

1 GENERAL**1.01 RELATED REQUIREMENTS**

- .1 Not applicable.

1.02 REFERENCE STANDARDS

- .1 CSA Group
 - .1 CAN/CSA C22.1:21 Canadian Electrical Code, Part I (25th Edition), Safety Standard for Electrical Installations, Includes Errata (2021) Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.
 - .2 CAN3-C235 Preferred voltage levels for AC systems, 0 to 50 000V

1.03 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.04 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for new equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in ON, Canada.
 - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .5 If changes are required, notify Consultant of these changes before they are made.
- .6 Certificates:
 - .1 Provide CSA certified equipment and material.

1.05 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

1.06 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions .
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

2 PRODUCTS

2.01 DESIGN REQUIREMENTS

- .1 Operating voltages: to [CAN3-C235](#).
- .2 Equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification for control items in English.

2.02 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified.

2.03 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

not applicable

2.04 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction/[inspection authorities.

2.05 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.06 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: plastic laminate/lamicoid 3mm thick plastic engraving sheet, black face, white core.
 - .2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Consultant prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per [nameplate][and][label].
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

2.07 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to [CSA C22.1](#).
- .4 Use colour coded wires in communication cables, matched throughout system.

2.08 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

<u>Type</u>	<u>Prime</u>	<u>Auxiliary</u>
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other	Green	Blue
Communication Systems		
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.09 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint outdoor electrical equipment.

3 EXECUTION

3.01 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.

- .1 Visually inspect substrate in presence of Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied [and after receipt of written approval to proceed from Consultant.

3.02 INSTALLATION

- .1 Do complete installation in accordance with [CSA C22.1](#) except where specified otherwise.

3.03 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.04 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 steel pipe plastic/sheet metal, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.05 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed [3000] mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.06 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 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1100 mm.
 - .2 Wall receptacles:
 - .1 General: 400 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .3 Card access: 900 mm to 1050 mm A.F.F., to the centreline of the control;
 - .4 All manual controls must be located between 900mm min. and 1100mm max. above the floor with a clear floor space of at least 750mmx1200mm

3.07 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.08 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Circuits originating from branch distribution panels.
 - .2 Systems: fire alarm.
- .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.09 SYSTEM STARTUP

- .1 Instruct Consultant and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.10 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

PART 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCE STANDARDS

- .1 NEMA WC 7 - Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- .2 NETA (International Electrical Testing Association) - ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- .3 ICEA S-66-524 (Insulated Cable Engineers Association)– Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

1.3 PRODUCT DATA

- .1 Product Data: Provide for cables, terminations, and accessories.

1.4 SUBMITTALS FOR INFORMATION

- .1 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Section 1.8 Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 SUBMITTALS FOR CLOSEOUT

- .1 Project Record Documents: Record actual sizes of cables.
- .2 Certificate of Compliance: Indicate approval of installation by Authority having jurisdiction.
- .3 Maintenance Data: Include instructions for testing and cleaning cable and accessories.

1.6 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.

1.7 REGULATORY REQUIREMENTS

- .1 Products: Listed and classified by Underwriters Laboratories, Inc and testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated by the Contract.

1.8 FIELD MEASUREMENTS

- .1 Verify that field measurements are as indicated in the Contract Documents.
- .2 Verify routing and termination locations of existing cable bank prior to rough-in.

- .3 Cable routing is shown in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 & RWU90.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type TWU rated at 600 V, concentric, stranded, with wire-woven conductor shield.
- .4 Neutral supported cable: insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size as indicated. Type: NS75/NS90 Insulation.

2.2 CONTROL CABLES

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: thermoplastic.
 - .2 Sheath: cotton braid/thermoplastic jacket, and armour of closely wound aluminum wire.
- .2 Type: low energy 300 V control cable: solid/stranded annealed copper conductors sized as indicated LVT: 2 soft annealed copper conductors, sized as indicated:
 - .1 Insulation: PVC/TW/TW 40 degrees C.
 - .2 Shielding: tape coated with paramagnetic material over each conductor..
- .3 Type: 600 V stranded annealed copper/semi-annealed aluminum conductors, sizes as indicated:
 - .1 Insulation: PVC/TW/TWH/TW 40 degrees C.
 - .2 Shielding: over each conductor/each pair of conductors.
 - .3 Overall covering: thermoplastic jacket/thermosetting jackets.

2.3 GENERAL WIRING

- .1 Copper conductors type "RW90", 600V insulation, except as otherwise noted or scheduled on Drawings.
- .2 Conductors of 8.3 mm² (No. 8) and larger shall be stranded.
- .3 Do not use wiring smaller than 3.3 mm² (No. 12) except for control wiring specified under Division 25.
- .4 Size branch circuits and feeders for maximum 2% voltage drop from panelboard to farthest outlet in circuit and large enough to be protected by fuse or breaker of which they form a part.
- .5 Feeders, circuit wiring and ancillary items shall be colour-coded for phase identification.
- .6 Neutral Conductor: Full capacity, white covering and continuous throughout system without fuses, breakers or switches of any kind.
- .7 Compression Connectors: Properly sized for joining conductors and insulated to suit Code requirements.

PART 3 Execution**3.1 Field quality control**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.

3.2 GENERAL CABLE INSTALLATION

- .1 Follow cable manufacturer's instructions for cable installations.
- .2 Avoid abrasion and other damage to cables during installation.
- .3 Use cable manufacturer's recommended pulling compound or lubricants and pulling equipment.
- .4 Sustain cable pulling tensions below recommended limits and observe minimum cable bending radius.
- .5 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .6 Conductor length for parallel feeders to be identical.
- .7 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .8 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .9 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.
- .10 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

3.3 FIELD QUALITY CONTROL

- .1 Inspect exposed cable sections for any physical damage.
- .2 Inspect cable for proper connections as indicated.

END OF SECTION

1. GENERAL

1.1. Action and Informational Submittals

1.1.1. Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.1.2. Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

1.1.3. Recycled Content:

.1 Submit listing of recycled content products used, including details of required percentages or recycled content materials and products, showing their costs and percentages of post-consumer content, and total cost of materials for project.

1.2. Delivery, Storage and Handling

1.2.1. Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

1.2.2. Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

1.2.3. Storage and Handling Requirements:

.1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect hangers and supports from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

2. PRODUCTS

2.1. Support Channels

2.1.1. U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted/ suspended.

2.2. Track lights

2.2.1. Track lighting to be supported by a 41 mm, 2.5 mm thick pierced channel strut.

2.2.2. Each 1200 mm pierced channel strut to be held by two 3/8" steel threaded rod and flat washer and hexagonal nut for 3/8" rod.

3. EXECUTION

3.1. Examination

3.1.1. Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hangers and supports installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Consultant.

.2 Inform Consultant of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2. Installation

- 3.2.1. Secure equipment to poured concrete with expandable inserts.
- 3.2.2. Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- 3.2.3. 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 and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- 3.2.4. Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- 3.2.5. For surface mounting of two or more conduits use channels at 1500 mm on centre spacing.
- 3.2.6. Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- 3.2.7. Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- 3.2.8. Do not use wire lashing or perforated strap to support or secure raceways or cables.
- 3.2.9. 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.
- 3.2.10. Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.3. Cleaning

- 3.3.1. Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- 3.3.2. Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 26 05 00.

1.2 REFERENCES

- .1 CAN/CSA C22.1:21 Canadian Electrical Code, Part I (25th Edition), Safety Standard for Electrical Installations, Includes Errata (2021) Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, protect, and handle Products to site.
- .2 Accept conduit on site. Inspect for damage.
- .3 Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

Part 2 Products**2.1 OUTLET AND CONDUIT BOXES GENERAL**

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

2.3 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 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 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 of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

- 1.1.1 Conform to Sections of Division 1 as applicable.
- 1.1.2 Conform to Common Work Results for Electrical, Section 26 05 00, as applicable.

1.2 REFERENCE STANDARDS

CSA Group (CSA)

- .1 CAN/CSA C22.2 No. 18.2.06 , Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
- .2 CSA C22.2 No. 45.2.08 , Rigid Metal Conduit.
- .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .4 CSA C22.2 No. 83.1, Electrical Metallic Tubing.
- .5 CSA C22.2 No. 211.2 Rigid PVC (Unplasticized) Conduit.
- .6 CAN/CSA C22.2 No. 227.3-15, Nonmetallic Mechanical Protection Tubing (NMPT), and Bi-National standard, with UL 1696.
- .7 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions..

2 Products

2.01 CABLES AND REELS

- .1 Provide cables on reels or coils.
 - .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.

2.02 CONDUITS

- .1 Rigid metal conduit: to [CSA C22.2 No. 45](#), galvanized steel threaded.
- .2 Epoxy coated conduit: to [CSA C22.2 No. 45](#), with zinc coating and corrosion resistant epoxy finish inside and outside.
- .3 Electrical metallic tubing (EMT): to **CSA C22.2** No. 83, With couplings.
- .4 Rigid PVC conduit: to **CSA C22.2 No. 211.2**.
- .5 Flexible metal conduit: to [CSA C22.2 No. 56](#),

2.03 CONDUIT FASTENINGS

- .1 One hole straps to secure surface conduits NPS 2/ 50 mm and smaller.
 - .1 Two hole steel straps for conduits larger than NPS 2/50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.04 CONDUIT FITTINGS

- .1 Fittings: to [CAN/CSA C22.2 No. 18](#), manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for NPS 1/25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.05 EXPANSION FITTINGS FOR RIGID CONDUIT

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

- 3.1.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 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/in unfinished areas.
- .3 Use rigid galvanized steel threaded conduit except where specified otherwise.
- .5 Use electrical metallic tubing (EMT) except in cast concrete/above 2.4 m not subject to mechanical injury.
- .7 Use rigid PVC conduit in corrosive areas.
- .8 Use liquid tight flexible metal conduit for [connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .10 Install conduit sealing fittings in hazardous areas.

- .1 Fill with compound.
- .12 Minimum conduit size for lighting and power circuits: NPS 3/4/19 mm.
- .13 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .16 Mechanically bend steel conduit over 19 mm diameter.
- .17 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .18 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .21 Dry conduits out before installing wire.

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 Nameplates and labels.
- .2 Wire and cable markers.
- .3 Conduit markers.

1.2 RELATED SECTIONS
Not Used.**1.3 SUBMITTALS**

- .1 Product Data: Provide catalogue data for nameplates, labels, and markers.
- .2 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under regulatory requirements. Include instructions for storage, handling, protection, examination, preparation and installation of Product.

1.4 REGULATORY REQUIREMENTS

- .1 Provide products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

Part 2 Products**2.1 NAMEPLATES AND LABELS**

- .1 Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- .2 Locations:
 - .1 Each electrical distribution and control equipment enclosure.
 - .2 Communication cabinet.
- .3 Letter Size:
 - .1 Use 3 mm (1/8 inch) letters for identifying individual equipment and loads.
 - .2 Use 6 mm (1/4 inch) letters for identifying grouped equipment and loads.
- .4 Labels: Embossed adhesive tape, with 5 mm (3/16 inch) white letters on black background. Use only for identification of individual wall switches and receptacles, control device stations.

2.2 WIRE MARKERS

- .1 Description: Cloth, tape, split sleeve, or tubing type wire markers.
- .2 Locations: Each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection.
- .3 Legend:
 - .1 Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.

- .2 Control Circuits: Control wire number indicated on [schematic and interconnection diagrams on shop drawings.

2.3 CONDUIT MARKERS

- .1 Location: Provide markers for each conduit longer than 2 m (6 feet).
- .2 Spacing: 6 m (20 feet) on center.

Part 3 Execution

3.1 PREPARATION

- .1 Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

- .1 Install nameplate and label parallel to equipment lines.
- .2 Secure nameplate to equipment front using screws, rivets, or adhesive.
- .3 Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.
- .4 Identify conduit using field painting to Section 09 91 10.

END OF SECTION

1 GENERAL**1.01 RELATED REQUIREMENTS**

.1 N/A.

1.02 REFERENCE STANDARDS

- .1 American National Standards Institute (ANSI)
- .2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)
- .3 ASTM International Inc.
 - .1 [ASTM F 1137](#), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 CSA Group (CSA)
- .5 ICES-005, Radio Frequency Lighting Devices.
- .6 Underwriters' Laboratories of Canada (ULC)

1.03 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide complete photometric data prepared by independent testing laboratory for luminaires where specified, for review by Consultant.
- .3 Quality assurance submittals: provide following in accordance with Section 01 45 00 - Quality Control.
 - .1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.04 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse of pallets and packaging materials.
- .4 Divert unused metal materials from landfill to metal recycling facility.
- .5 Disposal and recycling of fluorescent lamps as per local regulations.
- .6 Disposal of old PCB filled ballasts.

1.05 SUBSTITUTIONS

.1 Luminaires included under this Specification section are specified by manufacturer and type. Provide equipment, as specified, unless substitutions requests are approved by the Owner.

.2 Proposed substitutions will only be considered during the bidding period.

.3 Proposed substitutions are to conform to specification section 00 26 13 and as specified herein;

.1 submit proposed substitutions to the Consultant not less than two weeks prior to the tender close

date and time.,

.2 proposed substitution submission to include:

- (a) samples named as per the specifications,
- (b) catalogue cuts,
- (c) complete photometric reports,
- (d) complete descriptive and technical data, and
- (e) cost savings.

.3 Substitution submission are to be presented as an alternative price showing the amount to be deducted from or added to the base bid.

.4 Where proposed substitutions alter functional or visual design, or change the space requirements or mounting details indicated, detail such changes in the submission and include costs for revised design and construction for trades involved.

.5 After award of the contract, substitutions will not be considered unless compelling reasons are given such as inability to meet delivery schedule; however, this reason will not be considered if the delay is caused by the Contractor's failure to order luminaires in accordance with the project schedule. In such cases, it remains the Contractor's responsibility to provide luminaires as specified without delay to the project and without additional cost to the Owner.

2. PRODUCTS

2.1 GENERAL

- .1 Similar luminaires to be products of the same manufacturer.
- .2 Maintain finishes of luminaires, as specified in the "Luminaire List", with colours to be consistent and finishes protected from damage.
- .3 Where the description of the luminaire directs a "colour/ finish to suit Consultant" or similar language, it is to be understood that during construction the final colour/finish will be selected by Consultant at that time. The Consultant shall be permitted to make their choice from a standard colour/finish range and the selected colour to apply to all of the particular type of luminaire, unless otherwise specified.
- .4 Luminaires:
 - .1 completely assembled in factory,
 - .2 delivered to building in cartons or in palletized form, as directed.
 - .3 suitable for individual or continuous row mounting.
- .5 Recessed luminaires, to include plaster trim frame or ring and mounting brackets to match ceiling type.
- .6 Troffers: equipped with adjustable mounting brackets.

2.2 LED DRIVERS:

- .1 rated input voltage: 120V through 277V or 347V, as applicable,
- .2 voltage input range: sustained variations of $\pm 10\%$ with no damage to the driver,
- .3 power factor greater than 90% from 20% to 100% rated load,
- .4 total harmonic current distortion: less than 20%, from 20% to 100% rated load,
- .5 in-rush current limits: per NEMA 410,
- .6 output current regulated to $\pm 5\%$ across published load range,
- .7 output ripple current at maximum output:
 - (a) less than 15% measured (peak-average)/average,
 - (b) less than 5% low frequency content (< 120 Hz.),
- .8 integral means of limiting surges to the LED's, per IEEE/ANSI C62.41.2 surge characteristics:
 - (a) for interior applications: common mode and differential mode surge protection of 2.5kV (100kHz, 30 Ohm ring wave),
 - (b) for exterior applications: common mode and differential mode surge protection of 3kV (1.2/50 μ s, 2 Ohm combination wave),
- .9 able to tolerate sustained open circuit and short circuit output conditions without failure, without need for external fuses or trip devices,
- .10 auto resetting protection,
- .11 no visible flicker when tested with flicker wheel,

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

2.3 LAMPS:

Light Emitting Diodes:

- .1 1.2 or 3 watts per LED,
- .2 available in 2700K, 3000K, 3500K and 4000K correlated colour temperature (CCT) packages,
- .3 CCT tolerances to remain within a 3-step MacAdam ellipse and to maintain a CRI of ≥ 80 , and an $R9 > 50$,
- .4 colour temperature and lumen output for each luminaire per luminaire schedule, using IESNA LM-79 testing procedures,
- .5 maximum temperature at the base of the “LED cap” mounted to the substrate to be controlled to ensure full lamp life,
- .6 lumen maintenance of not less than L70 @ 50,000 hours, using IESNA LM-80 and LM-21 testing procedures,
- .7 LED's of the same type to be from the same manufacturing batch,
- .8 capable of continuous dimming, from 10-100% lumen output, flicker and noise free,
- .9 provide certified test results for each type of LED used on the project,
- .10 5 year warranty.

2.4 LUMINAIRES

- .1 LED luminaires to be supplied and installed as per lighting layout and luminaire schedule included in the electrical drawings - Color of LED fixtures be 3500K, CRI >80, lumen maintenance with L80 performance at 60,000 hours, DLC qualified and LED module to IESNA LM-79, LM-80 and TM-21 standard.
- .2 Provide only LED fixtures with a Design Lights Consortium (DLC) listing, a U.S. Department of Energy (DOE) "LED Lighting Facts" label, or a U.S. Environmental Protection Agency (EPA) ENERGY STAR label, which have demonstrated third-party testing verification.
- .3 Recessed lighting fixtures shall be thermally protected.
- .4 LED fixtures shall be modular and allow for separate replacement of LED lamps and drivers. User serviceable LED lamps and drivers shall be replaceable from the room side.
- .5 Dimmable LED fixtures shall have either a 0-10 volt, 3-wire dimming driver, or a two-step (50%-100%) line voltage as shown on the drawings.

Luminaires Types

- .1 **Type A:** 20"X60" Basket LED Recessed inverted T-Bar ceilings, opal linear lens diffuser, standard white enamel paint, powder coat finish. 3500K, dimmable
- .2 **Type A-1:** 5' led large blade luminaire, off white, 3500k, universal 110 - 277V / 0 - 10V 10% dimming, 38W, canopy concealed driver
- .3 **Type A2:** 20"X48" Basket LED Recessed inverted T-Bar ceilings, opal linear lens diffuser, standard white enamel paint, powder coat finish. 3500K, dimmable
- .4 **Type B:** Double Square Downlight Recessed: Double adjustable gimbal recessed LED luminaire with anodized aluminum reflector, 0-10V dimming driver, 40" beam angle and white trim finish 3500K.
- .5 **Type C:** 4' LED suspended indirect luminaire, diffuse flush lens and white finish. 3500K, dimmable
- .6 **Type L-1, L-2:** Suspended-Mounted Linear: Diffuse flush lens and white finish. 3500K, dimmable. 3' to 10' length, varies by location.
- .7 **Type L-3:** Single Square Downlight Recessed: Single adjustable gimbal recessed LED luminaire with anodized aluminum reflector, 0-10V dimming driver, 40" and 60" beam angle options and white trim finish, 3500K.
- .8 **Type L-4:** Small Pendant: Cord-suspended LED fixture with clear crystal glass. 3000K, dimmable. Approx. 7"H.
- .9 **Type L-5:** Large Drum Pendant: Suspended LED fixture with approx. 38" round drum shade and frosted diffuser. 3500K, dimmable
- .10 **Type L-6:** Medium Drum Pendant: Suspended LED fixture with approx. 22" round drum shade and frosted diffuser. 3500K, dimmable
- .11 **Type L-7:** Under cabinet: Under cabinet LED strip luminaire to be sized to suit length of millwork. Remote drivers and opal square cover.
- .12 **Type S:** custom suspended linear LED, Opal acrylic frosted lens, extruded aluminium housing, 0-10 V dimming standard length as indicated on the layout
- .13 **Type F:** custom suspended linear LED RGB around the perimeter of the room; include for black housing extrusion, LED strip tape, lens, and brackets; length as indicated on the layout

Refer to electrical drawings for manufacturer/cat.numbers.

1.2 LIGHTING CONTROL

1. Connect the lights to the base building lighting control system GE lighting control system. Identify the relay channels on the relay panel. Label control wires for easy identification and maintenance in the future. Perform a final inspection to ensure everything is securely connected and functioning correctly. Supply and install occupancy sensors designed for automatic lighting control in area in contract as indicated on the drawings.
2. Supply and install Creston lighting control system in the meeting rooms as indicated on electrical drawings.

Part 2 Execution**2.1 INSTALLATION**

- .1 Locate and install luminaires and luminaires control as indicated in the electrical drawings.

2.2 WIRING

- .1 Connect luminaires to lighting circuits as indicated in the electrical drawings.. Extend wiring/conduits as required in order to accommodate the proposed layout. Supply and install lighting occupancy sensors/dimmer switches as indicated on the drawings. Re-work the wiring to provide the proposed switching configuration.

2.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires independently of ceiling
- .2 Provide safety chains for fixtures to be recessed mounted and surface mounted at suspended ceilings, where applicable. Safety chains shall be secured to the building structure.

2.4 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION

1 GENERAL

1.01 REFERENCE STANDARDS

Standard	Title	Date
TIA-568.0-E	Generic telecommunications cabling for customer premises	2020
TIA-568.1-E	Commercial Building Telecommunications Cabling Standard	2020
TIA-568.2-D	Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components	2018
TIA-568.3-E	Optical Fibre Cabling Components Standard	2022
TIA-568.4-E	Broadband Coaxial Cabling and Components Standard	2022
TIA-568.5	Balanced Single Twisted-pair Telecommunications Cabling and Components Standard	2022
TIA 606-D	Administration standard for telecommunications infrastructure	2021
TIA- 607-D	Generic telecommunications bonding and grounding (earthing) for customer premises	2019
TIA-569-E	Telecommunications Pathways and Spaces	2019
TIA-862-C	Structured Cabling Infrastructure Standard for Intelligent Building Systems	2022
TIA-1152-A	Requirements for field test instruments and measurements for balanced twisted-pair cabling	2016
TIA-1005-A	Telecommunications infrastructure standard for industrial premises	2012
TIA-526-14-C	Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; Modification of IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant-Multimode Attenuation Measurement	2015
	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-	

TIA-526-7-A	Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement	2015
TIA-TSB-162-B	Telecommunications Cabling Guidelines for Wireless Access Points	2021
TIA-TSB-184-A	Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling	2017
TIA-604-10-C	FOCIS 10 Fiber Optic Connector Intermateability Standard- Type LC	2021
BICSI TDMM	Telecommunications Distribution Methods Manual, 14th Edition	2020
ANSI/BICSI 002-2019	Data Center Design and Implementation Best Practices	2019
ANSI/BICSI 007-2020	Information Communication Technology Design and Implementation Practices for Intelligent Buildings and Premises	2020
ANSI/BICSI 008-2018	Wireless Local Area Network (WLAN) Systems Design and Implementation Best Practices	2018

1.02 ACTION AND INFORMATIONAL SUBMITTALS

- Submit in accordance with Section 01 33 00 - Submittal Procedures.
- Shop Drawings shall be submitted to the City of Toronto IT staff for final review before proceeding with any works.
- The shop drawings and all submissions shall be reviewed and sealed by the RCDD Contractor's PM and re-reviewed and sealed by the Consultant's RCDD before reaching the City for final review.
- Final design drawings/construction drawings shall be submitted to the City of Toronto IT staff for final review and before proceeding with any works. These drawings shall be reviewed by PM RCDD Contractor and re-reviewed and approved by RCDD Consultant before reaching to the City for final review.
- The CADD drawings shall meet the City's CADD standards. Any non-compliance shall be at the Consultants own expense.
- Submit proposed cable and enclosure tag labels to the Contract Administrator and the City of Toronto IT Technical Representative for approval before proceeding with this work.
- Submit red-lined Site Drawings identifying the proposed location of all enclosures including Telecommunication Enclosures, Termination Panels and Work Area Outlets prior to installation and as part of shop drawing submittals.
- Submit site drawings identify the fibre optic backbone cable routes and horizontal cabling routes to be used prior to installation and as part of the shop drawing submittals.
- Prior to x-raying and coring access holes submit red-lined Site Drawings showing the proposed location of the holes.
- Submit red-lined annotated working Drawings to the Contract Administrator, to clearly document the as-built network including details related to: location (closets, work area outlets), cabling (size, length, type,

routing), tagging (cable ducting, cabling, closets and work area outlets).

- Submit all submissions in both a hardcopy and electronic native format. Handwritten submissions are not acceptable. Also, submit electronic files in a PDF digital format that is indexed and searchable.
- Submit the following documentation prior to starting the site acceptance test:
 - o City of Toronto IT/Network Services — Cable Test Results
 - o Operations and Maintenance Manual of any and all electronic equipment to or is installed.
 - o Revise and annotate Contract Drawings, to clearly document the as-built network including details related to: location (closets, terminations panels) cabling (size, length, type, routing), tagging (cable ducting, cabling, closets and termination panels) final as built drawings, cabling schematics, pathways and conduits drawings (containment system), any other documents, reports and drawings needed by the City of Toronto during or after work is completed.
- Consultants shall review and approve all submissions prior to final review by the City.
- Consultant is responsible to submit the final as-built drawings of the project / facility to the City.

1.03 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect communications equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 19 - Waste Management and Disposal.

2 PRODUCTS

2.01 APPROVED MANUFACTURERS

- All backbone fibre optic cables, connectors, patch cords, patch panels, cassettes and adaptors shall be from Belden.
- All CAT6/CAT6A modular jacks, faceplates, U/UTP patch cords and Category 6/6A cables shall be from Belden.
- Where cross connect punch down is required at Entrance Facility for termination of all voice backbone cables, it shall be from Belden.
 - o www.belden.com
- All fire-stopping EZ-PATH components shall be from Specified Technologies Inc.
 - o www.stifirestop.com
- For UPS and Power Distribution Unit, Liebert - Emerson and APC shall be the manufacturers.
 - o www.emersonnetworkpower.com ; www.apc.com
- Manufacturer Substitution of any part other than those specified in this standard is strictly prohibited without the written consent of the City of Toronto Information Technology (IT) Network Services Division.

2.02 WORK AREA OUTLETS FOR OFFICE AREA

- All modular jacks, faceplates and furniture inserts shall be Belden and performance rated to Category 6/6A.
- Provide one 4-port, single-gang, work area outlet in each work area for termination of the horizontal CAT6/6A cables with faceplates or decora module frames.
- It is recommended that the outlet boxes be 100mm X 100mm X 54mm deep, complete with a mud ring cover specifically designed for single gang faceplates intended for flush mounting to the wall. This single gang outlet box aids in the maintaining of Category 6/6A and higher bend radius requirements.
- Where walls are not suitable or have insufficient depth, stand electrical size outlet boxes shall be used.
- One (1) 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 4 or 2) on the snap-in faceplate installed in the patch panel of the TE or TR as is provided.
- Within each office outlet, only two of the ports shall be terminated at the work area faceplate and patch panel unless otherwise specified.
- Space shall be left in each conduit and faceplate for a third and fourth cable to be added at a later time.
- One (1) 4-port, work-area outlet shall be installed within each systems furniture cubical work area partition.
- Within systems furniture, only two of the four positions shall be terminated with work area jacks and on the

patch panels unless otherwise specified.

- Space shall be left in conduits and faceplates for the inclusion of a third and fourth cable at a later time.

2.03 FACEPLATES

- Faceplates shall be modular Belden white format opening to allow the possibility of changing connector types in the future without replacing the entire unit.
- Faceplates shall be equipped with small form factor terminating connectors to fit the individual outlet's requirements
- Faceplates shall be equipped with a minimum of four (4) openings for modules. Contractors are to equip the faceplate with the required number of blank inserts as required.

2.04 WORKSTATION FACEPLATES AND ADAPTERS – CUBICLES

- Workstation outlets shall be supplied and installed for all terminations at the workstation end and as further specified below to suit the application.
- The Communications Consultant shall confirm the color of outlets prior to placing order.
- Modular Furniture Faceplates
 - Modular furniture faceplates shall be installed in all furniture outlets that have a modular furniture knockout shall consist of 4 ports.
 - Each outlet shall be installed with the specified termination modules or a blank insert. No openings shall remain exposed.
 - Belden MDVO modular furniture adapter, 4 port, white
 - Belden MDVO modular furniture adapter, 4 port, black
- Surface Mount Boxes
 - Surface mount boxes shall be installed for all furniture outlets that do not have a modular furniture knockout, exposed ceiling outlets or any location not provided with an electrical back box.
 - The surface mounted box shall consist of a minimum of two (2) ports.
 - Each outlet shall be installed with the specified termination modules or a blank insert. No openings are to remain exposed.
 - Belden MDVO side entry box, white
 - Belden MDVO side entry box, black

2.05 RJ45 CAT6/6A JACKS

- Belden Eight-position modular jack (RJ45), type Category 6/6A to TIA-568 shall be green color and shall have the following minimum performance characteristics:

- Modular jack current rating: 1.5 Amperes maximum
- Modular jack durability 1,000 mating cycles
- Modular jack contact Pressure: 100 grams minimum per contact
- Dielectric voltage strength: 1,000 V RMS at 60Hz for 1 minute
- Insulation resistance: 200 milli-ohms minimum
- Contact resistance 1 milli-ohms per contact
- The contact material of the jack in a modular jack connector shall be phosphor bronze with 50 micro-inches of gold over nickel.
- UTP termination modules shall be of the same category as the UTP cabling to ensure that manufacturer end to end warranties can be attained.
- All UTP termination modules shall be Belden MDVO type.
- Belden CAT6/6A modular jack, MDVO style, green color.
- Belden ID data tab, MDVO style, green color.

2.06 COPPER PATCH PANEL (CPP)

- All horizontal CAT6/6A U/UTP cabling shall be terminated on 1U, 24 ports, Belden CAT6/6A modular patch panel.
- All copper patch panels shall be black.
- All modular patch panels shall be populated with CAT6/6A UTP modules/jacks as required.
- The modular copper patch panel shall mount to standard TIA 482.6 mm (19") rack.
- Contractor to refer to installation instructions provided with the patch panel for proper installation.

2.07 COPPER CAT6/6A HORIZONTAL CABLE (U/UTP)

- 2.08 Belden, four-pair, 100 ohm balanced unshielded-twisted-pair (U/UTP) cable, appropriate flame test classification, Category 6/6A (CAT 6/6A) shall be in compliance to TIA-568 standard.
- All cables fully contained within conduit or areas that are not plenum rated shall use CMR/FT4 rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated CMP/FT6.
- All UTP cables shall meet requirements identified below:
 - Color: Blue
 - Rating: CMR/FT4 (riser rated or in conduit) or CMP/FT6 (plenum areas or in J-hooks)
 - Category: 6/6A
 - 23 AWG, spool-in-a-box
- All CAT6/6A horizontal cables shall be eligible for the Belden 25 years Certification Warranty.
- Cabling shall be installed and terminated as per the BICSI Installation Methods Manual, Belden

Certification training and the manufacturers' installation instructions.

2.08 COPPER CAT6/6A PATCH CORD (U/UTP)

- Patch cord shall be manufactured of stranded conductor cable with 8-position, 4-pair terminations at both ends.
- All patch cords shall be manufactured by Belden and performance rated to CAT 6/6A.
- All patch cords shall be of the same or higher performance category and manufacturer of the U/UTP horizontal cabling system that shall be warranted as part of the end-to-end solution.
- All patch cords shall be standard compliant and minimum of FT4 or LSZH rated.
- All patch cords shall be manufactured and certified, 4-pair stranded conductors copper cables, field assembled patch cords are not allowed.
- All patch cords shall be gray in color.
- The Contractor shall supply patch cords in the following length:
 - At patch panel location, provide 0.5 metres long patch cords for all terminated horizontal cables unless otherwise advised by Consultant or CoT-IT.
 - At workstation or work area outlet location, provide patch cords of suitable length and not longer than 5 metres (typically 2.1 metres but Project Consultant to finalize) for every terminated horizontal cable unless otherwise advised by Consultant or CoT-IT.
- Patch cords shall be installed and terminated into the final device by the Contractor as per the BICSI Installation Methods Manual, Belden Certification training and the manufacturer's installation instructions.

2.09 INDOOR BACKBONE MULTIMODE OM4 FIBREOPTIC CABLE

- The cable is performance rated to OM4 and shall be used only if the backbone link length is less than or equal to 150 meters.
- Primary and redundant, 12 strands in each cable shall run between the equipment room and the telecom room. Total of 2 x 12 strands shall run with diverse pathways between the equipment and telecom rooms.
- All cables shall be fully contained within conduit or areas that are not plenum rated shall use OFNR/FT4 rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit or using cable tray / J-hook shall be rated OFNP/FT6.
- Fiber cables shall be protected when entering the patch panel with a black color flexible conduit.
- Core-locked, tight-buffered, black, indoor/outdoor fiber-express distribution cables.
- 50/125-micron core/cladding, laser optimized.
- 4700 MHz-km bandwidth at 850nm wavelength (EMB).
- 3500 MHz-km bandwidth at 1300nm wavelength.
- Only cables from Belden shall be accepted.
- All fibre optics cables shall be installed and terminated into fibre optic adapters contained in fibre optic patch panels by the Contractor as per the BICSI Installation Methods Manual, Belden certification training and installation instructions.
- Belden:

- OFNR/FT4
- OFNP/FT6

2.10 FIBREOPTICS PATCH PANEL (FPP)

- Fibre optics cabling shall be terminated in patch panels intended for fibre optic cable management.
- Belden Fibre optics Rack Mount Enclosure for Telecommunication Enclosures shall be:
 - 3U - 19" Rack Mount Enclosure
 - Durable black powder coat finish
 - Be equipped with cable strain relief and slack storage
- Belden Blank Fibre Adapter Panel shall be:
 - Blank Fibre Adapter Panel to fit Fibre Adapter Patch Panel
 - Durable black powder coat finish
- Belden Fibreoptics LC Fibre Adapter Strip shall be:
 - Loaded with TIA-604 FOCIS-10 compatible adapters, TIA-568.3 standard compliant
 - Split sleeve: Zirconia Ceramic
 - Adapter housing colors follow TIA-568.3 suggested color identification scheme.
 - Belden part number for 6 LC duplex adapter strip
- Belden 1U fibre cover, smoked plexiglas
- Belden Splice Case / Modules / Trays for OM4 Cable Terminations shall be:
 - Belden splice tray for 3U rack mount fibre enclosure

2.11 FIBREOPTICS LC CONNECTOR FOR FIELD TERMINATION OF OM4 CABLE

- Optical fibre terminations for OM4 cable shall be made for field termination with a pre-polished connector and shall be of the same manufacturer and LC style to suit the cabling installed.
- Fibre connectors shall match the performance of the fibre optics cable (OM4).
- Fibre terminations shall be made with a ceramic ferrule and cable boot.
- Optical fibre cables shall be terminated with pre-polished connectors having the characteristics as below:
 - Return loss: >20dB (multimode)
 - Termination Style: Pre-Polished

- Connector Type: LC
- Ferrule Type Zirconia Ceramic
- The connector shall include connector body / ferrule assemblies, crimp sleeves, dust caps, clip, and appropriate boot.
- All Fibre optics connector terminations and adapters shall be contained in fibre optic patch panels from Belden by the Contractor as per the BICSI Installation Methods Manual, Belden certification training and installation instructions

2.12 FIBREOPTICS LC PIGTAIL FOR FIELD TERMINATION OF OM 4 CABLE

- Optical fibre OM4 cable shall be fusion spliced to pig-tails for field termination and shall be of the same manufacturer and LC style to suit the cabling installed.
- Pigtail shall be OFNR (FT4) or LSZH rated and stamped/printed accordingly.
- The pigtail shall be 100% factory terminated and inspected end face geometry in compliance with Telcordia GR-326-CORE, issue 3.
- Typical insertion loss per pigtail connection: 0.25dB.
- Field assembled pigtails are not allowed.
- The Contractor shall supply and fusion splices every strand of the fibre backbone cable with a pigtail. The pigtail length shall be 1m.
- Belden OM4 pigtail
- Belden fusion splice heat shrink protector sleeves

2.13 FIBREOPTICS MULTIMODE LC-LC DUPLEX PATCH CORDS – OM4

- All patch cords shall be CSA/TIA/UL approved, CMR (FT4) or LSZH rated and printed accordingly.
- All optical fibre patch cords shall be OM4.
- All optical fibre patch cords shall be manufactured and certified, 1-pair (duplex, 2 strands). Field assembled patch cord is not allowed.
- The Contractor shall supply a minimum two (2) patch cords for every OM4 backbone cable:
- At patch panel in the telecom room (TE), provide one (1) 2-meter-long patch cord unless otherwise specified by CoT IT.
- At patch panel location in the equipment room (ER), entrance facility (EF), or any other space provide one (1) 2-meter-long patch cord unless otherwise specified by CoT IT.
- All optical fibre patch cords shall be LC to LC duplex.

2.14 PATHWAY SYSTEM – CONDUIT AND CABLE TRAY

- All pathway (conduit and cable tray) systems shall be designed in accordance with the latest version of the ANSI/TIA-569-E Standard which exceeds the minimum requirements of Canadian Electrical Code. Pathway systems that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA-569-E standard will be considered substandard and removed until such time as they are in compliance.

2.15 ELECTRICAL METALLIC TUBING CONDUIT – EMT

- To be used within the office areas only (if applicable).
- Electrical Metallic Tubing shall be electro-galvanized steel.

2.16 FITTINGS

- Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.
- Die-cast or pressure cast fittings are not permitted.
- Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.
- Provide conduit body types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasket covers secured with corrosion-resistant screws.

3 EXECUTION

3.1 GENERAL

- Contractors / Technicians shall be certified with Belden and Fluke Networks to perform installations and testing / commissioning.
- Contractors must have an RCDD installation Team Lead / Project Manager.
- Technicians who have not completed the appropriate certification or training shall not pull, terminate or otherwise be involved in the installation of the telecommunications physical infrastructure with the exception of bonding to ground.
- Installers performing the testing (SAT, Acceptance, Commissioning, etc.) shall be Certified Cabling Test Technician on Fluke DSX / Versiv and Optifibre OTDR equipment.
- Following are the procedures to follow for successful project handing over:
 - o Cable Acceptance Testing (CAT) – See Appendix for correct Sample Test Results and Compliance Sheet
 - o Site Acceptance Testing (SAT) - See Appendix for Sample SAT Documents
 - o As-built Drawings and Documents (ADD)
 - o Consultant Review and Comments (CRC)
 - o CoT-IT Approval of Satisfaction (AoS) – Signing off.2

3.2 HORIZONTAL CABLE INSTALLATION

- All cables and components shall be installed as per the Belden's instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the Category 6/6A cabling system shall be with Fluke DSX-5000 / 8000 Versiv Cable Analyzers.
- All cables and components shall be installed as per Belden's instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the fibre optic installation shall be with test equipment from Fluke DSX-5000 / 8000 Versiv and if required (upon CoT-IT request) Optifibre OTDR..4 Install armoured cables by

direct burial using:

- .1 Cable plow.
- .2 Trench.

3.3 FIBRE OPTIC CABLE INSTALLATION

- All cables and components shall be installed as per Belden's instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- All testing of the fibre optic installation shall be with test equipment from Fluke DSX-5000 / 8000 Versiv and if required (upon CoT-IT request) Optifibre OTDR.

3.4 CABLE ACCEPTANCE TESTING

- This section specifies the acceptance testing requirements for backbone fibre optic as well as horizontal UTP cabling.
- Supply all of the test equipment required to conduct acceptance tests.
- Submit acceptance documentation as defined in this section.
- All of the installed cabling must be tested and successfully pass all test criteria.
- Standards referenced in this section include:
 - o ANSI/TIA-568: Telecommunications Cabling Standard. All standards referenced within the TIA- 568, where applicable, constitute standard provisions of this specification.
 - o ANSI/TIA-526-14: Optical Power Loss Measurement, Multimode
 - o ANSI/TIA-526-7: Optical Power Loss Measurement, Single-mode
 - o ANSI/TIA-1152: Requirements for field test instruments and measurements for balanced twisted-pair cabling
- Visually inspect all cables, cable reels and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods shall be returned to the supplier and replaced at no additional cost to the City.
- All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568 standard. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables installed without cost to the City.

3.5 COPPER PERMANENT LINK TESTING – HORIZONTAL CABLING

- All unshielded twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance to Category 6/6A. Horizontal cabling shall be tested using a minimum level IIIe test unit for Category 6/6A performance compliance.
- Continuity - Each pair of installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. The test shall be recorded as pass/fail as indicated by the test unit and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

- Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA-568.2 standard. Cable length shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cable, the shortest pair length shall be recorded as the length for the cable.
- Horizontal twisted pair cable shall meet or exceed the permanent link, performance requirements specified in ANSI/TIA-568.2 for Category 6/6A, Unshielded Twisted Pair (U/UTP).
- All tests shall be conducted using permanent link configuration on the testing equipment. Double wire armour cables in [deep water][strong tides][heavy ice formations].

3.6 COPPER TEST EQUIPMENT

Category 6/6A Test Equipment - Category 6/6A test equipment shall meet the following minimum criteria:

- All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Acceptable test equipment manufacturer is Fluke Networks. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall be not more than a year from cable test date. Recommended test equipment is a Fluke Networks DSX 5000 / 8000 Versiv Cable Analyzer.
- Test adapters must be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable. For horizontal cabling, permanent link adapters shall be used.
- Baseline accuracy of the test equipment must meet or exceed TIA Level IIIe, as indicated by independent laboratory testing.
- Test equipment must be capable of certifying Category 6/6A to TIA-568.2 standard.
- Test equipment must have a dynamic range of at least 100 dB to minimize measurement uncertainty.
- Test equipment must be capable of storing full frequency sweep data for all tests.
- Test equipment must include S-Band time domain diagnostics for NEXT and return loss (TDNXT and TDRL) for accurate and efficient troubleshooting.
- Test equipment must be capable of running individual NEXT, return loss, etc., measurements in addition to auto tests. Individual tests increase productivity when diagnosing faults.
- Test equipment must make swept frequency measurements in compliance with ANSI/TIA-568.2 standard.
- The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurement.
- The calibration of equipment shall be valid within one (1) year of the test date.

3.7 HORIZONTAL CABLE TESTING DOCUMENTATION – COPPER

Category 6/6A (UTP) Documentation - As a minimum, test reports shall include the following information for each U/UTP CAT6/6A cabling element tested:

- o Wiremap results that indicate the cabling has no shorts, opens, split, reversed, or crossed pairs and end-to-end connectivity is achieved.
- o Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT and PSELFEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations and in both directions when required by the appropriate standards.
- o Length (in meters), propagation delay and delay skew relative to the limit.
- o Any individual test that fails the relevant performance specification shall be marked as a FAIL.
- o Cable manufacturer, cable model number/type and NVP.
- o Tester, manufacturer, model, serial number, hardware version and software version.
- o Circuit ID number (Cable Tag Id) and Facility name.
- o Test criteria used.
- o Overall pass/fail indication.
- o Date and time of test.

3.8 BACKBONE FIBRE OPTIC TESTING

- Backbone fibre optic cable shall meet or exceed the permanent link, performance requirements specified in ANSI/TIA-568.3 for multimode and singlemode fibre.
- Test link attenuation with an OLTS:
 - o For multimode fibre, make reference measurements in accordance with TIA-526-14, Annex A – One cord reference method. Measure optical loss on each fibre at 850nm and 1300nm. It is required to measure loss on each fibre from each direction (bi-directional).
 - o For singlemode fibre, make reference measurements in accordance with TIA-526-7, one cord reference method. Measure optical loss on each fibre at 1310nm and 1550nm. It is required to measure loss on each fibre from each direction (bi-directional).
- Measure link length optically or calculate using cable sheath length markings.
- Multimode backbone fibre optic cabling shall meet the following loss and length criteria:
 - o Attenuation @ 850nm shall be less than or equal to: fibre length (km) x 3.0 dB/km + number connector pairs x 0.5 dB + number of splices x 0.3 dB.

- o Attenuation @ 1300nm shall be less than or equal to: fibre length (km) x 1.5 dB/km + number connector pairs x 0.5 dB + number of splices x 0.3 dB.
 - o Length shall be less than or equal to 150 meters.
- VCSEL driver is preferred to be used for testing as the SFP active modules on the switch runs with VCSEL drivers up to 10Gbps.
- Singlemode backbone fibre optic cabling shall meet the following loss and length criteria:
 - o Attenuation @ 1310nm shall be less than or equal to: fibre length (km) x 0.4 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
 - o Attenuation @ 1550nm shall be less than or equal to: fibre length (km) x 0.4 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
 - o Length more than 150 metres and shall be less than or equal to 10000 meters.

3.9 FIBRE OPTIC TEST EQUIPMENT

- All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output. Acceptable test equipment manufacturer is Fluke Networks. Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall not be more than a year from cable test date. Recommended test equipment is a Fluke Networks DSX-5000 /8000 Versiv Cable Analyzers using VCSEL fibre modules (preferred) for multimode testing and/or OptiFiber OTDR (if advised by CoT-IT).
- The calibration of equipment shall be valid within one (1) year of the test date.
- Fibreoptics test equipment shall meet the following minimum criteria:
 - o Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA-526-14, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant."
 - o Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA-526-7, "Optical Power Loss Measurement of Installed Single-mode Fibre Cable Plant."
 - o Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.
 - o Multimode test equipment shall incorporate both 850nm and 1300nm VCSEL/LED sources.
 - o Single-mode test equipment shall incorporate both 1310nm and 1550nm laser sources.
 - o Sources and meters shall automatically synchronize wavelengths to prevent calibration- related errors.
 - o Test equipment shall employ a communications port to facilitate uploading of saved information from tester to PC.
 - o Test equipment capable of measuring a Tx/Rx fibre pair simultaneously is recommended to enhance productivity. It is recommended that test equipment utilizing dual function main and remote units be used for bi-directional testing, eliminating the need to swap optical source and power meter.

3.10 CABLE TEST RESULTS MANUAL

- Consulting Engineer shall first review and comment on the test report. CoT-IT shall only receive the report after the review and approved comments of the Consulting Engineer. CoT-IT will finally provide their final review comment.
- Submit test reports in both a hardcopy and electronic format (native file). Hand-written test reports are not acceptable. If test results cannot be converted to a PDF format then provide any necessary proprietary/native software to view the results at no cost to the City.
- Fibre optic backbone cable test results shall be incorporated in the City of Toronto, Network - Cable Test Results manual. Submit two (2) copies of the Cable Test Results manual for each facility. The manual consists of hardcopy test result reports placed into lockable 'D' ring binders with a cover and spine that clearly indicates the title of the manual. Put a CD with the electronic copies of test reports in a pocket in the Cable Test Results manual.
- The Contractor (RCDD) PM must sign hardcopy reports before submitting it to the Consultant.

3.11 TEST COMPLIANCE SHEET

- A compliance sheet shall be prepared for every project of City of Toronto - IT. The criteria is summarized as below:

1	Test equipment with latest software version	8	Test results limits - TIA
2	Test equipment with latest test limit version	9	Test results based on VCSEL/LED Encircled Flux for OM4
3	Calibration of test equipment	10	Test results based on Laser for OS2
4	Test results submitted in native format and PDF format	11	MM testing at 850nm and 1300nm wavelength
5	Test result cable ID in compliance	12	SM testing at 1310nm and 1550nm wavelength
6	Permanent Link testing performed on copper (CAT6/6A)	13	Bi-directional testing
7	Test result cable type (copper and fibre) in compliance	14	Accurate quantity of adapters and splices

3.12 SITE ACCEPTANCE TEST (SAT)

- A Site Acceptance Test (SAT) will NOT test functionality of the system or its components. Site Acceptance Tests will evaluate the workmanship and verify installation against the *Installation* and

Layout drawings.

- The SAT plan shall be submitted to CoT-IT, two (2) weeks in advance of commencement.
- The SAT plan shall have a checklist and identify tests with a schedule for CoT-IT to review and coordinate staff. Submit to the Contract Administrator/Project Manager and Consultant, three weeks prior to the commencement of the test, for review. The Contractor shall conduct the test when directed by the Contract Administrator. As a minimum, the Contract Administrator/Project Manager, Consultant and CoT-IT shall witness the test.
- The plan shall be sealed by the Installation Project Manager RCDD, followed by the RCDD Consultant.
- Prior to SAT, the Consultant shall review and approve all copper and fibre cabling testing, bonding and grounding inspections and any other criteria as may be described in the project tender.
- The SAT shall evaluate workmanship and verify construction and components against the Layout Drawings and associated Component Schedules submitted to and reviewed by the Consultant.
- The SAT shall be completed only when all items in the checklist have been witnessed and installed by the Contract Administrator/Project Manager, Consultant and CoT-IT as being in conformance with the design as specified.
- SAT of Equipment Room / Telecom Room
 - Each facility shall have one or more equipment room / telecom room, which house the server and network core closets. Each equipment / telecom room shall undergo a witnessed SAT.
 - The Consultant is responsible for the equipment / telecom room UPS, lighting panel and any ER/TR modifications noted in the tender drawings and specifications. The extent of ER/TR modifications varies for each facility.
 - In addition to the above, the ER/TR SAT shall include the evaluation of the server and core closet installation, power supplies to each closet and external cable management (e.g. cable tray). For the purpose of the ER/TR SAT the server and core closets shall be empty except for the installation of duplex receptacles to receive the UPS.
- SAT of Telecom Enclosure
 - As a minimum, the complete Telecom Enclosure for the SAT shall include the installation of copper patch panels, fibre patch panel, power supplies, horizontal cable terminations, cable management and patch cords.
 - At each facility, the Contractor shall provide one complete telecom enclosure, associated accessories and horizontal cable for the SAT. Following acceptance, the Contractor will be directed to proceed with the installation of the remaining TEs and horizontal cabling. The Contractor is to note that the fibre optic backbone cable installation will be included in the core closet SAT.
 - The City reserves the right to do a random inspection of the telecom enclosure and those that do not comply with the above shall be made compliant at no expense to the City.

3.13 FIELD SUPPORT

- Provide 160 hours of on-site support for each facility beginning immediately after successful site acceptance test at that facility for a period of 24 months following Substantial Performance.

- Respond within 24 hours to a request for on-site support.
- The minimum site time per support call will be four (4) hours.
- The cost for the on-site field support shall be paid based on the rates quoted in the Schedule of Prices.

3.14 MAINTENANCE

- For a period of twelve (12) months following Final Acceptance, the Contractor shall provide a qualified technician/electrician to assist in the resolution of network related problems. The Contractor shall be given twenty-four (24) hours notice as to their requirement on-site.
- The Contractor will be compensated at the per diem rate quoted by the Contractor in the Form of Tender. However, if the source of the problem is discovered to be a result of work or components supplied by the Contractor, the Contractor shall not be compensated.

3.15 WARRANTY

- Testing and certification of the Building Network Distribution Cabling System shall be by the installer and shall include the provision of a Belden Warranty covering performance, products and installation.
- The Warranty shall cover the full repair and/or replacement of any component failing or failure to meet the design requirements within one (1) year.
- Warranty shall be delivered by the Contractor in coordination with Belden to the Client's Project Manager with the Testing and Certification documents. The project site shall receive manufacturer's plaque. All coordination regarding warranty and handing over of the manufacturer's plaque is the responsibility of the Contractor.
- The manufacturer shall warrant the project for twenty-five (25) years against application assurance and extended product manufacturing defects.
- The Contractor shall warrant installation against all product installation defects and that all approved cabling components meet or exceed the specified requirements for a period of twenty-five (25) years following acceptance.
- The Contractor shall warrant that all permanent fibre optic links meet or exceed the performance requirements of TIA-568.3 for multimode and singlemode fibre.
- The Contractor shall warrant that all permanent twisted pair links meet or exceed the performance requirement of TIA-568.2 for category 6/6A, unshielded twisted pair.
- Contractor must provide complete end to end mapping of all connectivity at the end in both hard and softcopy formats. This includes but not limited to horizontal data / voice cable number, copper and fibre backbone cable and active equipment ports.
- Within ten (10) days after testing, the cable installer shall provide the Project Manager with documentation, which shall include cable test results, a marked-up copy of the as-built cable network

drawing and an electronic copy of the completed installation in Bentley Microstation Ver. 8 and AutoCAD or as per City's CAD guidelines.

- Contractor shall provide a manufacturer written certificate, plaque and warranty that the structured cabling platform is installed and fully operating in accordance with this standard and manufacturers specification.
- The warranty must guarantee that the design or installation negligence on the part of the Cabling Contractor shall not negate or void any portion of the certified system. The manufacturer must guarantee that all material, components and labour are covered in this circumstance for the full certification period of twenty-five (25) years. It must also guarantee that in the event a Cabling Contractor is no longer able to service the warranty, the full certification remains valid and is responsibility of the manufacturer.
- If a warranty issue arises for the cabling, the Warrantor must make arrangements to undertake the repair or replacement of warranty issues within 24 hours of notification. This may require the repair/replace of cabling components outside regular working hours at no additional cost.
- The warranty for the cabling must be such that the cable meets or exceeds the requirements of TIA-568 'Transmission Performance Specifications for 100 Ohm 4-pair Category 6/6A Cabling" including all Standards stated in this Contract.
- The Cabling Contractor shall forward the Structured Cabling Platform certification request form(s) to the proper authority and ensure that a Plaque and Certificate is issued to the Customer / Project Site along with the Structured Cabling Platform user manual. The successful bidder shall provide a certification number within two weeks of award of this project. Please
note that the Plaque/Certificate must have the Customer name/Project name on the Plaque/Certificate.
 - The Cabling Contractor shall provide letter(s) of Certification within two weeks of substantial completion of the project to the Customer. This document will include the following: verification of the performance of the installed system, identification of the installation by location and project number and a copy of the warranty.
 - Upon request and at no additional cost to the Customer the Cabling Contractor must provide a manufacturer's technical representative to conduct an on-site visit to ensure complete technical compliance.
 - The Cabling Contractor must supply a copy of an unexecuted warranty statement (at the time of bidding) including all related terms and conditions. This copy shall be the Standard to which the warranty will be held. No changes shall be accepted unless it is deemed to benefit the Customer. Any proposed changes to the warranty must be submitted in writing to the Customer/their representative for review. The changes will then be accepted or declined by the Customer at their discretion. This is to remain valid for the entire warranty period.
 - All cable Cabling Contractor technicians on site must be trained by the manufacturer of the Structured Cabling Platform being installed.
 - Any defective or improperly installed products shall be replaced, or correctly reinstalled at no cost to the Customer.

3.16 QUALIFICATIONS AND TRAINING

- An on-site training may be required for the Client to understand the system and installation.
- Contractors shall be certified with Belden and Fluke Networks to perform installations and testing.
- Contractors must have an RCDD installation Project Manager.
- Technicians who have not completed any certification program shall not pull, terminate or otherwise be involved in the installation of the telecommunications physical infrastructure with the exception of bonding to ground.
- Installers performing the testing (SAT, Acceptance, Commissioning, etc.) shall be certified CCTT on Fluke DSX and/or Optifibre OTDR.
- All Fluke credentials shall be submitted to the City during project award process for validation.
- The testing equipment shall be valid and calibrated within one (1) year as per manufacturer specifications.
- The cable installer shall have full working knowledge of cabling low voltage applications such as, but not limited to, Non-Secure Data/Voice communications cabling systems.
- Provide references of the type of installation provided for in this specification.
- Have knowledge of all applicable Telecommunication Standards such as but not limited to: CSA, TIA, IEEE and ANSI.
- Have experience in the installation of pathways and support for horizontal and backbone cabling.
- Be experienced in the installation and testing of telecommunication network cabling system, including the use of a light meter and OTDR.
- Provide proof of being a manufacturer certified installer for all cable network components being installed such as but not limited to cables, connectors and end termination equipment. The use of a non-manufacturer certified installer is not permitted.

3.17 AS-BUILT DRAWINGS

- The drawings shall include cable routes and outlet locations.
- Outlet locations shall be identified by their sequential number as defined elsewhere in this document.
- Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.
- For new infrastructure project, the Consultant shall provide the design drawings /

tender drawings / floor plans in paper and electronic (Microstation) formats on which as-built construction information can be added.

- For an existing infrastructure upgrade, the Owner may provide floor plans in paper and electronic (Microstation) formats on which as-built construction information can be added.
- These documents shall be modified accordingly by the Telecommunications Contractor to denote as-built information as defined above and returned to the Owner.
- The Contractors shall annotate the base drawings and return a hard copy (same plot size as originals) and electronic (Microstation) form.

3.18 FINAL ACCEPTANCE

- Once all work has been completed including all documentation submissions, the City will notify the satisfaction to the Consultant in writing of formal acceptance of the system.
- Consultant must warrant in writing that 100% of the installation meets the design requirements as specified.
- Contractor must warrant in writing that 100% of the installation meets the requirements specified in the tender documents.
- The CoT-IT reserves the right to conduct, using Contractor equipment and labour, a random re- test of up to five (5) percent of the cable plant to confirm documented results. Any failing cabling shall be re-tested and restored to a passing condition. In the event more than two (2) percent of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Owner.
- Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating and receipt of full documentation as specified.
- The City may agree to allow certain cable runs to exceed acceptable standardized performance criteria. If required these cable runs will be exempt from meeting the specified standards. However, the Contractor will still be required to test these cable runs to validate component and installation performance.
- Documentation: The Contractor shall submit the following documentation for final acceptance:
 - City of Toronto - IT Network — Cable Test Results Manual.
 - Cable Acceptance Test (CAT) – Compliance Sheet
 - Site Acceptance Test (SAT)
 - As-built Drawings and Documents (ADD)

- Consultant Review and Comments (CRC)
- CoT-IT Approval of Satisfaction (AoS) – Signing off

3.19 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 00 - Cleaning.

3.20 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by communications equipment installation.

APPENDIX-A: SAMPLE OF CABLE ACCEPTANCE TEST (CAT)



CITY OF TORONTO - CABLE TEST RESULTS COMPLIANCE SHEET

Project Name		Contract/Project Number	
Facility Name		Facility Address	
Location		Closet/Rack Number	
Consultant		Contractor	
Original Submission Date	Second Submission Date	Third Submission Date	Fourth Submission Date
City Reviewer	Date Issued	Status <input type="checkbox"/> Approved <input type="checkbox"/> Disapproved	

General

No.	GENERAL	Comply	Does Not Comply	Not Applicable
1	Cable test equipment DSX-5000 / 8000 with latest software version			
2	Cable test equipment DSX-5000 / 8000 with latest limit version			
3	Calibration certificate of the cable test equipment provided to the City			
4	Cable test results supplied to the City in PDF and Native format			
5	Test result specify the project name and / or contract number			
6	Test result specify site name or facility code			

Copper Test Results

No.	COPPER	Comply	Does Not Comply	Not Applicable
1	Permanent link testing performed			
2	Patch cord testing performed			
3	Test result cable identification in compliance with CoT-IT Standard			
4	Test result cable type in compliance with CoT-IT Standard – TIA-568 Horizontal			

Fiberoptics Test Results

No.	FIBRE	Comply	Does Not Comply	Not Applicable
1	Test results based on LED/VCSEL for OM4 50/125 um MM fibre cabling			
2	Test results based on FP Laser for OS2 9/125 um SM fibre cabling			
3	MM testing at 850nm and 1300nm modal bandwidth			
4	SM testing at 1310nm and 1550nm modal bandwidth			
5	Test result cable identification in compliance with City of Toronto-IT Standard			
6	Test result cable type in compliance with City of Toronto-IT Standard and TIA-568 Backbone MM/SM			
7	Test link attenuation in accordance with TIA-526-14 or TIA-526-7 makes reference measurements in accordance with METHOD-B (one jumper cable measurement for MM) or METHOD-A.1 (one jumper cable measurement for SM). Measure optical loss on each fibre at 850nm and 1300nm (for MM) or 1310nm and 1550nm (for SM).			
8	Measure loss on each fibre from each direction (bi-directionally) as per CoT-IT Standard			
9	Accurate quantity of adapter and splices			
10	Smart Remote mode used for testing dual-fibre strands			

APPENDIX-B: SAMPLE OF SITE ACCEPTANCE TEST (SAT) DOCUMENTS

Facility:	Project Name:
Contract No.:	Telecom Enclosure / Network / Core Closet Tag:
Building:	Sub-Location:
Consultant:	Contractor:
Date:	CoT-IT Staff:

TELECOM ENCLOSURE (TE) / NETWORK / CORE CLOSET LAYOUT AND AS-BUILT DRAWINGS

Procedure:

- Verify that the as-built drawings are present.
- Verify the Telecom Enclosure components match the bill of materials.
- Verify equipment layout is as shown in the as-built drawings.
- Verify all components are tagged and wiring is labeled as per the drawings. (Enclosure, Patch Panels, Copper Patch Panel(s) Work Area Outlets, Cables, Power Distribution Components, etc.)
- Verify the horizontal and backbone fibre cable terminations and labeling.

If any comments are necessary, enter a note number in the test form column and record the comment in the comments form at the end of this document.

Acceptance Criteria:

Telecom Enclosure construction and labeling shall match the as-built drawings.

As Built Drawings Verification			
Item No.	Description	Pass/Fail	Notes
1	As built drawings present		
2	Bill of materials in compliance		
3	Layout / arrangement of components in compliance		
4	All components tagged as per as-built drawings. (Enclosure, Patch Panels, Copper Patch Panel(s) Work Area Outlets, Power Distribution Components, etc.)		
5	All wiring labeled as per as-built drawings		

END OF SECTION