# PART1. GEneral

## General

### All conditions of the contract apply to the work of this section.

### Section 13510 is a functional specification. The Contractor is to provide all the devices necessary to meet the intent of this specification and to ensure a fully functional wide area network that meets the performance requirements specified herein.

### This specification is applicable to PCS/SCADA installations only. This specification does not apply to Corporate IT/Networking installations.

## Technical Definitions

### Fibre Optic: The fibre optic segments radiating out from the Network Core to the Network Closets. The fibre optic network will be comprised of redundant, full-duplex, 1000BASE-FX segments.

### Horizontal Cable Segments: The unshielded twisted pair (UTP) or shielded twisted pair (STP), category 6 (CAT6) cables that permanently interconnect the patch panel in the Network Closet with a work-area outlet.

#### Horizontal cables will always be collated as a group of four (4) cables. Each group of horizontal cables will be associated with a single 4-port, work-area outlet and a 4-port, snap-in faceplate in the Network Closet or Core Closet, patch panel.

### Network Closets and radio panels are defined as any enclosure that contains active network components.

### Work Area Outlets will only contain passive network components for the termination of horizontal cables.

## Scope of Work Definitions

### The following terms are used in this specification to describe the scope of work associated with various devices. The terms shall have the following definitions in this context:

#### Abandon: Abandon and make safe all process and electrical connections, make pertaining process and electrical systems work safely after disconnection of abandoned item(s).

#### Free-issue: Equipment or services supplied by the Region for incorporation into the Contract by the Contractor.

#### Reasonably to Scale (RTS): Dimensions shown are approximate only. Contractor to field verify the dimensions prior to starting work.

#### Provide: Supply the named device or equipment and all necessary appurtenances, install, test and commission. Unless otherwise noted, the device or equipment supplied and all appurtenances shall be new.

#### Remove: Abandon and make safe all process and electrical connections, remove the item and mend the void space/process to its intended function.

#### Replace: Verify that replacement material fits the replaced item and provide adapters as required, abandon and make safe all process and electrical connections, remove the item, supply and install new item with required adapters, make pertaining process and electrical systems work safely after replacing item(s).

#### Re-wire: Abandon electrical connections to existing and install new wiring and conduit to new destination, as indicated.

#### Region: Refers to the designated Region Staff or Region Representative.

#### Consultant: The term Consultant is used interchangeably with the term Contract Administrator and has the same meaning.

## References

### Comply with the latest edition of the following statutes codes and standards and all amendments thereto.

#### TIA/EIA-568-B: Telecommunications Cabling Standard All standards referenced within the TIA/EIA-568-B, where applicable, constitute standard provisions of this specification. Furthermore, compliance with the Ontario Electrical Safety Code will supersede all other specifications.

#### Ontario Electrical Safety Code, Section 56 – Optical Fibre Cables.

#### Ontario Electrical Safety Code, Section 60 – Communication.

#### TIA/EIA-606: Administrative Standard for Telecommunications.

#### TIA/EIA-526-14-A: Optical Power Loss Measurement, Multimode

#### TIA/EIA-607: Commercial Building Grounding and Bonding Requirements for Telecommunications - October 2002

#### TIA-1005 Telecommunications Infrastructure Standard for Industrial Premises.

### Section 13310 Panel Specifications.

## Site Summary Requirements

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. | Site | Address | New/Existing  Facility | Network Configuration Drawing |
| 1 | Add sites as needed |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |

### The following table identifies the Network Configuration to be installed at the facilities under this construction project:

## Submittals

### Comply with the requirements of Division 1.

### Shop Drawings:

#### Complete bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of network enclosures.

#### Provide internal and external layout scale drawings showing exact dimensions of the equipment provided.

#### Catalog information on electrical devices furnished with system.

#### Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.

#### Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.

#### Submit proposed schedule of all nameplates, cable and enclosure tag labels for approval before proceeding with this work.

#### Provide calculations for sizing the UPS cooling fans, air conditioners, heaters and heat exchangers.

### Submit the following documentation prior to starting the site acceptance test:

#### Fibre Optic Cable Test Results Manual

#### Copper Ethernet Cable Test Results Manual

#### Link Test Results Manual

#### Ethernet device spreadsheet

#### Operations and Maintenance Manual.

### Provide one additional set of panel "As-Built" drawings and all documents to place in the door pocket. Provide electronic copies (CAD and PDF format) of “As-Built” drawings on a CD in the door pocket. “As-Built” drawings to clearly document the as-built network including details related to: Campus layout (Manholes, ductbanks), location (closets, terminations panels) cabling (size, length, type, routing), tagging (cable ducting, cabling, closets and work area outlets).

## Enclosure Identification

### Closet Identification

#### Provide a nameplate for each enclosure on the top-left corner of the door.

#### Use engraved gravoply laminate nameplates having white letters on black background. Minimum nameplate height shall be 50 mm. Minimum character height shall be 12 mm.

#### Mount nameplates with two stainless steel machine screws.

#### Centre lettering on each line.

#### Include device identification (tag) number as well as a descriptive name. Network enclosure name is based on site code naming as follows:

##### AYYYYNN, where

###### A = Network device, where x = switch, r = router, w = wireless, c= controller

###### YYYY = Site Code

###### NN = Building Number

#### Example: XMTSS1 Mt. Albert Sewage Station Switch Enclosure.

### UTP, STP and Fibre Patch Panels

#### Labels for patch panels shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels will not be accepted.

#### Lettering shall be black on a white background. Characters are a minimum of 6 mm high.

#### Labels shall be applied to patch panels in such a manner as to be readily visible and not obscured by structured cabling or patch cords.

#### The tagging convention for network closet, patch panels will employ a four (4) character alphanumeric tag. The first two characters will indicate the type of patch panel. The second two characters will be a unique index within each closet starting from the top. The characters “TX” will denote Copper Ethernet Patch Panels. The characters “FX” will denote Fibre Patch Panels. For example the second patch panel from the top in Network Closet 14 would be labeled TX02.

### UTP Patch Panel Termination Point

#### Refer to the Bill of Materials in the contract drawings

#### Each 24-port patch panel will have six (6) snap-in faceplates that group four terminations. Each snap-in faceplate will be associated with a work-area outlet or another snap-in faceplate.

#### Where more than 24 ports are required, a 48-port patch panel shall be used as opposed to 2 x 24-port patch panels.

#### Labels for each snap-in faceplate shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels will not be accepted.

#### Lettering shall be black on a white background. Characters are a minimum of 4 mm high.

#### A label shall be applied to the top of each snap-in faceplate indicating the destination of the faceplate and destination port number. For example: a snap-in faceplate whose destination is Work Area Outlet WAO-05, Port 3 would be tagged as 05-3.

#### Provide a four-character label immediately beneath each port (RJ) indicating its network membership (PCS or CONVERGED).

#### Provide colour-coded, snap-in icons for each port (RJ). The following colours will indicate network membership: PCS (RED), CONV (BLUE).

### Fibre Optic Patch Panel Termination Point

#### Terminate all fibres of each fibre optic cable in either rack mounted Fibre Enclosures or surface mounted Fibre Enclosures as shown in the contract drawings

#### The ordering and colour of individual fibres will be the same for each fibre cable and compliant with TIA/EIA-568-B.

#### Labels shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels will not be accepted.

#### Lettering shall be black on a white background. Characters are a minimum of 4 mm high.

#### A label shall be applied to the top of the fibre duplex adapter modules associated with a single fibre cable indicating the destination of the cable.

#### A four-character label shall be applied, that indicates the network membership (PCS or CONV), either directly on the adapter module or on the cable position map.

### Work-Area Outlet

#### Labels for each 4-port work area outlet shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels will not be accepted.

#### Lettering shall be black on a white background. Characters shall be a minimum of 4 mm high.

#### A label shall be applied to the top of each 4-port work-area outlet utilizing sequential numbering. For example: WAO-XY, where XY is a sequential incrementing number..

#### A three-character label shall be applied immediately beneath or above each port (RJ) indicating its network membership (PCS or CONV).

#### Provide colour-coded, snap-in icons for each port (RJ). The following colours will indicate network membership: PCS (RED), CONVERGED (BLUE).

## Network Cable Identification

### Use durable non-fading sleeve type wire markers to identify all network cables.

### Labels for cabling shall be pre-made, laser printed, heat shrink specific for the type of cable and size, suitable for indoor or outdoor application. Hand-written labels will not be accepted.

### Lettering shall be black on a white background. Characters shall be a minimum of 4 mm in height.

### Fibre Optic Cables

#### As a minimum, all fibre optic cables are to be labeled at both ends of the cable.

#### In addition, the fibre cables are to be labeled at each transition. A transition is defined as: a change in ducting (e.g. cable tray to conduit), a change in direction of more than 45 degrees, or an entrance and exit of ducting through a wall or floor.

#### If the fibre cable is run in conduit then the transition labels shall be applied to the conduit.

#### The tagging convention for identification of fibre optic cables shall indicate the source and destination of the cable separated by a colon. For example a fibre optic cable whose source is Mt. Albert Sewage Station Switch 1 (XMTSS1) and Mt. Albert Sewage Station Switch 2 (XMTSS2) would have the following tag:

**XMTSS1:XMTSS2**

#### The Network Closet has only one patch panel and therefore the patch panel number does not need to be included.

### Horizontal Cables

#### As a minimum, all horizontal CAT6 cable is to be labeled at both ends of the cable.

#### Copper cabling should not be used between network closets; fibre cabling shall be utilized.

### Patch Cords

#### As a minimum, all Contractor installed CAT6 and fibre optic patch cords shall be labeled at both ends of the cable.

#### Provide colour-coded, plug-boots to indicate network membership: PCS (RED) and CONVERGED (BLUE).

#### The tagging convention for identification of patch cords shall indicate the source and destination of the cable separated by a colon. The source is the switch port and the destination is the patch panel, termination point.

#### Each patch cord length should be required length + 30cm (maximum).

### Cable Routing

#### All ducting (cable tray or conduit) carrying fibre optic cable shall be tagged as “PCS LAN FIBRE”.

#### All ducting carrying horizontal cables shall be tagged as “PCS LAN”.

#### Labels shall be applied to ducting at each end, every 100 metres and at points of transition (passage through a barrier or right angle turn).

# PRODUCTS

## Fibre Optic Cable

### Provide all fibre optic cable, connectors and appurtenances that make up the fibre optic cable segments.

### The fibre optic cable segments shall meet the requirements of the TIA/EIA-568-B specification for 50 micron, multi-mode fibre.

### Multi-mode fibre optic cable shall be at a minimum Corning Cable Systems, FREEDM One Riser Cables, Part Number: 012T8F-31131-29.

### All fibre optic cables are to be colour coded as per TIA/EIA 598-A.

## Fibre Optic Connectors

### All fibre optic cables to be terminated to fibre optic patch panel.

### All connectors for the termination of the fibre optic cable shall be duplex LC connectors.

### For all fibre optic terminations inside network enclosures or Fibre Patch Panels the connectors shall be preloaded adapters configured with LC duplex multimode adapters fitted with a phosphor bronze split sleeve.

## UTP Horizontal Cable

### Provide twisted-pair cable, connectors and appurtenances that make up the horizontal cables segments.

### Horizontal cable segments shall meet the requirements of IEC 11801/TIA/EIA-568-B specification for Category 6 (CAT6), Unshielded Twisted Pair (UTP) cable.

### Acceptable Manufacturers

#### Acceptable manufacturers are listed in the following table in order of preference. The design has been completed around the first named supplier. The Contractor is responsible for all costs associated with any changes required to the design to accommodate an alternate manufacturer.

|  |  |  |
| --- | --- | --- |
| Preference | Manufacturer | Model |
| 1 | Belden Canada Inc | 7851A cable |
| 2 | Or Equivalent |  |

#### The Contractor shall select the appropriate options to suit the application and the requirements of the Section.

### Where an alternate manufacturer is provided, they shall meet the performance specifications of the first named manufacturer

## STP Horizontal Cable

### Provide twisted-pair cable, connectors and appurtenances that make up the horizontal cables segments.

### Horizontal cable segments shall meet the requirements of IEC 11801/TIA/EIA-568-B specification for Category 6 (CAT6), Shielded Twisted Pair (STP) cable.

### Acceptable Manufacturers

#### Acceptable manufacturers are listed in the following table in order of preference. The design has been completed around the first named supplier. The Contractor is responsible for all costs associated with any changes required to the design to accommodate an alternate manufacturer.

|  |  |  |
| --- | --- | --- |
| Preference | Manufacturer | Model |
| 1 | Belden Canada Inc | 7953A 0021000 |
| 2 | Allen-Bradley | 1585-C8EB-S\* |
| 3 | Or Equivalent |  |

#### The Contractor shall select the appropriate options to suit the application and the requirements of the Section.

#### Where an alternate manufacturer is provided, they shall meet the performance specifications of the first named manufacturer.

## Armored Horizontal Cable

### Provide twisted-pair cable, connectors and appurtenances that make up the horizontal cables segments.

### Horizontal cable segments shall meet the requirements of the TIA/EIA-568-B specification for Category 5e (CAT5e), Shielded Twisted Pair (STP) cable.

### Armored Horizontal Cable Segments shall be Belden 121700R cable.

## UTP Horizontal Connectors

### All category 6 (CAT6) UTP connectors shall be modular jacks and wired for a T586B wire-map.

### All cables to be terminated to a WAO and/or patch panel.

### CAT6 UTP connectors shall meet or exceed the following minimum requirements:

#### Four position modular shall meet or exceed the TIA/EIA Category 6 standard.

#### The termination to 4 pair 24 AWG unshielded twisted pair cable shall not require the use of a punch down tool.

#### Shall limit conductor untwist to less than 23 mm (½”).

#### Shall be IEC 60603-7 compliant.

#### Shall accommodate icons for network identification.

#### Shall support gigabit Ethernet.

## STP Horizontal Connectors

### All category 6 (CAT6) STP connectors shall be shielded modular jacks and wired for a T586B wire-map. Only one end of the shielded jacks are to be bonded to a ground.

### All cables to be terminated to a WAO and/or patch panel.

### CAT6 STP connectors shall meet or exceed the following minimum requirements:

#### Eight position modular shall meet or exceed the TIA/EIA Category 6 standard.

#### The termination to 4 pair 24 AWG Shielded twisted pair cable shall not require the use of a punch down tool.

#### Shall limit conductor untwist to less than 23 mm (½”).

#### Shall be IEC 60603-7 compliant.

#### Shall accommodate icons for network identification.

#### The shielded connector must include a cable strain relief cap and TIA/EIA 607 compliant grounding and bonding metallic housing and ground termination.

#### Shall support gigabit Ethernet.

## General Enclosure Requirements

### Refer to Section 13310 Panel Specifications for additional requirements to this specification.

### All screws, bolts, fasteners etc. are to be corrosion resistant stainless steel.

### All wall-mounted panels are to be separated from the wall by stainless steel spacers or galvanized steel struts.

### Cable bundles are to be neatly laced, run in ducting or approved cable managers and secured to 19” rack or mounting back-panel.

### Single access enclosure doors shall open through 180 degrees without restriction.

### All enclosure doors shall open through 180 degrees without restriction.

### Mid-section of the enclosure shall open through 90 degrees without restriction from wall-mount section.

### Enclosure layout and equipment spacing shall be constructed to allow for device removal, calibration and maintenance without disassembly of adjacent devices.

### All freestanding, floor-mounted enclosures shall have removable CSA eyebolts to facilitate sling handling of each enclosure. Eyebolt mounting shall be a part of the structural support bracing to distribute stresses and enclosure weight while sling handling enclosures during installation.

### All enclosures shall have sufficient structural reinforcements to ensure a limited plane surface vibration and to provide rigidity during shipment, installation and operation without distortion or damage to the enclosure, mounting panel or mounted instruments.

### All enclosure seams shall be continuously welded and ground smooth to be undetectable after painting.

### Devices shall be installed on the enclosure back-panel or 19” rack.

### There shall be no devices installed on the side plates of the enclosure.

## Enclosure Wiring

### All enclosure wiring shall run through a cable manager.

### Cable managers shall not be filled to more than 50% of their volume upon initial installation.

### All wires and cables, including spares, shall be identified at each end and at any connection. Use durable non-fading sleeve type wire markers to identify all network cables as follows:

#### Labels for cabling shall be laser printed, self-laminating, adhesive, polyester (indoor/outdoor).

#### Hand-written labels will not be accepted.

#### Lettering shall be black on a white background. Characters shall be a minimum of 4 mm high.

#### Wire markers are required on each conductor in panel board gutters, and at load connections. The identification shall include branch circuit or feeder number for power and lighting circuits, and control wire numbers for control wiring.

#### All field wires and cables terminated within enclosures shall be identified at each termination with a marking that corresponds with the drawings and supporting documentation.

#### Power wiring insulation shall be as per Section 13310 Panel Specifications.

## Network Closets

### Provide Network Closets in all locations as identified in the contract drawings and Site Summary Requirements Table. Construct closets to support the termination of cables (fibre optic, horizontal cables, power) and equipment. Refer to the contract drawings for layout and Bill of materials.

### Refer to Section 13310 Panel Specifications for additional requirements to this specification.

### Bond 19” rack to ground.

### The door is to incorporate a padlock-capable quarter turn latch. Padlocks are to be identically keyed such that a single master key can lock all closets.

### All enclosure doors shall open through 180 degrees without restriction.

### Mid-section of the enclosure shall open through 90 degrees without restriction from wall-mount section.

### Except where noted on the Tender drawings, all conduits will enter the enclosure from the bottom or top of the closet.

### All Electrical distribution components are to be mounted on a rear accessory panel.

### Each Network Closet shall be supplied with 120 VAC UPS power supplies as identified in the Contract Documents. All Network Closet equipment is to be powered from UPS.

### The required power supply for the Network Closet from the UPS is 120 VAC, 10A. The UPS and power supply wires shall be sized accordingly by the Contractor. Provide and install separate 10A breaker in the local lighting panel for the Network Closet UPS feed. If standby power is available at the facility, then the network closet is to be powered from a lighting panel which is fed from the standby power source.

### The Contractor is to ensure that installation of the fibre optic enclosure allows the sliding drawer to be fully extended and lowered without interference from or to other components.

### Terminate all fibres in the fibre optic enclosure. Fibre colour and Tx/Rx orientation is to be identical in all Closets. All fibres are to be labeled as Section 1.9 Network Cable Identification. Dark fibres are to be covered to prevent damage. Dark fibres are to be colour coded/identified as per the Region’s standards for easy identification. Blank spaces in the breakout enclosure are to have blank covers installed.

### Provide 24-port modular patch panels, connectors and appurtenances for termination of the horizontal cabling within each Closet.

#### The connection between the Access Switch and horizontal cables is an inter-connect rather than a cross-connect.

#### Faceplate modules are to be removable enabling front access to connectors and cable. Each faceplate module will group either four (4) UTP or STP connectors and will be associated with a single 4-port, work-area outlet.

#### All category 6 (CAT6) UTP connectors shall be modular jacks, keystone snap in type and wired for a T586A wire-map.

### Provide duplex fibre optic patch cords for each Ethernet Switch per the contract drawings. The Closet fibre optic patch cords shall be 50 micron multi-mode patch cords. Patch cables shall be terminated at both ends with a duplex LC to LC style plug. Quantity of fibre patch cords to be supplied is equal to the number of fibre pair terminations in the fibre patch panel plus 10% spare. Minimum quantity of four (4) fibre patch cords are to be supplied.

### Fibre optic patch cords are to be factory assembled and tested by the manufacturer***.*** Provide written certification from the manufacturer. The Contractor is responsible for determining the length of patch cords.

### Supply category 6 (CAT6), unshielded twisted pair (UTP), patch cords for each Ethernet Switch installed by the contractor. Install only those patch cords required to interconnect the Switch and Patch Panels as noted in the contract drawings. Quantity of copper patch cords to be supplied is equal to the number of terminations in the copper patch panel plus 10% spare. Minimum quantity of eight (8) copper patch cords are tpo be supplied.

### CAT6 UTP patch cords are to be factory assembled and tested by the manufacturer***.*** Provide written certification from the manufacturer. The Contractor is responsible for determining the length of patch cords.

### All programming and configuration of active network devices will be carried out by the Region.

## PAC Panel Installation

### Provide network access switches in PAC panel in all locations as identified in the contract drawings and Site Summary Requirements Table. Refer to the contract drawings for layout and Bill of materials.

### Provide power for access switch in PAC panel from the PAC panel redundant 24 VDC power source.

### For PAC panels with fibre:

#### Provide a surface mount fibre optic patch panel enclosure for termination of the fibre optic cable. Fibre optic patch panel is to be mounted outside of the PAC panel on wall within 1.0 m of the PAC Panel. Provide 1” rigid PVC conduit between patch panel and PAC Panel.

#### The Contractor is to ensure that installation of the fibre optic enclosure allows for the maintenance and support of the fibre without interference from or to other components.

#### Terminate all fibres in the fibre optic enclosure. Fibre colour and Tx/Rx orientation is to be identical in all Closets. Dark fibres are to be covered to prevent damage. Blank spaces in the breakout enclosure are to have blank covers installed.

#### Provide duplex fibre optic patch cords for each Ethernet Switch as per contract documents. The Closet fibre optic patch cords shall be 50 micron multi-mode patch cords. Patch cables shall be terminated at both ends with a duplex LC to LC style plug. Quantity of fibre patch cords to be supplied is equal to the number of fibre pairs plus 10% spare. Minimum quantity of four (4) fibre patch cords are to be supplied.

#### Fibre optic patch cords are to be factory assembled and tested by the manufacturer***.*** Provide written certification from the manufacturer. The Contractor is responsible for determining the length of patch cords

### Supply category 6 (CAT6), unshielded twisted pair (UTP), patch cords for each Ethernet Switch installed by the contractor. Install only those patch cords required to interconnect the Switch and Patch Panels. Quantity of copper patch cords to be supplied is equal to the number of devices plus 10% spare. Minimum quantity of eight (8) copper patch cords are to be supplied.

### CAT6 UTP patch cords are to be factory assembled and tested by the manufacturer***.*** Provide written certification from the manufacturer. The Contractor is responsible for determining the length of patch cords.

### All programming and configuration of active network devices will be carried out by the Region.

## Work Area Outlets

### Work Area Outlets.

#### Provide one 4-port, single-gang, work-area outlets, connectors and appurtenances for termination of the horizontal CAT6 cables. If eight (8) CAT6 cables are consolidated at the Work Area Outlet then one 8-port work-area outlets is required.

#### Each work-area outlet will be associated with a 4-port, snap-in faceplate installed in the Network Closet patch panels. Work area outlets shall be associated with sequential ports on the patch panel. The typical assignment for work-area outlets will be 1-PCS, 2-PCS, 3-PCS, 4-CONV.

#### All category 6 (CAT6) connectors shall be modular jacks and wired for a T586 wire-map.

### PAC Work Area Outlets.

#### Provide a minimum of 4 DIN rail mounted copper Ethernet patching device for termination of the horizontal CAT6 cables in PAC Panels. Provide all connectors and appurtenances for termination of the horizontal STP CAT6 cables connected.

#### Each DIN rail mounted copper patch connector will be associated with a 4-port, snap-in faceplate installed in the Network Closet patch panels. The typical assignment for work-area outlets will be 1-PCS, 2-PCS, 3-PCS, 4-CONV.

#### All category 6 (CAT6) connectors shall be modular jacks and wired for a T586A wire-map.

#### The number of copper cabling to the PAC WAO to the Network Closet shall be number of devices + 1 such that one spare copper cable is always included.

### UTP Patch Cords

#### Supply four (4) 10 metre, CAT6 UTP patch cords for each work area outlet. Hand over to the Region, the patch cables. The Contractor will supply the patch cords to the Region for free-issue to others for installation.

#### Certify in writing that the patch cords supplied under this Contract meet or exceed the requirements for CAT6 UTP patch cords as described in the TIA/EIA-568-B standard.

# EXECUTION

## General

### Install network enclosures in all locations identified in the Contract Drawings. Field verify and obtain written approval from the Consultant of all final locations of the enclosure prior to commencing this work. All costs required to relocate enclosures in unapproved locations will be at no additional cost to the Region.

### Provide a complete and operational system, all components and appurtenances necessary to ensure that the network closets are functional and meet the intent of this specification and Division 13***.***

### Contract Drawings are dimensioned reasonably to scale. Contractor is to field-verify dimensions before starting work.

### Contractor is to maintain a complete set of Contract Drawings on-site as Site Drawings. Contractor is to annotate the Site Drawings in red ink with any differences noted between the Contract Drawings and the as-constructed network.

### Locate work area outlets such that the length of the horizontal cable runs from the Network Closet interconnect to the work area outlet shall be less than 90 metres including patch cables. For work area outlets where this proves impossible the Consultant will authorize in writing an exception if the link still meets the performance requirements of this specification.

### The Consultant reserves the right to relocate Network Closets and work area outlets within 3 m of the locations identified in the Contract Drawings at no additional cost to the Region.

### It is the Contractor's responsibility to size all power supply cables to meet the requirements of the Ontario Hydro Safety Code based on field verified length of cable run and power supply load.

### It is the Contractor’s responsibility for all X-raying and coring where conduit passes through floors, walls, and ceilings.

### Local network switches installed in package control panels are not permitted. A WAO is to be installed in the package control panel. All ports on the WAO are to be home run back to the Network Closet or PCS switch. Patch cables to be installed in the package control panel for connection of Ethernet equipment to the WAO.

### Cable and Conduit

#### Provide four (4) or eight (8) CAT6, horizontal cables to each work area outlet from an Network Closet in a single 35 mm (1 ¼”) conduit. Where eight (8) cables are required it will be noted on the Network Closet Installation drawing, otherwise, four (4) cables are required.

#### Conduit carrying horizontal cables shall enter the work area outlet through the top or bottom.

#### Conduit shall be Rigid PVC unless otherwise noted on the drawings.

### Pull Boxes

#### Pull Boxes will be placed at strategic locations in the conduit system to allow installers: to pull cable through the conduit with minimum difficulty, to protect the cable from excess tension, and ensure that the manufacturer’s recommended minimum bend radius requirements are maintained.

#### Pull Boxes will be installed at points where a larger conduit carrying multiple fibre cables transitions to smaller conduits each carrying fewer cables.

#### Pull Boxes will be installed every 100 metres of conduit run.

#### Other locations for Pull Boxes are to be recommended by the Contractor.

#### Conduit entry points must be at opposite ends of the pull box.

#### All pull box covers must be marked for easy identification

## Fibre Optic Cable Installation

### Installation of the fibre optic cable shall comply with Section 56 (Optical Fibre Cables) of the Ontario Electric Safety Code and the EIA/TIA-568-B Telecommunications Building Standard.

### Each fibre segment shall be a continuous run (no splices) from the Network Core Closet to the target Network Closet.

### The fibre optic cable shall be installed in a ring configuration as per the contract drawings*.* All fibre shall be installed in a minimum 27 mm (1”) Rigid PVC conduit. For HDPE (high density polyethylene) conduit installations, the fibre optic cable shall be installation in 50.8 mm (2”) orange coloured corrugated HDPE conduit.

### HDPE conduit shall meet or exceed the following minimum requirements:

#### Corrugated

#### Orange Coloured

#### 50.8 mm (2”) Minimum ID (inner diameter)

#### 53.34 mm (2.1”) Average OD (outer diameter)

#### ASTM D-3350 for cell classification 334470 C

### The fibre optic cable shall be installed in HDPE conduit in all electrical duct bank vaults. HDPE conduit shall be supported by guide wires and supported every one (1) meter.

### HDPE conduit shall be inserted 0.6 m (24”) into all electrical duct transition points.

### Rigid PVC or Corrugated HDPE installations:

#### Install a continuous length of pull string in all conduit runs.

#### Install conduit into the walls, ceilings or floors as required on the Contract Drawings. The actual route of the conduits to be selected to avoid beams, columns and other obstructions, provided permission has been granted by the Consultant.

#### Conduit shall not interfere with other trades and shall be mounted over other piping where possible in parallel rows, parallel or perpendicular to walls and ceilings. Bends and offsets shall be uniform and symmetrical. The use of conduit bends shall be kept to a minimum.

#### Conduit and cables shall be installed to avoid proximity of water and heating pipes. In no case shall they run within 75 mm of such pipe except where crossings are unavoidable in which case they shall be kept at least 25 mm from the covering of pipe crossing.

#### For wall, ceiling or floor installations, HDPE conduit to be anchored every one (1) meter.

### As a minimum, a one (1) metre loop for every 100 metres of cable length, shall be left at the end of each fibre optic cable and housed in the Network Closet and Core Closet. If the cable length is less than 200m, then a two (2) metre loop of cable shall be left at each end of the fibre optic cable and housed in the Network Closet and Core Closet.

### The bend radius for fibre optic cable shall not be less than the manufacturer’s recommended minimum bend radius.

### The tensile load for fibre optic cable shall not exceed the manufacturer’s recommended maximum tensile load.

### To prevent micro-bends the Contractor shall not use nylon cable-ties. Instead the Contractor shall use straps to secure or collate fibre optic cable.

### Individual fibre segment lengths are shown in the *Campus Layout*. Segment lengths are estimates calculated from the Campus Layout for each plant. The Campus Layouts provided are Reasonably-To-Scale (RTS). Contractor is to field verify cable lengths. The recommended fibre route to the Network closets is provided in the contract drawings.

### Labeling:

#### Use durable non-fading sleeve type wire markers to identify all network cables.

#### Apply the tagging convention described in this specification for all Fibre Optic cables.

#### As a minimum, label both ends of the fibre optic cable.

#### Individual fibre cables are to be labeled within pull boxes.

#### In addition, label the fibre optic cable every 20 metres from the Network Core and at all major transitions. Major transitions are defined as: the entrance and exit of a wall or floor, a change in method of ducting, or a change in direction of more than 45 degrees.

## Horizontal Cable Installation

### Run horizontal cables connecting Network Closets to work area outlets in 35 mm (1 ¼”) rigid PVC conduit.

### Run either four (4) or eight (8) horizontal cables in a conduit as noted on the Installation drawings.

### For horizontal cabling runs in corrosive environments shielded twisted pair (STP) CAT6 cable will be used. The CAT6 STP cable will be installed in rigid PVC conduit and must be properly grounded.

### STP cable will be used for Multilin protection relays, MCCs, power meters and any other location where susceptible to electromagnetic interference. For these installations, jacks, patch panel ports, and other associated equipment must also be shielded. Proper grounding is to be applied.

### Install a continuous length of pull string in all conduit runs.

### Maximum cable length is to be no longer than 90m end to end including patch cables.

### The bend radius for horizontal cable shall not be less than the manufacturer’s recommended minimum bend radius.

### Horizontal cables within the network core may be run in cable tray or through the plinth but must be segregated from power distribution cable.

### Conduit carrying horizontal cables shall enter the work area outlet through the top or bottom.

### Labeling

#### Use durable non-fading sleeve type wire markers to identify all network cables.

#### Apply the tagging convention described in this specification for all horizontal cables.

#### As a minimum, label both ends of the horizontal cable.

#### Install laminated termination chart summarizing all copper cable termination points. Termination points of both ends of the cables are to be included.

## Cable Acceptance Testing - General

### This section specifies the inspection, test, and acceptance requirements for the structured cabling of the Process Control System (PCS) Local Area network.

#### This section specifies the acceptance testing requirements for PCS fibre optic and horizontal cabling.

#### Provide 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:

#### TIA/EIA-568-B: Telecommunications Cabling Standard. All standards referenced within the TIA/EIA-568-B, where applicable, constitute standard provisions of this specification.

#### TIA/EIA-526-14-A: Optical Power Loss Measurement, Multimode

### Visually inspect all cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Region.

### The Region 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 failed 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 Region.

### 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 Region 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.

### Fibre Optic Testing

#### Fibre optic cable shall meet or exceed the permanent link, performance requirements specified in TIA/EIA-568-B.3 for 50 micron multi-mode fibre.

#### Test link attenuation in accordance with TIA/EIA-526-14A for multi-mode fibre. Make reference measurements in accordance with method B or equivalent. Measure optical loss on each multi-mode fibre at 850 nm and 1300 nm. Measure loss on each fibre from each direction (bi-directionally).

#### Measure link length optically or calculate using cable sheath length markings.

#### Multimode fibre optic cabling shall meet the following loss and length criteria:

#### Attenuation @ 850 nm shall be less than or equal to: fibre length (km) x 3.75 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.

#### Attenuation @ 1300 nm shall be less than or equal to: fibre length (km) x 1.50 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.

#### Length shall be less than or equal to 550 metres.

### 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 manufacturers are Fluke, HP, or MicroTest.

#### Fibre optic test equipment shall meet the following minimum criteria:

#### Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-14A, "Optical Power Loss Measurement of Installed Multimode Fibre Cable Plant."

#### Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.

#### Multimode test equipment shall incorporate both 850 nm and 1300 nm sources. The coupled output power into multimode fibre shall be >= -20 dBm at each wavelength. Detectors shall have a dynamic range of at least +3 dB to -55 dB.

#### Sources and meters shall automatically synchronize wavelengths to prevent calibration-related errors.

#### Test equipment shall employ a serial port to facilitate uploading of saved information from tester to PC.

#### The time-of-flight methodology shall be employed when optically measuring fibre length.

#### Test equipment capable of measuring a Tx/Rx fibre pair simultaneously is recommended to enhance productivity.

### Cable Test Results Manual

#### Submit test reports in both a hardcopy and electronic format. Hand-written test reports are not acceptable. Submit electronic files on a CD format disk in a PDF format. If test results cannot be converted to a PDF format then provide any necessary proprietary software to view the results at no cost to the Region.

#### Fibre optic cable test results shall be incorporated in the PCS Network – Cable Test Results manual. Submit five (5) copies of the Cable Test Results manual for each plant. The manual consists of hardcopy test result reports placed into lockable ‘D’ ring binders with a cover and spline 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.

#### Both the Contractor and Consultant must sign hardcopy reports.

### Fibre Optic Documentation. As a minimum, test reports shall include the following information for each fibre optic cabling element (fibre) tested:

#### Actual measured attenuation, maximum allowable attenuation (loss) and the attenuation margin at the specified wavelengths. An individual test that fails the link criteria shall be marked as FAIL.

#### Reference method.

#### Number of mated connectors.

#### Actual length and maximum allowable length. Any individual test that fails the link length criteria shall be marked as FAIL.

#### Group refractive index (GRI) for the type of fibre tested, if length was optically measured.

#### Tester manufacturer, model, serial number and software version.

#### Circuit ID number (Cable Tag Id) and facility (Plant).

#### Link criteria used.

#### Overall pass/fail indication.

#### Date and time of test.

### Unshielded horizontal twisted pair cable shall meet or exceed the permanent link, performance requirements specified in TIA/EIA-568-B.2 for Category 6, Unshielded Twisted Pair (UTP).

### Shielded horizontal twisted pair cable shall meet or exceed the permanent link, performance requirements specified in TIA/EIA-568-B.2 for Category 6, shielded Twisted Pair (STP).

### Category 6 Test Equipment. Category 6 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 manufacturers are Fluke, HP, or MicroTest.

#### Test adapters must be approved by the manufacturer of the test equipment. Adapters from other sources are not acceptable.

#### Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing.

#### Test equipment must be capable of certifying Category 6 UTP to TIA/EIA-568-B.2 standards.

#### Test equipment must have a dynamic range of at least 200 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 autotests. Individual tests increase productivity when diagnosing faults.

#### Test equipment must make swept frequency measurements in compliance with TIA/EIA-568-B standards.

#### 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.

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

#### Wiremap results that indicate the cabling has no shorts, opens, mis-wires, split, reversed, or crossed pairs, and end-to-end connectivity is achieved.

#### 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.

#### Length (in metres), propagation delay, and delay skew relative to the relevant limit.

#### Any individual test that fails the relevant performance specification shall be marked as a FAIL.

#### Cable manufacturer, cable model number/type, and NVP.

#### Tester, manufacturer, model, serial number, hardware version, and software version.

#### Circuit ID number (Cable Tag Id) and Facility (Plant).

#### Test criteria used.

#### Overall pass/fail indication.

#### Date and Time of test.

## Factory Acceptance Test – Network Closets

### The Factory Acceptance Test (FAT) will be performed at the location where the panels are manufactured and/or assembled.

### The system components that will be Factory Acceptance Tested are all Network Closets. The FAT will evaluate workmanship and verify construction and components submitted to and reviewed by the Consultant.

### Prepare a checklist or test sheet using Microsoft Excel. Submit to the Consultant and Region PCS group, three (3) weeks prior to the commencement of the test, for review. The Contractor shall conduct the test when directed by the Consultant. As a minimum, the Consultant and Region shall witness the test.

### The FAT will be completed when all items in the checklist have been witnessed and initialed by the Consultant as being in conformance with the design as specified.

### To mitigate the possibility for major re-work, a single (1) Network Closet of each type will be Factory Acceptance Tested. Following acceptance of these enclosures the Contractor will be directed to proceed with construction of the remaining Network Closets.

### All Network Closets will be FAT tested. All deficiencies noted in the FAT tests must be corrected prior to shipment to site. The Region may request that the Contractor submit photos to verify.

## Site Acceptance Test (SAT)

### Site Acceptance Tests will evaluate the workmanship and verify installation against the contract drawings.

### Prepare a checklist or test sheet using Microsoft Excel. Submit to the Consultant, three weeks prior to the commencement of the test, for review. The Contractor shall conduct the test when directed by the Consultant. As a minimum, the Consultant and Region shall witness the test.

### The SAT will be completed when all items in the checklist have been witnessed and initialed by the Consultant as being in conformance with the design as specified.

### Network Closet SAT

#### The Contractor will provide one complete Network Closet, and all associated work area outlets, cabling, terminations, patch panels, Radio Links, power supplies, switches cable management and all patch cords for a complete Network Closet SAT. Following acceptance, the Contractor will be directed to proceed with the installation of the remaining Network Closets, work area outlets and cabling.

#### All Network Closets will undergo a witnessed Site Acceptance Test.

## Link Acceptance Test (LAT)

### This section specifies acceptance requirements for the link acceptance tests of PCS Local Area network.

### Provide all of the test equipment required to conduct acceptance tests.

#### Connect one laptop to server port on a Core Switch.

#### Connect one laptop to an Access Switch.

### Submit acceptance documentation as defined in this section.

### All of the installed cabling and network equipment must be tested and successfully pass all test criteria.

### The Region reserves the right to conduct, using Contractor equipment and labour, a random re-test of up to five (5) percent of the tests to confirm documented results. Any failed tests shall be re-tested and restored to a passing condition. In the event more than two (2) percent of the tests fail during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the Region.

### 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.

### Basic Network Connectivity Tests

#### Network testing to be carried out with Region to prove all of the physical connections completed by the contractor.

#### Assist the Region in testing any external network connections to the system.

### Link Acceptance Test Results Manual

#### Submit test reports in both a hardcopy and electronic format. Hand-written test reports are not acceptable. Submit electronic files on a CD format disk in a PDF format. If test results cannot be converted to a PDF format then provide any necessary proprietary software to view the results at no cost to the Region.

#### Link Acceptance test results shall be incorporated in the PCS Network –Test Results manual.

#### Both the Contractor and Consultant must sign hardcopy reports.

### Documentation. As a minimum, test reports shall include the following information for each test performed:

#### Test criteria used.

#### Source IP address, subnet and gateway

#### Destination IP address, subnet and gateway

#### Overall pass/fail indication.

#### Date and Time of test.

## Field Support

### Provide field support, response time and on site personnel during warranty period as identified the contract documents.

**END OF SECTION**