ISDN T568A wiring configuration is to be used. The splitting of pairs is strictly prohibited.

- .5 All drop locations and quantities to be confirmed prior to the start of the installation. Allow a variation of 4.5m.
- .6 Horizontal cabling will be terminated on Passive Patch Panels in the IT Closets. Distribute cables evenly and neatly in bundles.
- .7 The length of each individual run of horizontal cable from the patch panel on each floor to the telecommunications outlet shall not exceed 90m.
- .8 All cables shall be loosely bundled using Velcro cable ties every 150mm. To minimize the effects of alien cross-talk, do not comb-out cables.
- .9 Utilize all indicated and available cable pathways such as conduit, cable trays, ducts, raceways and furniture system channels except where otherwise noted. Exercise caution when pulling cables in such pathways to avoid damage to any cabling and to ensure that the cable manufacturers' maximum pull-force and minimum bend radii specifications are adhered to.
- .10 All cables shall run in either conduits or cable tray. The use of J-hooks, hangers or bridle-rings is prohibited.
- .11 Route all cables to maintain minimum separations from sources of lighting, power cables, HVAC and electrical equipment as indicated in the Manufacturer's minimum separation schedule or otherwise required. The Contractor shall be responsible for co-ordination on site during construction to maintain minimum separations.
- .12 In the Telecommunications Rooms all communications cables shall be supported and routed to the corresponding termination field. Velcro tie-wraps on cables should be loose and rotate freely.
- .13 Each run of cable between the termination block and the outlet jack shall be continuous without any joints or splices.
- .14 Where the Contractor is required to remove ceiling tiles, such work shall not break or disturb grid or tiles.
- .15 Terminated conductor ends shall be properly trimmed to assure a minimum clearance of 0.250" between the conductors of adjacent modules.
- .16 Ground all new Telecommunications equipment, and cable trays using green insulated #6 AWG copper wire to the Telecommunications Ground Bar. All ground wires shall be home-run back to the Telecommunications Ground Bar. Do not daisy chain.
- .17 Upon completion of each phase of the project, a certification inspection walk through will be performed by the Owner and the Consultant to verify compliance to the standards.
- .18 Completely test out systems and, before they are turned over to Owner, demonstrate them to Owner's representative until such time as he is fully conversant with the operation of the systems.
- .19 Contractor shall work and engage services of existing hospital service providers for specific services such as:
 - .1 Wireless access points
 - .2 Distributed antenna system
- .20 Include 5 spare data/voice network drops as part of this project for the hospital to use at their discretion at any time of the construction phase. The spare drops will include all hardware, installation, termination, and commissioning/certification required for installation of these data drops.

7.2 Plywood Backboards

- .1 If required contractor will provide and install a plywood backboard for mounting additional equipment as part of this project in locations specified by the owner.
- .2 Each backboard shall be 19mm thick A-C grade void free plywood. The "A" grade side shall be exposed. The "C" grade side shall be mounted facing the wall.
- .3 Plywood shall be fire rated or painted with two (2) coats of fire retardant paint. Any fire rated stamps must be in clear view.

7.3 Cleaning

- .1 The Contractor shall clean all Telecommunication Rooms, Server Rooms, Telephone Rooms and Riser Rooms where they performed work before the Owner takes occupancy. All equipment shall be cleaned using compressed air and the floors are to be vacuumed, such that the environment is dust and debris free. Contractor shall clean room after all trades have completed work.
- .2 Remove and dispose of all unused and redundant cables and communications equipment, both vertical and horizontal. Removal and disposal of cables and equipment (including existing racks and cabinets) from the existing infrastructure shall be included in the submitted price.

7.4 Demolition and removal of existing cabling

- .1 The contractor shall remove any existing cabling in the demolition area from the work space to the termination point. No cut cabling shall be left in the ceiling space.
- .2 Documentation of cables to be removed shall be submitted to the hospital prior to removal of the cabling so the hospital staff can de-activate any line active ports to ensure no damage can happen to the active equipment due to removal of cable.
- .3 Schedule of removed cables shall be submitted to hospital showing all cables removed by this project as part of the 'As-Build' documentation upon completion of work in hard and soft copy.

8 COMMUNICATIONS HORIZONTAL CABLING

8.1 General

- .1 All horizontal cables will be FT4 rated.
- .2 All terminations shall be in T568A configuration.
- .3 For all horizontal cables provide 2m of slack at the Telecommunications Room end and 1m of cable slack at the workstation end.
- .4 Follow the Manufactures guidelines for pulling force. If no guidelines are present the maximum pull-force for 4-pair horizontal twisted-pair cables is 111N.
- .5 Maintain the manufactures recommended bend radius at all times. If no guidelines are present ensure the bend radius does not exceed four (4) times the outside cable diameter.
- .6 The communications wiring system shall be an end-to-end solution provided by a single manufacturer.

- .7 Cables will be routed through conduits and cable tray. The Contractor will provide the conduits and cable tray where shown.
- .8 Cabling must be an end-to-end solution.
- .9 Communication cabling shall be in conduit until the cable tray, and then shall terminate into the communications closet. FT4 cabling can be used. Conduit shall be run until cable tray in main hallway.
- .10 48 port Belden passive patch panels will be provided as part of this project.

8.2 Horizontal Cable Management

- .1 Horizontal cable management panel shall be 2U, 76mm deep.
- .2 Panel shall have a hinged cover with positive closing mechanism
- .3 Colour: Black
- .4 Contractor shall provide cable managers with patch panels.

8.3 Horizontal Voice Cables

- .1 Cables from the work area outlets to local IDC shall be four pair Category 6 cable.
- .2 Voice cables shall terminate on patch panels in the rack located in the TR.
- .3 Category 6 pigtailed shall be installed from the termination point in the rack to the wall mounted BIX termination point of the voice backbone cable in the adjacent Telephone Demarcation room via the sleeves provided as part of this project.
- .4 All analog voice cross-connect wire shall be 4-pair, Category 6 wire.
- .5 Each telephone outlet shall include the following parts:
 - .1 8-conductor 8-wire (RJ45) modular jack for Category 6 performance.
 - .2 Blank inserts (where required) coloured to match faceplate.
 - .3 Faceplate of wall strap depending on the application
 - .4 Analogue voice modular jacks shall be Black in colour
- .6 The 8-conductor 8-wire modular telecommunications jack shall accept 4 or 6 position modular plugs (RJ11 or RJ12) while providing proper electrical connection and not damaging telecommunications outlet (jack).
- .7 When terminating voice cables, all four (4) pairs must be punched-down.
- .8 New BIX mounts and inserts shall be included as part of this project for all new voice cable drops.
- .9 Voice cables to match existing voice cable colours used by the owner.
- .10 Voice cables terminate on patch panels in the racks and pigtailed from the patch panel to the wall mounted BIX.
- .11 Supply the same number of pigtailed as there is voice drops.

8.4 Horizontal Data Cables

- .1 Cables from the work area outlets to local Communications rooms shall be four pair Category 6 cable.
- .2 Data cables shall terminate on patch panels in the rack located in the TR.
- .3 Each data outlet shall include the following parts:
 - .1 8-conductor 8-wire (RJ45) modular jack for Category 6 performance.
 - .2 Blank inserts (where required) coloured to match faceplate.
 - .3 Faceplate of wall strap depending on the application
 - .4 Colour of data modular jacks and inserts at both termination ends shall match existing hospital network colour scheme.
- .4 The 8-conductor 8-wire modular telecommunications jack shall accept 4 or 6 position modular plugs (RJ11 or RJ12) while providing proper electrical connection and not damaging telecommunications outlet (jack).
- .5 When terminating data cables, all four (4) pairs must be punched-down.
- .6 Any available ports shall be used on patch panels
- .7 All patch panels shall be fully loaded with the appropriate connectors, 20% spares shall be provided.
- .8 Patch Panel quantities shall accommodate the number of terminated cables.
- .9 Material and equipment shall be new, and conform to grade, quality and standards specified.
- .10 All copper products such as patch panels and jacks shall conform to T568A standard pin-out termination sequences.
- .11 Data cables to match existing colours used for Data cables by the owner.

9 COMMUNICATIONS CONNECTING CORDS, DEVICES AND ADAPTERS

9.1 Voice Patch Cords

- .1 RJ11 voice patch cords used with analog telephone handsets shall be provided along with the telephones by the Owner.

9.2 Data Patch Cords

- .1 For each data drop installed provide one (1) CAT 6 patch cord at the termination field end. Provide quantities as follows:
 - .2 All data patch cords shall be installed by the Contractor.
 - .3 All data patch cords shall be RJ45 to RJ45 with booted connector ends.
 - .4 All patch cords shall be FT4 rated.
 - .5 Colours to match existing patch cord colours used by the Owner.

- .6 Patch cables will be supplied as follows (as per drawings):
 - .1 Single (1) drop location will include one (1) 3m patch cord at the device end and one (1) 2m patch cord at the termination end.
 - .2 Two (2) drop location will include two (2) 3m patch cords at the device end and one (1) 2m patch cord + one (1) pigtail cord at the termination end.
 - .3 Four (4) drop locations will include four (4) 2m patch cords at the device end and two (2) 2m patch cords + two (2) pigtail cords at the termination end.
 - .4 Length of pigtail to be coordinated with location of wall mounted BIX mounts in the Telecommunication Room.

10 IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

10.1 General

- .1 The Administration Subsystem links all of the subsystems together. It consists of labelling hardware for providing identification.
- .2 Administration shall be in compliance with the TIA/EIA-606-A standard for Class 2 Administration. Identifiers are required in the following locations:
 - .1 Telecommunications Room
 - .2 Horizontal link
 - .3 Vertical link
- .3 The Owner may deviate from the TIA/EIA-606-A standard to suit they own particular administration system.
- .4 Submit a complete labelling schedule (as noted in the per-construction submits section) to the Owner for review. Allow for the Owner to make changes.
- .5 The Contractor shall provide labels at the following locations:
 - .1 At each end of the cable jacket within 6" of where the jacket has been stripped.
 - .2 On the front of each faceplate
 - .3 On the inside of each outlet box
 - .4 On the front of the patch panel or termination block
 - .5 At each end of each patch cord and pigtail cable within 50mm (2") of the connector
- .6 Labels shall be machine printed with black text on white backing.
- .7 The minimum height of text shall be 3/16".
- .8 Use labels produced by the cabling manufacture as recommended for the application.
- .9 Labelling to follow the existing hospital labelling standard.

10.2 Numerical Identification

- .1 All copper cables, terminations, and outlets will be labelled as per the Electrical guidelines for Acute Care and the Hospital's Network labelling standard, as applicable.

11 COMMISSIONING OF COMMUNICATIONS

11.1 General

- .1 Provide commissioning verification, inspection and certification of all communications cables installed.
- .2 100% of all cables installed must be tested, and certified.

11.2 Copper Cable Test Requirements

- .1 Every cabling link in the installation shall be tested in accordance with the field test specifications defined by the Telecommunications Industry Association (TIA) standard ANSI/TIA/EIA-568-B.1.
- .2 The installed twisted pair horizontal links shall be tested from the IDF in the Telecommunications Room to the telecommunication outlet in the work area against the Basic Link performance limits specification as defined in ANSI/TIA/EIA-568-B.1.
- .3 The testing of the Category 6 4-pair UTP copper cables shall include but not be limited to..
 - .1 Basic Link
 - .2 Grounds
 - .3 NEXT
 - .4 ELFEXT
 - .5 Continuity
 - .6 Correct Polarity
 - .7 PSNEXT
 - .8 PSELFEXT
 - .9 Shorts/Opens
 - .10 Length
 - .11 ACR
 - .12 Return Loss
 - .13 Attenuation
 - .14 PSACR
 - .15 Resistance
- .4 Test all Category 6 cables end to end in "Channel Test Configuration"
- .5 100% of the installed cabling links must be tested and must pass the requirements of the standards mentioned in above specifications. Any failing links must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section below.
- .6 Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- .7 The test equipment (tester) shall comply with the accuracy requirements for Level III field testers as defined in TIA-568-B.1

- .8 The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
- .9 The tester interface adapters must be of high quality and the cable shall not show excessive twisting or kinking resulting from repetitive coiling and storing of the tester interface adapters.
- .10 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*.
- .11 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.
- .12 A representative of the consultant and end-user 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.
- .13 A representative of the consultant and end-user 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 end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.
- .14 Copper Cable Test Standards
 - .1 Test all horizontal copper cable links to Category 6 standards.

END OF SECTION