Toronto Water - Commercial Facilities

Structured Cabling System-Inside Plant (ISP)

Design Guide For

Consulting Engineers, Architects & Designers

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SECTION-1: INTRODUCTION

This design guide is to provide consulting engineers, architects and designers working for Toronto Water (TW) with a document for the design of commercial facilities communications distribution and structured cabling systems that accurately reflects Toronto Water (TW) and industry standards in effect as of this publication. This document shall be referenced to develop project specification documents.

Therefore, it is obligatory for consulting engineers, architects and designers of telecommunications systems of Toronto Water (TW) to follow and practice the most updated revision to reflect the methods, materials and standards that have been used for providing telecommunications services to the existing TW facilities. The updated document also reflects changes in industry practice as of this publication.

In general, it is the responsibility of the commercial building communications distribution designer to coordinate with the other designers on a project (architect, structural, electrical, mechanical etc.) to ensure that other systems are both compatible with and complementary to the communications cabling system. Toronto Water (TW) design philosophy is that it is critical to coordinate between disciplines during the design phase of a project, rather than attempting to make adjustments in the field during construction or occupation.

Communications distribution systems designed for Toronto Water (TW) commercial facilities are expected to support and integrate voice, data and video communications with common media (fiber optic and unshielded twisted pair copper cable).

DOCUMENT INTENT AND LIFE CYCLE

The purpose of this standard is to define the general guidelines and standards for the design, specification, installation, testing, troubleshooting, documentation and handing over of the commercial facilities communications distribution and structured cabling systems. This standard follows published industry standards and best practices applicable to the water and wastewater industry. The life cycle of this document version is from January to December every year since 2015. Always consult Toronto Water Division for the latest version of this standard guide.

This document addresses commercial buildings communications distribution and structured cabling system design as it relates to:

- Design guide, topology and methodology
- Communications Media – fibreoptics and copper unshielded twisted pair (UTP)
- Pathway System – cable trays, conduits, etc.
- Products
- Execution (installation)
- Testing and Commissioning

- Handing over (final acceptance)

This document should serve as a guide for making standards compliant project specification which, in due course, will be reflected in a master tender specification document. In addition to specifications for a telecommunications project, plan drawings and schematic diagrams will also need to be produced by the designer. The drawings should conform to the guidelines contained in this document. This document is to be used in conjunction with the latest edition of BICSI TDMM.

TYPES OF CONSTRUCTION

Throughout this document, reference will be made to three types of construction: new, overbuild and basic construction. Construction of a new commercial building communications distribution and structured cabling system as well as the addition to and/or modification of an existing commercial facilities communications distribution and structured cabling systems are considered to be included in these construction projects. Tradeoffs between design standards and practicality will many times be dependent upon the type of construction. Different design approaches may be warranted given differing types of construction.

The three types of construction are defined below. These definitions are applicable to the purposes of this document only.

A- NEW CONSTRUCTION

New construction is defined as construction that results in a new (or new portion of an existing) commercial buildings communications distribution and structured cabling systems. For the most part, new pathway will be constructed and new communications media will be installed in the pathway.

B- OVERBUILD CONSTRUCTION

Overbuild construction is defined as construction which may include demolition and/or abandonment of existing pathway and communications media, reuse of existing pathway for installation of new communications media and the addition of new pathway and/or media to existing pathway and/or media. Common terms referring to this type of construction include expansion, renovation, remodel, addition and retrofit, among others.

C- BASIC CONSTRUCTION

Basic construction is defined as construction that includes reuse of existing distribution pathway for the installation of new communications media. Demolition of existing communications media may be involved as well. In general, basic construction is focused on the installation of new communications media with no (or very minor) modifications made to the existing pathway system.

TORONTO WATER COMMERCIAL FACILITIES

This Toronto Water (TW) design guide document of structured cabling systems for commercial buildings applies to the design and construction of the communication networks at the Toronto Water commercial, administrative and yard facilities (facility code) listed below:

- Tiffield Yard and Data Centre, 60 Tiffield Road (YTF)
- Toronto Water Laboratory, 30 Dee Avenue (YDE)
- Central Services, 545 Commissioners Street (YCS)
- Kipling Yard, 435 Kipling Avenue (YKP)
- Business & Customer Support Office, 275 Merton Street (YMT)

TORONTO WATER TENDER DRAWINGS

This standard guide should be read in conjunction with the Toronto Water (TW) standard drawings. The drawings shall typically be produced by the consulting engineers / designers and shall consist of (applicable to the project) the followings. The information on the drawings and the set shall not be limited to:

1. Title/Cover Page and Drawing Index

2. Symbols (legends) and Notes General

3. Campus / Building Layout (Exterior Pathways and Inter-Building Backbones, shows physical and logical connections from the perspective of an entire campus)

    a. Fibreoptics Inter-Building Backbone Layout (if applicable); Fibreoptics Patch Panel Port Assignment (if applicable)

    b. Voice (copper) Inter-Building Backbone Layout (if applicable); Copper Patch Panel / BIX Blocks Port Assignment

4. Building Floor Plan (Layout of Complete Building Per Floor, Serving Zone Boundaries, Building riser pathway –Horizontal and Backbone system).

5. Serving Zone Floor Plan (Drop/Work Area Outlet Locations and Outlet & Cable IDs)

6. Service Provider Entrance Facility Layout/ Backboard Elevation and Bill of Materials

7. Equipment Room Layout /Plan Views

8. Telecom Room Layout/Plan Views
9. Ceiling / Wall / Furniture / Floor Mounted Work Area Outlet Details, Labelling and Bill of Materials
10. Telecom Enclosure Elevation and Bill of Materials
11. Telecom Enclosure Power Distribution Diagram
12. Telecom Enclosure UPS Panel Layout
13. Telecom Pathways (Cable Trays / Conduits) Details
14. Typical Details Labelling of Horizontal/Backbone, Cable Tray, Conduit/Sleeve, Fire-stopping,
15. Telecom Grounding and Bonding Layout (Riser and Floor Plan)
16. HVAC – Mechanical System Layout for Equipment Room / Telecom Room
17. Electrical / Power Layout for Equipment Room / Telecom Room / Work Areas
18. Demolition Drawings (all applicable drawings / layouts)
19. Schedules (Work Area Outlet list, Equipment Mapping and Location, Cable Plant Management) for Cutovers

SERVICES NOT PROVIDED BY TORONTO WATER

- The voice system technology (Bell Centrex etc.) shall be supplied and installed by others.
- The cabling from the service provider's demarcation point in the entrance facility room (or panel) to the facilities property line and on to the service provider's facilities. Entrance Facility and demarcation point shall be outlined in the specific design drawings.
- Service providers shall terminate the incoming copper cables on BIX and BIX cross-connect between the ISP and the OSP cabling at the Entrance Facility. Service providers shall terminate the incoming fibre cables in either wall mount or rack mount fibre enclosures between the ISP and the OSP cabling in the Entrance Facility.
- Witnessing field cable testing at site is NOT TW DNS responsibility. The Contractor shall submit the test results to Consultant for their review, validation, witnessing and comment. Consultant shall forward the test results to TW DNS for further review (only if approved by the Consultant after their review).

- BOQs/BOMs, layouts, elevations, drawings and schematics shall be prepared/reviewed by the Consultant.

MANDATORY DESIGNERS' QUALIFICATION REQUIREMENTS

- The standard is to be observed by the City of Toronto – Toronto Water Staff and Consultants involved with the design and implementation of structured cabling systems for data networks which include data networks, security networks, VoIP networks and any other networks that require a structured cabling system that is unified and connected to Toronto Water network.
- The preparation and review of any network cabling system design, drawings and specification documents shall be conducted by a Registered Communications Distribution Designer (RCDD). The credential holder shall be in good standing who have demonstrated knowledge in the design, integration and implementation of telecommunications and data communications transport systems and related infrastructure.
- All consultant design drawings and specification document shall be sealed / stamped by RCDD.
- All cabling is to be provided from the manufacturers noted with the following sections. Cabling provided by alternate manufacturers is not acceptable.

In addition, the RCDD shall have the following qualifications:

- The RCDD shall demonstrate a minimum of 5 years of experience in the design of commercial buildings communications distribution systems. Experience not directly related to the design and installation of commercial buildings communications distribution systems, such as sales and/or marketing, is not acceptable.
- The RCDD shall demonstrate that he/she has designed or has had personal design oversight of a minimum of five projects similar in size and construction cost to the current TW project.
- The RCDD consultant must have verifiable design experience with products and solutions from Belden.

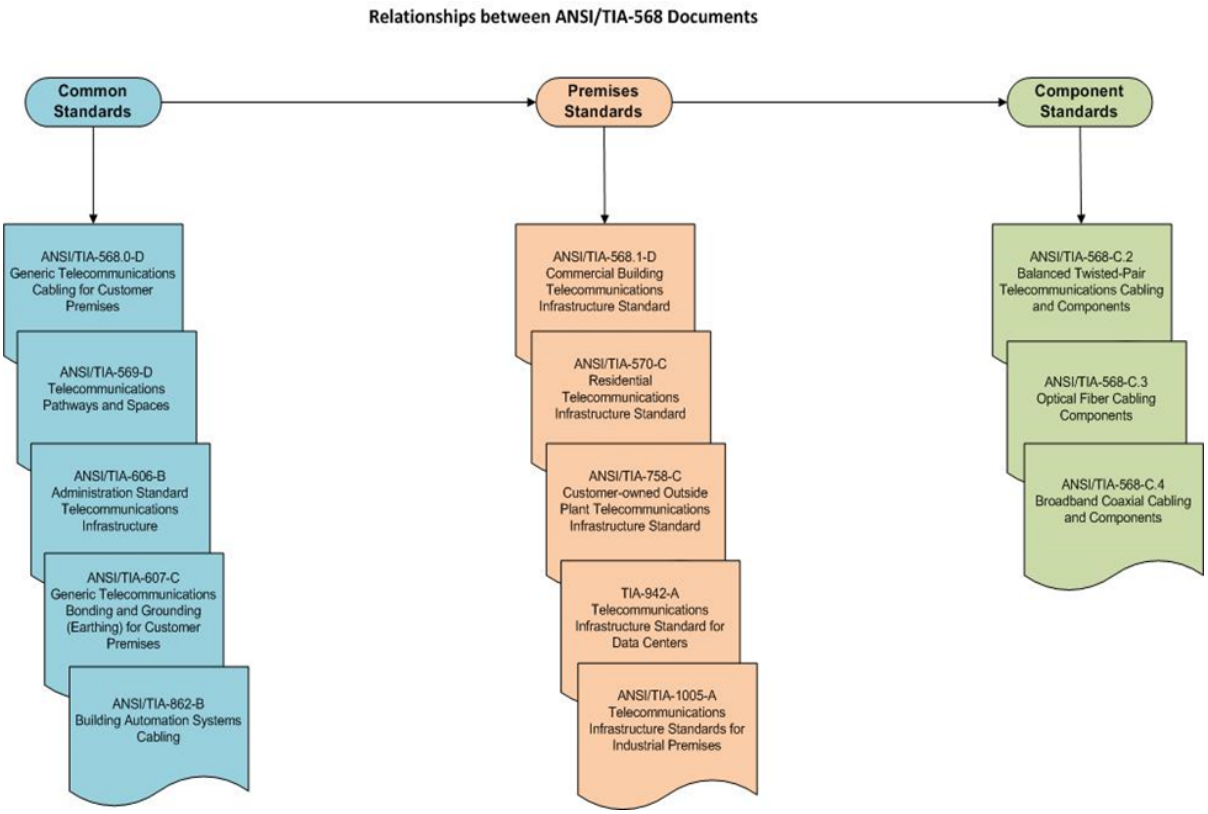
Before commencing any work for or on behalf of Toronto Water, the RCDD shall provide a copy of their RCDD certificate showing up to date registration in accordance with all Building Industry Consultant Services International (BICSI) policies and guidelines.

MANUFACTURERS

In addition to the standards listed below, Toronto Water has selected Belden as a manufacturer of communications cabling infrastructure products for commercial buildings. The manufacturer is identified in the Product Section. The commercial building communications distribution designer is required to incorporate only this manufacturer into the design and to design a communications

distribution structured cabling system that will be suitable for the use of products from the manufacturer.

ANSI-TIA STANDARD RELATIONSHIP DIAGRAM



DESIGN AND REFERENCE STANDARDS

It is required that the designer be thoroughly familiar with the content and intent of these references, standards, and codes and that the designer be capable of applying the content and intent of these references, standards, and codes to all commercial communications system designs executed on behalf of Toronto Water.

Listed in the table below are references, standards, and codes applicable to commercial communications systems design. If questions arise as to which reference, standard, or code should apply in a given situation, the more stringent shall prevail. As each of these documents is modified over time, the latest edition and addenda to each of these documents is considered to be definitive.

Standard	Title	Date
TIA-568.0-D	Generic telecommunications cabling for customer premises	2015
TIA-568-C.0-2	Generic Telecommunications Cabling for Customer Premises-Addendum 2, General Updates	2012
TIA-568-1-D	Commercial Building Telecommunications Cabling Standard	2015
TIA-568-C.1-1	Commercial Building Telecommunications Cabling Standard, Addendum 1 Pathway and Spaces	2012
TIA-568-C.2	Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted- Pair Cabling Components	2009
TIA-568-C.3	Optical Fibre Cabling Components Standard	2008
TIA-568-C.3-1	Optical Fibre Cabling Component Standard-Addendum 1, Addition of OM4 Cabled Optical Fibre and array connectors	2011
TIA 606 –B	Administration standard for telecommunications infrastructure	2012
TIA- 607-C	Generic telecommunications bonding and grounding (earthing) for customer premises	2015
C22.2 NO. 214-08 (R2013)	Communications cables (Bi-national standard, with UL 444)	2013
C22.2 NO. 232-09 (R2014)	Optical fibre cables	2014
CAN/CSA-C22.2 NO. 0-10 (R2015)	General requirements - Canadian Electrical Code, part II	2015
CAN/CSA-C22.2 NO. 182.4-M90 (R2015)	Plugs, Receptacles, and Connectors for Communication Systems.	2015
TIA-1005-A	Telecommunications infrastructure standard for industrial premises	2012
TIA-569-D	Telecommunications Pathways and Spaces	2015

Standard	Title	Date
TIA-526-14-C	Optical Power Loss Measurements of Installed Multimode Fibre Cable Plant; Modification of IEC 61280-4-1 edition 2, Fibre-Optic Communications Subsystem Test Procedures-Part 4-1: Installed cable plant- Multimode attenuation measurement	2015
TIA-526-7-A	Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement	2015
TIA -598-D	Optical Fibre Cabling Coding	2014
BICSI TDMM	Telecommunications Distribution Methods Manual, 13th Edition	2013
TIA-1152	Requirements for field test instruments and measurements for balanced twisted-pair cabling	2009
TIA-455-244	Standard test procedure for fibre optic fibres, cables, transducers, sensors, connecting and terminating devices, and other fibre optic components	2011
ICEA S-83-596-2011	Indoor Optical Fibre Cables	2011
ICEA S-87-640-2011	Fibre Optic Outside Plant Communications Cable	2011
ICEA S-90-661-2012	Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for Use In General Purpose and LAN Communication Wiring Systems	2012
TIA-604-10-B	FOCIS 10b fibre optic connector intermateability standard - type LC	2008
CSA C22.1-15	Canadian electrical code, part I (23rd edition), safety standard for electrical installations	2015
NEMA WC 63.1-2005	Performance Standard for Twisted Pair Premise Voice and Data Communications Cables	2005
O. Reg. 213/07, Division C, ss. 2.1.1.1., 2.1.2.1.	The Ontario Fire Code	2007

Standard	Title	Date
UL 444 Edition 4	Communications Cables	2010
ANSI Z136.2	Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources	2012
ANSI/EIA/TIA-455-50B	Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements	1998
ANSI/TIA/EIA-455-59A	Measurement of Fiber Point Discontinuities Using an OTDR	2000
ANSI/TIA/EIA-455-60A	Measurement of Fiber or Cable Length Using an OTDR	2000
ANSI/TIA/EIA-455-61A	Measurement of Fiber or Cable Attenuation Using an OTDR	1989
TIA-TSB-4979	Practical Considerations for Implementation of Multimode Launch Conditions in the Field	2013
IEC-61300-3-35	Basic Test and Measurement Procedures Standard for Fiber Optic Interconnecting Devices and Passive Components	2015
ANSI/TIA-942-A	Telecommunications Infrastructure Standard for Data Centers	2014
ANSI/TIA-942-A-1	Telecommunications Infrastructure Standard for Data Centers, Addendum 1 – Cabling Guidelines for Data Center Fabrics	2013
ANSI/BICSI-002	Data Center Design and Implementation Best Practices	2014
EIA/ECA-310-E	Cabinets, Racks, Panels, and Associated Equipment	2005
TSB-162-A	Telecommunications Cabling Guidelines for Wireless Access Points	2013
ANSI/TIA-862-B	Structured Cabling Infrastructure Standard for Intelligent Building Systems	2016
TIA -5017	TELECOMMUNICATIONS PHYSICAL NETWORK SECURITY STANDARD	2016

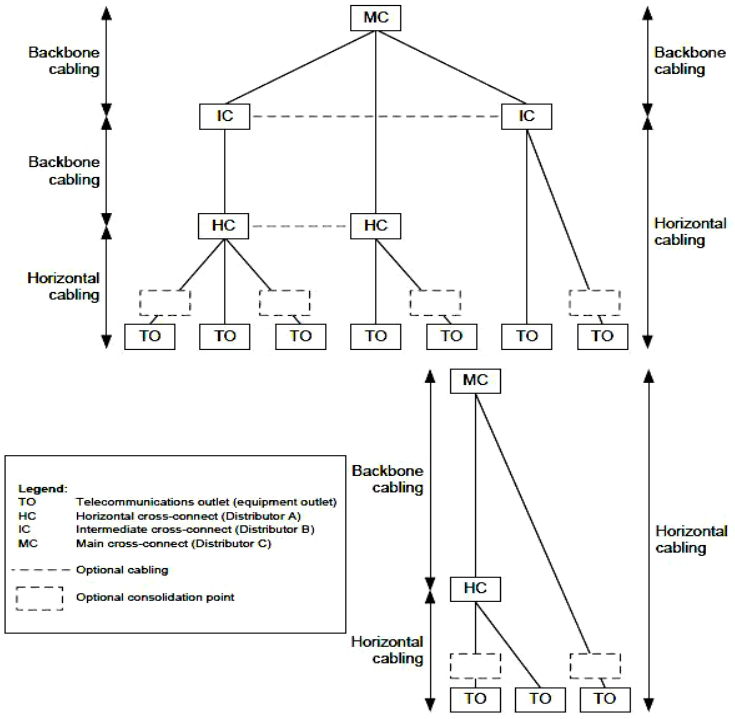
DEVIATION FROM STANDARDS

It is the intent of Toronto Water (TW) to rigidly impose standards on every aspect of a commercial building communications system design. However, each design is unique and may be subject to situations in which deviations from the standards are warranted.

If the designer feels that deviation from a given standard is warranted, the designer shall submit a written deviation request to Toronto Water (TW DNS). The request will, at a minimum, indicate the standard from which there is a proposed deviation, the substitution being proposed in place of the standard, the reason of the request being made, and an explanation of the justifications (economic, technical or otherwise) for the deviation. The designer may, upon written approval from TW-DNS, incorporate the design deviation into the overall design. Toronto Water (TW) approval is required on a project-by-project basis. The designer should not assume that a deviation approval for one project means that the deviation will necessarily be approved for a subsequent project.

GENERIC TOPOLOGY

The figure below is an illustration of a generic cabling topology for Cabling Subsystem 1, Cabling Subsystem 2, Cabling Subsystem 3, Distributor A, Distributor B, Distributor C, an optional consolidation point and the equipment outlet. Elements of Generic Cabling Topology in both Standards are as below:



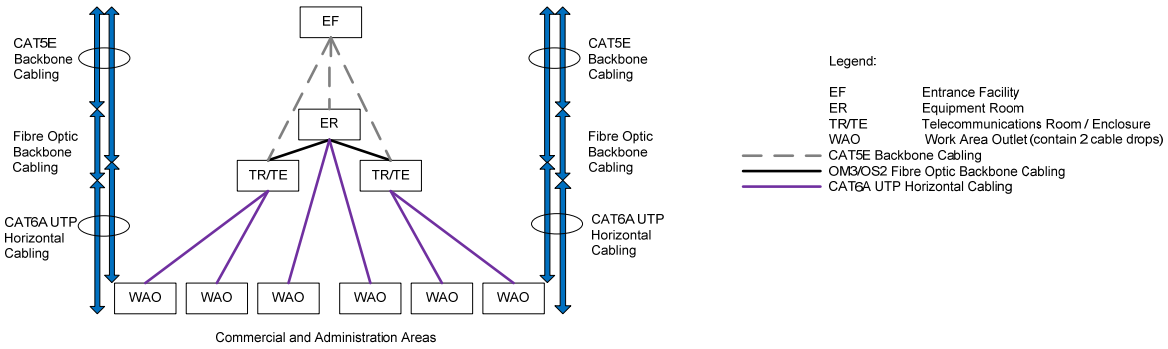
ANSI/TIA-568 Terminologies

TORONTO WATER STRUCTURED CABLING SYSTEM - DESIGN CONSIDERATIONS

This section highlights design considerations of particular importance to Toronto Water (TW). It also discusses differing TW standards given the type of construction (new, overbuild, or basic) for a particular project, as well as TW standards that may differ from the standards listed previously.

TORONTO WATER COMMERCIAL BUILDING CABLING TOPOLOGY

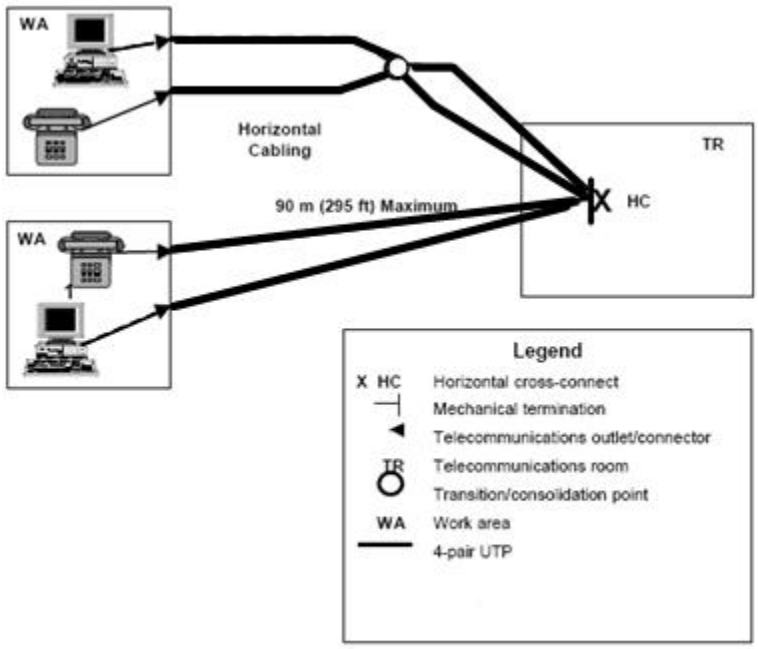
The figure below is an illustration of the Toronto Water commercial building cabling topology.



Elements of the Toronto Water Standard Topology for Commercial Facilities

DESIGN SUMMARY

- The network shall be a distributed star topology network.
- All copper cables shall link to the TE/TR and hence link back to the ER (Server Room) via fibre Cable.
- The specified copper network cables for all commercial buildings shall be Belden.
- All the horizontal copper cables (voice, data, and video) shall be UTP Category 6A and shall be in accordance to this specification. Category 6A cabling will target to support 10GBASE-T & HDBASE-T high speed applications, next generation IEEE 802.11ac Wave 2 (802.3bz 2.5G/5GBASE-T) wireless access points, as well as next-generation Power-over-Ethernet standard (802.3bt 4PPoE).
- Length of the cables from WAO to the end device shall be in compliance to the Ethernet and structured cabling applicable standards.



- The backbone copper multi-pair (minimum 25 pairs) cable is mainly for voice and shall be UTP Category 5e and shall be in accordance to this specification.
- The containment system for the voice and data network shall be as per the specified material mentioned in this document, unless specified otherwise on the design drawings. The approved conduit system is EMT type, appropriately sized as per TIA-569-D standard. The cable tray shall be basket wire mesh type, corrosion resistant, appropriately sized as per TIA-569-D standard.
- The horizontal copper cables are to be permanently interconnecting the patch panel in the Telecommunications Enclosure with a work-area outlet located on the walls of commercial building.
- Length of the cables from WAO to the respective TE/TR shall be in compliance to the Ethernet and structured cabling applicable standards.
- Horizontal cables in the commercial buildings shall always be collated of two (2) cables per work area outlet located on the wall/furniture of the closed office or a cubicle.
- Office cubicles shall contain 1 WAO (1 Voice / VoIP, 1 Data and 2 Blank ports).
- Closed offices shall contain 1 WAO (1 Voice / VoIP, 1 Data and 2 Blank ports) shall be provided to every $10m^2$ of office space (i.e. if the office is $10m^2$ then it shall have 1 WAO). If the office is

larger than 10m^2, then 2 WAOs shall be provided (with 2 Data and 2 Blank ports for the 2nd WAO).

- Each group of horizontal cables shall be associated with a single 4-port, work-area outlet/faceplate on the wall / furniture and a 4-port in the Telecommunication Enclosure patch panel.
- Approval for additional ports per cubicle or office must be granted by DNS Technical Representative before proceeding with this work.
- Containment pathways shall be designed and sized for a minimum of four (4) horizontal cables, unless otherwise mentioned differently in the design drawings.
- The specified fibre backbone cables shall be Belden.
- The Fibre Optic Backbone is defined as the fibre optic segments radiating out from the Network Core Closet to the Telecommunications Enclosures / Room.
- The fibre allocation within the fibre optic backbone cable is as follows:
    - 12 core fiber is minimum, 24 Core fibre backbone is recommend: Multimode (OM3) when length under 300meters; Singlemode (OS2) when length is more than 300 meter.
    - Toronto Water LAN — 4 fibres active (2 primary strands and 2 redundant strands);
    - Toronto Water LAN — 8 fibres or 20 fibers reserved for future applications~~;~~
    - All fibre cables are to be terminated and tested;
- All passive network components shall be from a single manufacturer (Belden).

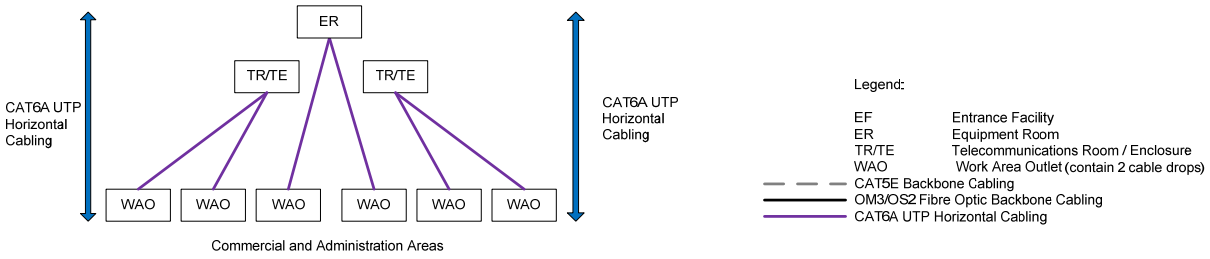
DESIGN DETAILS OF HORIZONTAL CABLING SYSTEM (CABLING SUBSYSTEM – 1)

Horizontal cabling includes horizontal cable, telecommunications outlet / connector / jack in the work area (WA), mechanical terminations and patch cords or jumpers located in a telecommunications room (TR) or telecommunications enclosure (TE). Horizontal cabling topology, distances, requirements and recommendations as specified in the ANSI/TIA-568.0-D standard apply unless otherwise specified in this Standard.

TOPOLOGY

The horizontal cabling shall meet the star topology requirements of ANSI/TIA-568-C. Each telecommunication work area outlet (WAO) outlet/connector shall be connected to the horizontal cross-

connect (HC) located in the TE/TR as shown in figure below. The horizontal cable shall be terminated on a jack (balanced twisted pair) at one or both ends.



Horizontal Cabling Topology

LENGTH

The horizontal cable length extends from the termination of the media at the TE/TR to the telecommunications outlet/connector/jack in the work area outlet (WAO). For balanced twisted-pair cabling the maximum permanent link length in the office/administration areas shall be 90 m (295ft.).

The length of the cross-connect jumper and patch cord in the cross-connect facility, including TE/TR, jumper and patch cord which connect horizontal cabling with equipment or backbone cabling should not exceed 5m (16 ft.) in the office/admin work area and 5m (16ft.) in the TE/TR.

RECOGNIZED MEDIA

The recognized media, which shall be used individually or in combination, are:

- 4-pair 100 ohm balanced twisted-pair cabling, Category 6A UTP (ANSI/TIA-568-C.2)

The Recognized media and associated connecting hardware, jumper, patch cord, equipment cord, and work area cord shall meet the requirements specified in this document.

CHOOSING MEDIA

Cabling specified by this Standard is applicable to different requirements within the commercial premises. Depending upon the characteristics of the individual application, choices with respect to transmission media should be made. In making this choice, factors to be considered include:

- Environmental classifications;
- Mitigation such as separation, protection or isolation;

- Cabling performance enhancements in accordance with performance test requirements mentioned in the document;
- Applications to be supported by the cabling system;
- Equipment vendor recommendations or specifications;
- Configuration of cabling components;
- Additional special requirements such as high pressure wash down, high flex, weld splatter, building grounds, etc.

Each recognized cable has individual characteristics that make it suitable for a myriad of applications such as voice, data, text, video, commercial and building controls, security, fire alarm and images.

DESIGN DETAILS OF BACKBONE CABLING SYSTEM (CABLING SUBSYSTEM – 2 AND 3)

Backbone cabling is the portion of the commercial building telecommunications cabling system that provides interconnections between Entrance Facility (EF), Equipment Room / Server Room (ER) and Telecommunications Room / Enclosure (TR/TE). Primary and redundant, minimum 12 strands in each cable shall run between the equipment room and the telecom room. Total of minimum 2 x 12 strands shall run with diverse pathways between the equipment and telecom rooms. As such, the backbone cabling shall meet the requirements of ANSI/TIA-568.0-D for Cabling Subsystem 2 and Cabling Subsystem 3.

Backbone cabling consists of the backbone cable, intermediate and main cross-connect mechanical terminations and patch cords or jumpers used for backbone-to-backbone cross-connection. The cabling should be planned to accommodate future equipment needs, diverse user applications, ongoing maintenance, service changes and relocation.

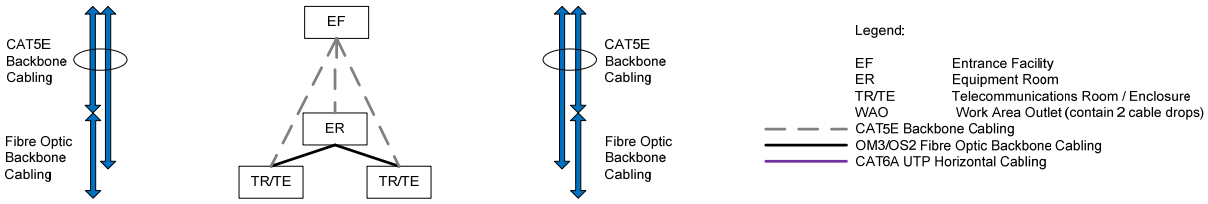
TOPOLOGY

The backbone cabling shall meet the hierarchal star topology requirements of ANSI/TIA-568.0-D, unless otherwise specified by this Standard.

There shall be no more than two hierarchical levels of cross-connect in the backbone cabling. From the horizontal cross-connect (HC) or TW equivalent Telecommunication Enclosure / Room (TE/TR), no more than one cross-connect shall be passed through to reach the MC or TW equivalent Equipment Room (ER) depending on configuration. Therefore, connections between any two HCs (TW-TE) shall pass through three or fewer cross-connect facilities.

NOTE – The topology required by this specification has been selected because of its acceptance and flexibility in meeting a variety of application requirements. The limitation to two levels of cross-connects

is imposed to limit signal degradation for passive systems and to simplify moves, adds and changes. This limitation may not be suitable for facilities that have a large number of buildings or those that cover a large geographical area.



Backbone Cabling Topology

COMMERCIAL FACILTIES

The incoming fibre cable from the service provider enters the building Entrance Facility (EF) and spliced to ISP fibre at EF if the distance from the EF to the ER exceeds 15 m (except the outdoor fiber cable contained in conduit). The ISP service provider cable runs from EF and terminates at Equipment Room (ER).

The multi-pair Category 5e copper cable for centrex voice runs from the ER/TR/TE to the EF.

SMALL COMMERCIAL SITES

In small commercial buildings of Toronto Water, there is no ER. The TE/TR acts as an ER. The fibre incoming cable from the service providers enters the facility and spliced to ISP fibre if the distance from the facility entrance to the TE/TR exceeds 15 m (except the outdoor fiber cable contained in conduit). The ISP service provider cable runs from entrance point and terminates at Telecom Enclosure (TE) / Telecom Room (TR) / Equipment Room (ER).

LENGTH

The backbone cable length extends from the termination of the media at the EF (Entrance Facility) to an IC (Equipment Room) or HC (Telecommunication Enclosure or Telecommunications Room). To minimize cabling distances, it is often advantageous to locate the EF near the center of the premises. Cabling installations may be divided into areas, each of which can be supported by backbone cabling within the scope of this Standard.

Cabling length is dependent upon the application and upon the specific media chosen (see ANSI/TIA-568.0-Dand the specific application standard). The backbone length includes the backbone cable, patch

cords and cross-connect jumpers. Applicable balanced twisted-pair de-rating factors (see ANSI/TIA-568-C.2) for cross-connect jumpers and cords shall be taken into account.

The length of the cross-connect jumpers and patch cords in the EF or IC should not exceed 20 m (66 ft.). The length of the cord used to connect telecommunications equipment directly to the EF or IC should not exceed 30 m (98 ft.). For backbone link length less than 300 meters, OM3 multimode fibreoptics cable shall be used, otherwise OS2 singlemode fiber cable shall be used.

BACKBONE RECOGNIZED MEDIA

Recognized cables associated connecting hardware, jumpers, patch cords, equipment cords and work area cords shall meet the requirements specified in this document. The recognized media of backbone, which shall be used individually or in combination, are:

- For Data:
    - Multimode OM3 optical fibre cabling (ANSI/TIA-568-C.3), 12-fibre (or higher fibre count)
    - Singlemode OS2 optical fibre cabling (ANSI/TIA-568-C.3), 12-fibre (or higher fibre count)
- For Centrex Voice:
    - CAT5e multi-pair UTP cabling (ANSI/TIA-568-C.2), 25 pair (or higher pair count)

CHOOSING MEDIA

Backbone cabling specified by this Standard is applicable to a wide range of different user requirements. Depending upon the characteristics of the individual application, choices with respect to transmission media have to be made. In making this choice, factors to be considered include:

- Link length (max. 300 meters for OM3, OS2 for 300 meters and above)
- Flexibility with respect to supported services
- Useful life of backbone cabling
- Site size and user population
- Environmental conditions
- Fiber to the desk /wore area (optional)

Each recognized cable has individual characteristics that make it useful in a variety of situations. A single cable type may not satisfy all user requirements. It is then necessary to use more than one media in the backbone cabling. In those instances, the different media shall support the same facility architecture

with the same location for backbone distribution area spaces, including cross-connects, mechanical / fusion terminations, inter-building entrance facilities.

CABLING DIRECTLY BETWEEN TELECOMMUNICATIONS ROOMS / TELECOMMUNICATIONS ENCLOSURES

Cabling directly between HCs (Telecommunication Enclosures or Telecommunications Rooms) is not permitted. All backbone cabling must follow the star topology specified in ANSI/TIA-568.0-D by connecting back to the IC/MC (Equipment Room / Server Room).

DESIGN CONSIDERATIONS FOR SPACES, ENCLOSURES AND ROOMS

SPACES

- Spaces in commercial premises shall meet the requirements of ANSI/TIA-569-D.
- Spaces should be designed to be compatible with the worst-case environment to which they will be exposed (see ANSI/TIA-568.0-D and TIA/TSB-185 for information on environmental classifications).
    - Spaces shall comply with local codes and regulations.
- Temperature and humidity shall meet the requirements for Class 4 in ANSI/TIA-569-D, unless stated otherwise.
- Perform additions and modifications to the existing Local Area Network as shown on Contract Drawings.

DESIGN GUIDE OF EQUIPMENT ROOM / SERVER ROOM (ER)

- If designing ER, consult TW DNS for a separate standard design guide of Equipment Room (ER). The below is just to be used as reference guide for carrying out works in existing ER.
- The ER shall be strategically located to minimize the size and length of the backbone, especially in multiple-backbone situations.
- The ER shall accommodate the delivery of large equipment.
- The doors and hallways shall be sized appropriately for the movement of large equipment.
- Elevator or hoist and loading docks shall be available for large equipment movement.
- The weight capacity of the floors must be rated for large equipment.

- Any potential difficulties in scheduling and use of access routes and facilities for moving large equipment during installation and future changes shall be considered.
- Present and future needs shall be considered in properly locating and designing the ER.
- The ER telecommunications infrastructure shall be sized as required and capable of supporting a broad range of telecommunications applications required by the building or campus.
- Infrastructure shall be present for a large volume of cable between main distribution equipment and server racks.
- The ER telecommunications infrastructure shall be capable of supporting existing telecommunications equipment and/or cabling.
- The length of electrical power feeds from the electrical service entrance to the ER shall be minimized to aid in an optimal bonding and grounding arrangement and minimize grounding disturbances.
- The distance (no closer than 3m [10 ft.]) to potential EMI and RFI sources shall be considered. These include transformers, motors, generators, radio transmitters, induction heating devices, photocopier, arc welding equipment, etc.
- The ER shall not be located in any place that may be subject to:
    - Water infiltration
    - Steam infiltration
    - Humidity from nearby water or steam
    - Heat (e.g. direct sunlight)
    - Corrosive atmospheric or adverse environmental conditions
    - Locations below water level unless water infiltration preventive measures are employed.
- The ER shall not be located in any space in or adjacent to:
    - Mechanical rooms
    - Washrooms
    - Custodial closets

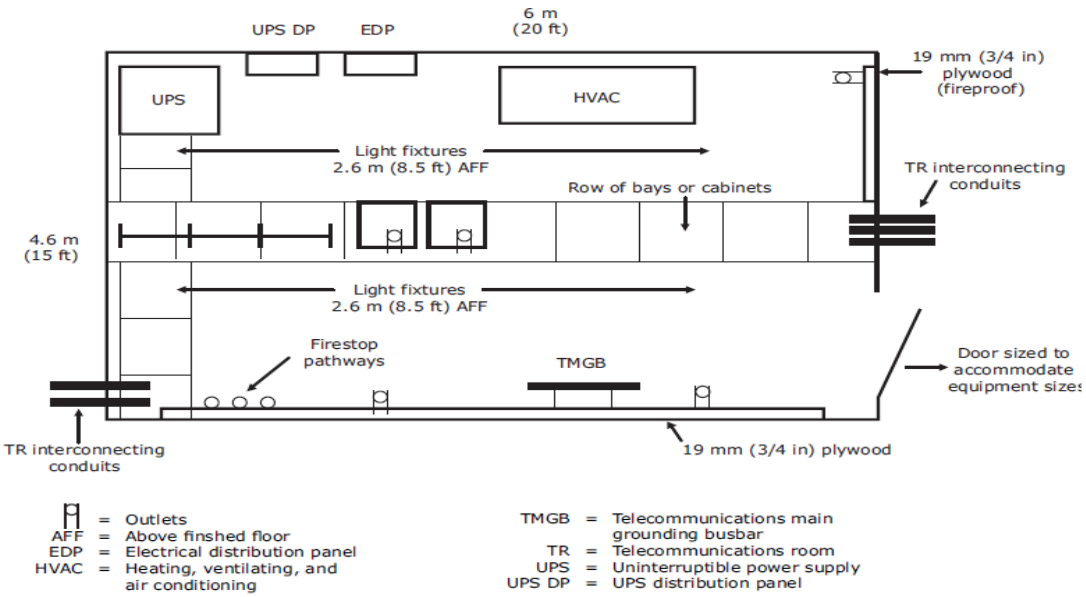
- Storage rooms
- Loading docks
- Any area that contains sources of excessive EMI, hydraulic equipment, heavy vibration, steam pipes, plumbing, and cleanouts

- The ER must provide space for all planned equipment and access to all equipment for maintenance, administration and growth.
- The ER must meet the space requirements specified by equipment providers. Space and layout requirements for different telecommunications applications (e.g. voice, data) must be taken into account.
- For voice and data, provide 0.07 m^2 (0.75ft^2) of ER space for every 10m^2 (100ft^2) of usable work area space.
- The minimum ER size shall be based on the known number of work areas as shown on the table below and not on usable floor area:

Work areas	Area m^2 (ft^2)
Up to 100	15 (160)
101 to 400	37 (400)
401 to 800	74 (800)
801 to 1200	111 (1200)

- The guidelines for other support equipment, such as power distribution, conditioner systems, and UPS up to 100kVA shall be permitted in the ER. UPS larger than 100kVA should be located in a separate room.
- The ER layout and floor plan shall comply with TIA-568, TIA-569 and BICSI TDMM latest editions.
- A minimum ER space of 3m (10ft.) by 5m (16ft.) shall be allocated.
- The ER shall include adequate space to support equipment changes with minimal disruption. Sizing shall include projected future as well as present requirements.
- Equipment not related to the support of the ER (e.g. piping, ductwork, pneumatic tubing, etc.) shall not be installed within, pass through, or enter the ER.

Typical equipment room layout



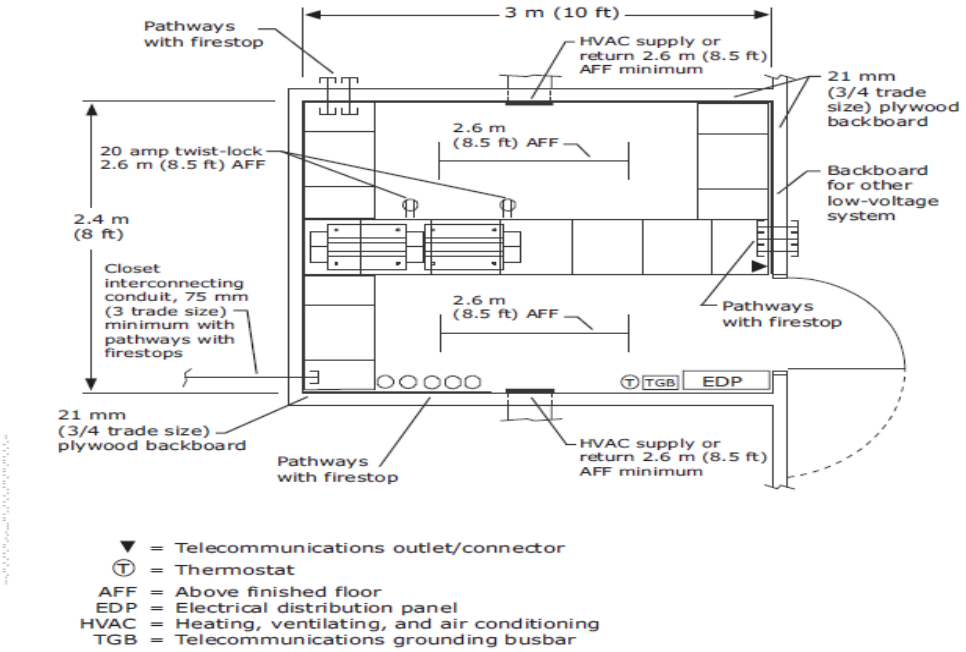
- The ER shall include space for environmental control equipment, power distribution/conditioners, and uninterruptible power supply (UPS) systems that may be installed.
- The ER shall include barriers to protect sensitive network equipment from dust including door seals and air filtration.
- The ER shall include equipment and systems (grounding straps) to protect sensitive network equipment from static electricity.
- The ER shall be designed to comply with local zoning requirements for earthquakes and other natural disasters.
- The ER shall be designed to comply with NFPA-75 and include a pre-action fire protection system and hand held fire extinguishers.
- The ER shall be designed for flood prevention and include a minimum of one floor drain for every 100m^2.
- The ER shall be designed and comply with TW Security requirements.
- The ER shall attenuate ambient room noise to acceptable Acoustic Noise Level Limits in accordance with applicable standards.

- There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure / Termination Panel / Cabinet / Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure / Termination Panel / Cabinet / Rack.

DESIGN GUIDE OF TELECOMMUNICATIONS ROOM (TR)

- If designing TR, consult TW DNS for a separate standard design guide of Telecommunications Room (TR). The below is just to be used as reference guide for carrying out works in existing TR.
- A properly designed TR includes an HC (FD) that provides a floor-serving distribution facility for horizontal cabling. This cross-connect is capable of providing horizontal cabling connections to floor-serving telecommunications equipment and backbone cables from:
    - Other TRs and TEs.
    - ERs and EFs.
- The TR should be provisioned to house telecommunications equipment. In some cases, it may be necessary to combine the building and floor-serving functions of the ER and TR in one room. Instances where the two may be combined include smaller buildings (i.e., less than 500 m^2 [5400 ft^2]) and those with limited space for distribution facilities.
- There must be at least one TR per floor. Multiple rooms are required if the cable length between the HC (FD) and the telecommunications outlet location, including slack, exceeds 90 m (295 ft) or if the usable floor space to be served exceeds 929 m^2 (10,000 ft^2). For TRs that serve areas with an office density of less than one work area per 9.3 m^2 (100 ft^2) of usable floor space, a TR may serve larger areas, provided the horizontal cable length requirements are met.
- Figure below shows a typical layout for a full size TR, suitable for a maximum of 480, 4-pair cable terminations. The drawing illustrates architectural, mechanical, electrical, and telecommunications requirements on a single plan view perspective for purposes of showing coordination issues. Actual design documents will typically separate requirements by discipline.

Typical telecommunications room layout



DESIGN GUIDE OF CABLING BETWEEN CORE NETWORK CABINET AND SERVER CABINET

- The server cabinet structure cabling design shall comply with the requirements of ANSI/TIA/EIA-942-A "Telecommunications Infrastructure Standard for Data Centers", ANSI/TIA-942-A-1 “Telecommunications Infrastructure Standards for Data Centers Addendum 1 – Cabling Guidelines for Data Center Fabrics” and ANSI/BICSI-002 "Data Center Design and Implementation Best Practices".

- For maximum flexibility and management, the server cabinet and core network cabinet shall be connected with OM3/OM4 fiber and Category 6A UTP cabling.

- The server cabinets shall be provided with One (1) X 1U fiber patch panel which can support 12 to 96 fibers. For potential 40GBASE-SR4 and 100GBASE-SR10 migration, minimum one (1) x the 24-fiber OM3 or OM4 MPO/LC trunking cabling system is recommended.

- The server cabinets shall be provided with one x 24 port 1U Category 6A UTP patch panel.

- All necessary horizontal (1U, and 2U) and vertical cable managers shall be provided per server cabinet detailed layout design drawing.

- The copper and fiber patch cords shall be provided for servers and network equipment connection.

ENTRANCE FACILITY REQUIREMENTS (EF)

- If designing EF, consult TW DNS for a separate standard design guide of Entrance Facility (EF).
- Where functions of an entrance facility (EF) are combined with functions of the ER in the same space, the ER may house equipment dedicated to the Access Provider (AP). Requirements specified by the AP must be considered.
- If separate AP space is required, it shall be adjacent to the EF. The design may require a mesh partition or locked cabinet. Space size at least 1.2m x 1.83m (4ft. x 6ft.) should be allocated for each AP.

WORK AREA OUTLET (WAO)

- The work area outlet (WAO) components extend from the telecommunications outlet/connector end of the horizontal cabling system to the work area equipment. The telecommunications outlet/connector shall meet the requirements of this Standard. To simplify relocations, consider a single style of outlet/connector for all work area outlets of the same media type.

WORK AREA OUTLET (WAO) FOR OFFICE AREAS

- Provide one 4-ports, single-gang, work area outlet in each work area for termination of the horizontal Category 6A cables. Faceplate or decora module frame shall be from Belden.
- One 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 2 or 4) on the patch panel of the Telecommunication Enclosure.
- In the majority of cases the 4-port, work-area outlet shall be installed within the cubical partitions. In some situations the work-area outlet shall be installed directly on the wall in office areas.
- All UTP connectors in the office area shall be unshielded modular jacks and wired for a T586A wire-map.

UTP PATCH CORD FOR WAO IN OFFICE AREAS

- Patch cords used in the WAO shall meet the requirements of ANSI/TIA-568-C.2 or ANSI/TIA-568-C.3. WAO cabling may vary in form depending on the application. When application-specific adaptations are needed at the WAO, it shall be external to the telecommunications outlet/connector.

- Supply two (2) 3-metres or less, Belden Category 6A UTP patch cords for each work area outlet. Field terminated patch cords are not acceptable.
- The contractor is responsible for certifying that the supplied patch cords shall meet or exceed the requirements for UTP patch cords as described in the ANSI/TIA-568-C standard.

WORK AREA OUTLET (WAO) FOR WIRELESS ACCESS POINT (WAP)

- Provide one (1) 4-port, single-gang, work-area outlet, connectors and accessories for termination of the horizontal UTP cables (populate 2 jacks for each WAP) dedicated for Wireless Access Point (WAP).
- 2 port surface mounted outlet box may be used when WAP is installed in drop/false ceiling.
- The WAP outlet positions shall base on City's requirement and WAP site survey.
- A custom based model is typically used which can cater to diverse needs and may include both capacity-based and coverage-based deployments throughout various parts of the site.
- It is recommended maximum number of devices desired for each WAP is less than 20 devices per radio.
- For small office, WAP often is placed in the midst of open-office work areas in order to maximize their reach and effectiveness.
- For large facility, pre-cabling using the square cell grid strategy for the coverage-based deployment that allows easy plug-in and flexible positioning of WAPs. Based on the typical coverage area of WAP and common commercial building layouts, a pre-cabled grid with 18.3 m square cells is recommended. This results in a cell radius (WAP patch cord maximum length) is 13 m, and the maximum length from WAP outlet horizontal cabling permanent link is about 80m.
- The total WAP horizontal cabling channel length shall not exceed 100 meters.
- For typical office environments, standard deployments primarily consist of WAP with internal, omni-directional antennas deployed at the ceiling level. A ceiling deployment can occur at, below, or above the level of the ceiling tiles. However, if the ceiling tile material is an RF absorber/reflector, a WAP should not be deployed at the ceiling level.
- When moving away from a ceiling RF absorber/reflector, or when a ceiling is not suitable for cabling and mounting, wall deployments will be occurred.

- For ceiling and wall mounted WAP, applicable ceiling or wall mounted bracket shall be used and follow WAP manufacturer's instruction.

WORK AREA OUTLET (WAO) FOR OTHER BAS SYSTEM

- With the trend of smart /intelligent building and IP convergence, more and more other Building Automation/ Control Systems (BAS) (such as security, HVAC, lighting etc) will be supported by using same standard based network cabling system platform. It is critical to coordinate with other parties between disciplines during the design phase of a project, rather than attempting to make adjustments in the field during construction or occupation.

- It is the responsibility of the commercial building communications distribution designer to coordinate with the other designers or other stake owners on the facility's various BAS to gather their network needs and requirement.

- Provide one (1) 4-port, single-gang, work-area outlet, connectors and accessories for termination of the horizontal UTP cables for requested BAS systems. The populate jack ports depend on the BAS request and needs.

- The BAS outlet can be wall, ceiling mounted and its location shall close to the BAS controller/devices.

- All the BAS system integration with City network platform shall follow all City's standards and security policy.

- All the BAS network outlet request and design shall be reviewed by TW DNS.

- Detailed BAS system design is not in scope of this Commercial Facilities Cabling Guide and not in scope of responsibility of TW DNS. City facility Energy Group looks after BAS systems for all CIty owned facilities.

UTP PATCH CORD FOR WAO IN OFFICE AREAS

- Patch cord used in the WAP WAO shall meet the requirements of ANSI/TIA-568-C.2 or ANSI/TIA-568-C.3. WAO cabling may vary in form depending on the application. When application-specific adaptations are needed at the WAO, they shall be external to the telecommunications outlet/connector.

- Supply and install two (2) 3-meters or less, Belden Category 6A UTP patch cables for each WAP work area outlet. Field terminated patch cords are not acceptable.

- The Contractor is responsible for certifying that the supplied patch cables meet or exceed the requirements for UTP patch cords as described in the ANSI/TIA-568-C standard.

UTP PATCH CORD FOR TE/TR/ER

- Supply 0.5 metre (2 ft.) Belden Category 6A UTP patch cords (gray color) for each data / VoIP drop (jack) to patch at TE/TR/ER. Field terminated patch cords are not acceptable.
- Supply Belden Category 5e or higher UTP patch cords (black color) for each analogy voice ports patching at TE/TR/ER.

DESIGN CONSIDERATION OF PATHWAYS AND CONTAINMENT SYSTEM

- Pathways in commercial premises shall meet the requirements of ANSI/TIA-569-D.
- Pathways should be designed to be compatible with the worst-case environment to which they will be exposed (see ANSI/TIA-568.0-D for information on environmental classifications).
- Pathways in commercial premises shall comply with local codes and regulations.

DESIGN GUIDE OF CABLE TRAY SYSTEM

- All cable trays shall be either a ventilated trough, wire-mesh or ladder-rack type, pre-fabricated structure 300mm (12 inches) in width or greater.
- Ventilated trays shall be equipped with two side rails with a minimum height of 100mm (4 inches) and consisting of a light, rugged and tubular steel or aluminum construction.
- Should aluminum trays be specified (TW DNS approval is mandatory), the engineer is to ensure that, during the grounding or bonding aspects of the installation, the contractor uses tin plated or zinc coated ground connectors.
- Install the ventilated cable tray in the horizontal cable distribution system such as hallways and under floor.
- A cable ladder rack system is to be installed within the Equipment/Server Room (ER) and Telecom Rooms (TR). Refer to the specifications in this document for the type of ladder rack to be used in the horizontal cable distribution system and within the applicable ER/TR's. Spine type and improperly centre hung cable trays are not authorized for use.
- All metal cable trays shall be bonded together to the TMGB or a TGB.
- All metal cable trays shall be coated to prevent rust or galvanic action.

- Accessories and fittings such as elbows and reducers shall be manufactured by the cable tray manufacturer.
- Install cable trays at least 300mm away from fluorescent luminaries and cross power cables at right angles.
- The minimum clearances for cable trays shall be in accordance with Canadian Electrical Code C22.1-09
- Allow 150mm vertical clearance excluding the depth of cable trays, between cable trays installed in tiers except where cables of 50mm diameter or greater are installed then the clearance shall be 300mm, and
- Minimum 200mm vertical clearance from the top of cable trays to all ceilings, 300mm clearance from heating ducts and heating equipment and 150mm for short length obstructions.
- 600mm horizontal clearance on one side of cable tray mounted adjacent to one another or to walls or other obstructions.
- All cable trays/ladders shall be labeled at regular intervals. The distance separating labels shall not exceed 15 metres.
- The maximum cable tray fill ratio is 50%.

DESIGN GUIDE OF CONDUIT SYSTEM

- All telecommunications cables shall be installed in home run EMT conduits originating from the outlet to the cable tray system, Telecommunications Enclosure, or Telecommunications Room. The use of J-hooks, brackets and other attachments are not preferred. Only Velcro ties are allowed. Plastic cable ties are not allowed in any condition.
- The inside radius of a bend in a conduit shall be not less than six times the internal diameter when the conduit is less than 50 mm in diameter and ten times the internal diameter when conduit is 50 mm in diameter or larger.
- All zone conduits shall be identified and labeled at both ends and at regular intervals not to exceed 10 metres. Tags shall identify start and finish of conduit runs. Pull boxes shall be labeled on the exposed exterior.
- All conduits shall originate and be physically connected to the telecom backboards in the Equipment Room, Telecommunications Room, cable tray and pull box.

- All metallic parts of the cable distribution supporting system shall be bonded together mechanically inclusive of all transition points (i.e. cable tray and distribution conduit not mechanically connected) using a 6 AWG green jacketed stranded copper ground wire. The metallic components of the cable distribution system shall be bonded together at the ER and TRs and then bonded to their respective telecom ground busbars.
- All fittings, connectors and couplings shall be of the same material as the conduit used on site.
- All conduits/sleeves that enter the ER or any TR shall be fitted with an approved ground bushing with ground lug and bonded together mechanically (one continuous piece preferred). This shall be connected to the approved building ground by means of a No. 6 AWG to the grounding bus bar.
- Cable fill capacities of conduit shall not be greater than 40%.
- All conduits entering or existing through the ceiling or walls of the ER or TR shall protrude into the room 25-50mm.
- Riser sleeves in the Equipment Room / Server Room and Telecommunication Rooms shall protrude through the floor 50-75mm above finished floor (AFF).
- All conduit runs shall follow building grid lines and shall be concealed where possible.
- All conduits shall be EMT, reamed and bushed at both ends and bonded to the distribution system unless installed in areas deemed chemically hazardous by Toronto Water in which cases PVC coated or Aluminum conduit shall be used. Approval from Toronto Water DNS is required in such instances.
- All conduit runs shall be a maximum of 30 meters (100 ft.) in length with a maximum of two 90 degree bends between pull points, unless otherwise specified.
- Conduits ending in the vicinity of a cable tray shall be terminated at a height of no less than 100mm and no more than 150mm from the top of the cable tray. Conduit runs shall not be punched through the side of the cable tray. Conduit ends are to be bonded to the cable tray.
- The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
- Conduit fittings shall not be used in place of pull boxes or bends.

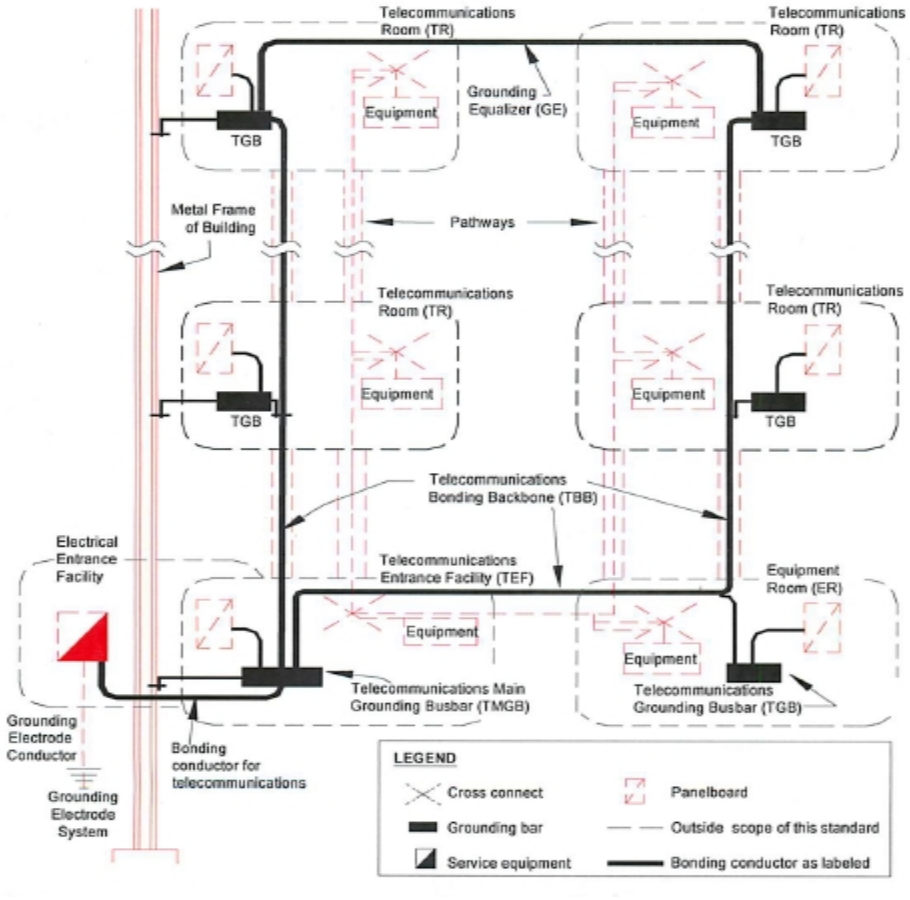
DESIGN GUIDE OF PULL BOX

- A pull box shall be placed in conduit runs where the sum of the bends exceeds 180 degrees, where the overall length of the conduit run is more than 30m, or if there is a reverse bend in the run.
- Pull boxes shall be constructed and sized in accordance with Canadian Electrical Code, TIA and BICSI standards of code gauge steel and shall have a rust resistant finish.
- In all instances pull boxes shall be placed in straight sections of conduit run and shall not be used in lieu of a bend. Corresponding ends of the conduit are to be aligned with each other. Conduit fittings shall not be used in place of pull boxes or bends.
- Pull boxes shall be installed at a reasonable height, in an exposed location and such that access for installation of cables is not prohibited. Pull boxes shall not be placed in a fixed false ceiling space, unless immediately above a suitably marked and hinged access panel. Provide indicator decals on ceiling T-bar rail or ceiling tiles showing location of pull box or splice box.
- Conduit must enter the outlet boxes from the top or bottom.
- All conduits shall be installed in accordance with Canadian Electrical Code, Part 1 Section 12, applicable building codes and TIA/EIA 569-D.
- The minimum size (inside diameter) for conduit running between the Equipment Room or a Telecommunications Room and the Telecommunications outlet at an outlet location is twenty-five millimeters (25 mm).
- The maximum horizontal cable run distance shall not exceed 90 metres.
- The cable length from the mechanical termination in the TR and ER to the Telecommunications outlet, where the horizontal distance exceeds 90 meters, provided additional rooms as required.
- Future requirements for additional cables to each outlet shall be considered.
- A pull cord shall be installed in all conduits.
- Place pull boxes in readily accessible locations only.
- The use of LB, LL, LR, C and T type fittings are not permitted. Only LBs designed and manufactured for communications systems are allowed where applicable.
- There shall be no attachment of pull boxes or any type of panel/enclosure onto the surface of the Telecom Enclosure / Cabinet / Rack. It is strictly prohibited and shall not be allowed in any circumstances to have a box or enclosure attached/fixed on the surface of a Telecom Enclosure / Cabinet / Rack.

DESIGN GUIDE OF TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM

In general, a telecommunications grounding system contains the following components:

- Telecom main grounding bus bar (TMGB)
- Telecom bonding backbone (TBB)
- Telecom grounding busbar (TGB)
- Telecommunications Bonding Conductor (TBC)
- The Telecommunications Bonding Backbone (TBB) consists of green jacketed stranded copper conductors and insulated copper busbars. The system extends from the Building Grounding Electrode Conductor through the ER to the TR's, within the building. The construction of the TBB is a requirement of the latest version of the ANSI/TIA-607-C. This standard shall be used in the design, installation, management and administration of the TBB systems in TW facilities.
- All metallic parts shall be bonded together mechanically and attached to the approved building ground in accordance with applicable CEC, TIA/EIA and CSA standards. In all cases, the CEC shall be met or exceeded.
- Bonding conductors shall be continuous and routed in the shortest possible straight-line path. Any bends placed in the conductor shall be sweeping bends.
- Aluminium wires, clamps or terminal connectors are not acceptable for grounding and bonding.



TIA--607-Terminologies

- The following general requirements shall apply when constructing the TBB system:
    - An insulated pre-drilled, electro tin plated copper busbar, minimum dimensions of 6mm thick x 100mm wide and variable in length, shall be installed on the wall of the ER/EF adjacent to the cable entrance conduits, 150mm from the corner of the ER/EF and 150mm AFF. This busbar is known as the Telecommunications Main Grounding Busbar (TMGB) and shall be insulated from its support by a minimum of 50mm.
    - An insulated pre-drilled, electro tin plated copper busbar, minimum dimensions of 6mm thick x 50mm wide and variable in length shall be installed on the wall of each TR (formally known as a Telecom Closet - TC), adjacent to the cable entrance sleeves, 150mm from the corner of the TR and 300mm AFF. These busbars are known as the Telecommunications Grounding Busbars (TGBs) and shall be insulated from its support by a minimum of 50mm.

- A green jacketed stranded copper ground wire sized to maintain a voltage drop of less than 40 Volts under maximum short time rating. This wire shall be sized no smaller than No. 6 AWG nor larger than a 3/0 and shall be installed from the service equipment ground (main building ground) to the TMGB in the ER/EF. This ground wire is known as the Telecommunications Bonding Conductor (TBC). The Telecommunications Bonding Conductor (TBC) may be secured to the surface of the building if not subject to physical and mechanical damage, or installed in non-ferrous conduit. If ferrous conduit, such as EMT is used, the conductors shall be bonded to each end of the conduit with a conductor minimum sized as a No. 6 AWG green jacketed stranded copper ground wire.

- The TBC shall be connected to Telecommunications Main Grounding Busbar (TMGB). The connection to the TMBG shall be done using a 2-hole electro tin plated compression lug. All joints to the TBC shall be done using irreversible compression-type connectors, exothermic welding, or equivalent.

- The Telecommunications Bonding Conductor (TBC) shall be connected to the service equipment ground (main building ground) by qualified personnel and in accordance with the CEC and TIA 607-C.

- A green jacketed stranded copper ground wire sized the same as the Bonding Conductor for Telecommunications, shall be installed from the farthest TR, through each TR to the Bonding Conductor for Telecommunications located in the ER/EF. This ground wire is known as the Telecommunications Bonding Backbone (TBB). The TBB may be fastened to the underside of open cable tray or installed in non-ferrous conduit. If ferrous conduit, such as EMT is used, the conductors shall be bonded to each end of the conduit with a conductor sized as a No. 6 AWG minimum.

- The TBB in each TR shall be connected to the TGB. All joints to the grounding wires shall be done using irreversible compression-type connectors, exothermic welding, or equivalent. The connection to the TGBs shall be done using 2-hole compression connectors.

- The TMGB in the ER/EF and the TGB in the TR/TE(s) shall be bonded to the closest electrical panel using a No. 6 AWG green jacketed stranded copper ground wire.

- The metallic components of the horizontal distribution supporting infrastructure (conduits, cable trays and ducts) shall be bonded to the to the telecommunications busbars of the ER/EF or TR/TE in which they originate using a No. 6 AWG green jacketed stranded copper ground wire.

- A No. 6 AWG green-jacketed stranded copper ground wire shall be installed from each telecommunications busbar to the metal frame (structural steel) of buildings that are effectively grounded and whose structural steel is accessible.

SEPARATIONS FROM EMI

- Copper cables shall not be installed at a distance less than 300mm from lighting ballasts, less than 1 meter from electric motors or at a separation distance from source of 480V or less.
- Where electric power cable is not installed in EMT conduit, telecommunications cable shall not be run in parallel with it for more than 10 meters if the separation is less than 300mm.
- Electrical protection must be provided for copper cables entering the building. Protection shall be in accordance with the Canadian Electrical Code CSA C22.1-2006 and BICSI practices.

DESIGN GUIDE OF TAGGING CONVENTION (IDENTIFICATION AND LABELING)

- The requirements of this section shall take precedence over other sections.
- The labeling of Toronto Water network components, structured cabling and cable routing/containment shall comply with the TIA-606-B standard and contract specification section 13040-Euipment and Data Tagging.
- The codification of network components, cables and cable routing shall follow the identification standards detailed in this standard.
- For example:
    - Building Location: YDE – Toronto Water 30 Dee Ave
    - Floor and Room Location: ER – Equipment Room / Server Room / Main Communications Room

      TRA – Telecom Room - A

      TRB – Telecom Room – B

      EF –Entrance Facility
    - Service Provider / Network Cabinet Label in ER: XYZ-ITS-COM-0100

      SERVICE PROVIDER/NETWORK CLOSET
    - Network Cabinet Label in ER: XYZ-ITS-COM-0200

NETWORK CLOSET

- Server Cabinet Label in ER: XYZ-ITS-COM-0300

SERVER CLOSET

- Patch Panel: A – Data Patch Panel A (A,B,C, etc …)

  FP01 – Fibre Optic Patch Panel

  TP01 – Telephone/ Voice Patch Panel
- Patch Panel Port: 01 – Patch Panel Port (01, 02..24)
- Work Area/room Number: 125 – Work Area/room number associated in the admin/office areas of the facility
- Work Area Outlet: WA01 – Work area outlet (01, 02, 03…)

  1 – Port number (1, 2, 3, 4)

EQUIPMENT ROOM / SERVER ROOM CABINETS IDENTIFICATION AND LABELING

- The labeling of Toronto Water network components, structured cabling and cable routing/containment shall comply with the TIA-606-B standard and contract specification section 13040 – Equipment and Data Tagging.
- Equipment Room / Server Room network enclosure contains active network components, including: Network Core Closet, Server Closet and Telecommunications Enclosure.
- All Network Closets/Cabinets related to the Equipment Room (ER) shall be tagged as follows:

  XYZ- ITS-COM-XX00, where:

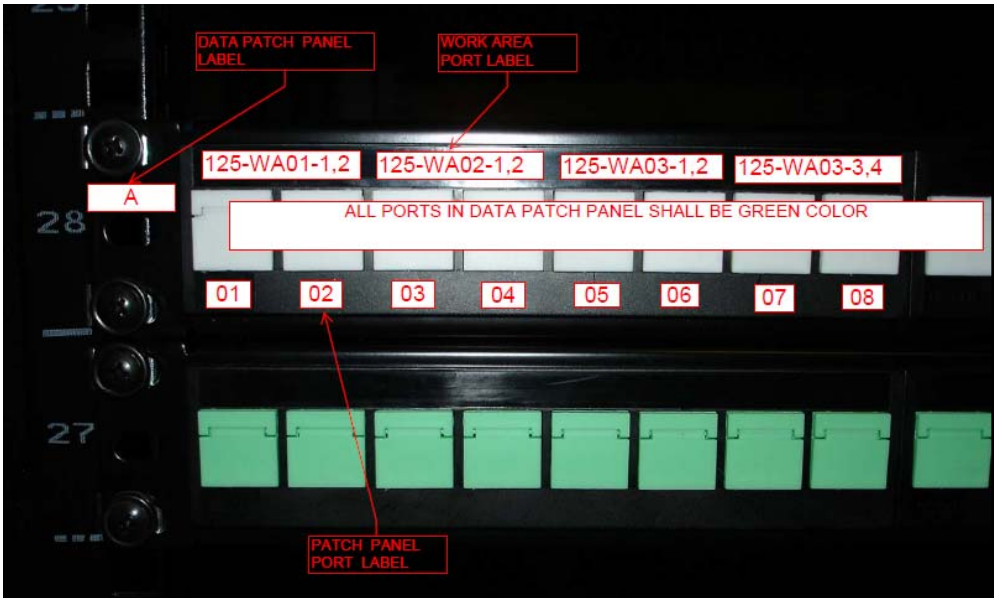
  XYZ = Site three character code name.

  XX00 = First two numbers (XX) identify the closet.
- For all closets/enclosures/cabinets in the Equipment Room, the last two numbers are always zero (00).
- For Closets/Cabinets in the Equipment Room, they are numbered from (0100) to (1000).
- Network Core Closet and Server Closet nameplate shall conform as follows:

- Provide nameplate for each enclosure on the bottom-center of the door, front and back.
- Use engraved gravoply laminate nameplates using black letters on a white background.
- The laminate nameplates shall have a dimension of 210mm W x 50mm H.
- Minimum character height shall be 12 mm. Character lettering shall be centered on each line.
- Affix name plates on the center of cabinet bottom frame, both front and rear side (using adhesive tape present on name plate).Include device identification (tag) number as well as a descriptive name.
- For example: the tag name: XYZ-ITS-COM-0100 followed by the description: Sample nameplate diagram is as below.

COPPER PATCH PANEL & WORK AREA OUTLET IDENTIFICATION AND LABELING

- The copper data patch panels in a Telecommunications Enclosure / Closet shall employ one character A, B, C, …, Z. The rack shall be populated with patch panel/s as necessary and labeled in sequential order from top to bottom.
- For example, the first copper data patch panel from the top of the rack shall be labeled A, the second shall be B, and so on.
- For office areas, the minimum number of ports associated with a work area outlet shall be a group of two (2) or four (4) ports.
- 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.
- Labels for each 4-port or 2-port, shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- Lettering shall be black on a white background. Characters are a minimum of 4 mm high.
- Apply a label on the top of each group of 4 ports or 2 ports to indicate the destination of the cables terminated on the data ports (RJ).
- For office areas, the label 125-WA01 would be applied on the patch panel for a group of 2 ports with destination cables to work area outlet 125-WA01. Whereas, 125 represents the room number of the facility and WA01 represents the work area 01.
- Apply a two-digit label immediately above each data port (RJ) indicating its destination port number on the work area outlet. For example, a group of four consecutive ports on a 24-port patch panel whose destination is port numbers 1 to 4 on a WAO would have the ports labeled 1, 2, 3, 4.



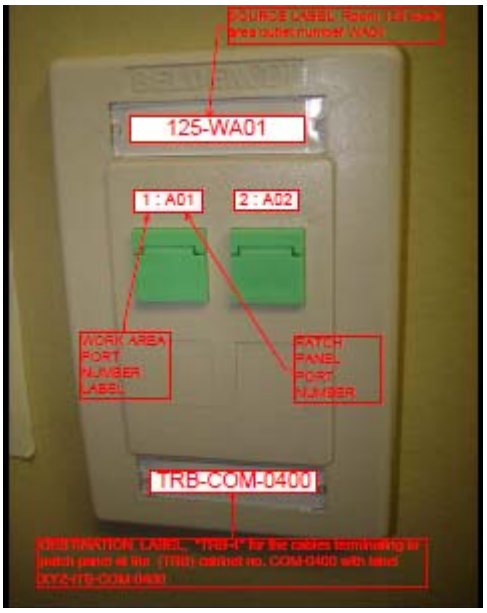
FIBREOPTICS PATCH PANEL (FPP) IDENTIFICATION AND LABELING

- Lettering shall be black on a white background. Characters are a minimum of 4 mm high.
- Terminate all 12 fibres of each fibre optic cable in Fibre Enclosures (Telecommunications Enclosure or Network Core Closet).
- The ordering and color of individual fibres shall be the same for each fibre cable and compliant with ANSI/TIA-568-C.3
- Labels for patch panels shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted.
- 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 fibre patch panel label shall be labeled as follows FPXX where XX is the fIbre patch panel sequence i.e. 01, 02, 03…etc. The rack shall be populated with patch panels as necessary and labeled in sequential order from top to bottom.
- For example, the first patch panel from the top of the rack would be labeled as FP01, the second is FP02 and so on.

- In addition, a label shall be applied to the top of the LC duplex adapter modules associated with a single fibre cable indicating the destination of the cable.
- For example, the adapter modules that terminate the fibre cable whose destination is Telecommunications Enclosure 1400 would be labeled as XYZ-1400.
- It is recommended to use fiber panel provided label holder to install the label for the fiber adapter module/plate.

WORK AREA OUTLET (WAO) IDENTIFICATION AND LABELING

- Labels for each 4-port, work area outlet shall be laser printed, self-laminating, adhesive, polyester or polyolefin. Hand-written labels shall not be accepted. When using the faceplate provided label cover, standard white paper printed by laser printer and manufacturer's label template is acceptable.
- 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 indicating the source of the Horizontal cables.
- For example, WAO port 1 connected to patch panel A port 1 would be labelled as A01. WAO port 2 to patch panel A port 2 is labelled A02 and so on.



CABLE IDENTIFICATION AND LABELING

- Use durable non-fading sleeve type wire markers to identify all network cables.
- 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 in height.
- All the cable labels (both ends) shall be submitted to TW – DNS on excel sheet showing end to end wire mapping (source to destination and vice versa) for review and approval, before the installation.

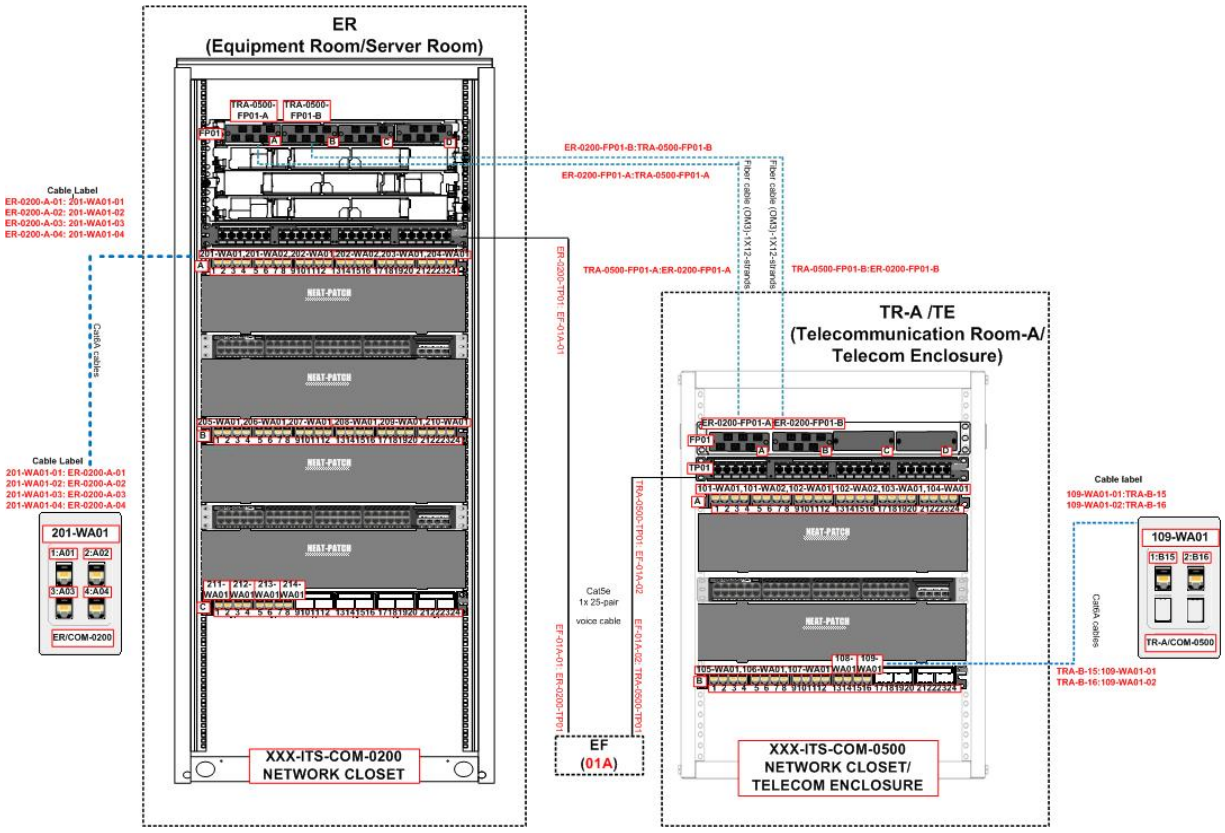
FIBREOPTICS BACKBONE CABLE IDENTIFICATION AND LABELING

- As a minimum, all fibre optic backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the fibre backbone cables shall 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 backbone cables shall indicate the source and destination of the cable separated by a colon.
- For example a fibre optic backbone cable whose source is Network Core Closet 2 (XYZ-0200), Fibre Patch Panel 01, adapter panel A and terminates in Telecommunications Enclosure 1400 (XYZ-1400) on the fibre patch panel 01 adapter panel A would have the following tag: 0200-FP01-A: 1400-FP01-A. It is recommended to use provided label holder with the fiber patch panel to install the adapter panel labelling.
- The Telecommunications Enclosure fibre optic patch panel must be labeled. For example: Telecommunication Enclosure 1400 with two fibre optic patch panels would be labeled "FP01" and "FP02", where "FP01" is the first patch panel from the top.

HORIZONTAL COPPER CABLE IDENTIFICATION AND LABELING

- As a minimum, all horizontal Category 6A cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.

- In addition, the cables shall 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 cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of Horizontal cables shall indicate the source and destination of the cable separated by a colon.
- Example 1: a horizontal cable whose source is Telecommunications Enclosure TRB-COM-0400, Patch Panel A, port 01 and whose destination is port 1, Work-Area Outlet 01, in room number 125 would have the following tag: TRB-COM-0400-A01:125-WA01-1.



Typical Commercial Building Cabling Labeling Scheme (Sample)

VOICE BACKBONE COPPER CABLE IDENTIFICATION AND LABELING

- As a minimum, all voice backbone cables shall be labeled at both ends of the cable, within every pull box and every 15 metres.
- In addition, the voice backbone cables shall 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 voice cable is run in conduit then the transition labels shall be applied to the conduit.
- The tagging convention for identification of voice cables between the voice block and the Telecom Closet/Enclosure patch panel in the building shall be VFFA-CC: XYZ-A-TP01 (indicate the source and destination of the cable separated by a colon), where V indicates voice, FF indicates the floor number, EF indicates telecommunications entrance facility ID, CC indicates 2-digit voice cable number, and XYZ-A is telecommunications closet/enclosure ID.

  For example, voice cable 01 whose source is entrance room EF and terminates in Telecommunications Room B (TRB) on patch panel TP01 would have the following tag: V01EF-01 : TRB-TP01.

PATCH CORD IDENTIFICATION AND LABELING

- As a minimum, all Contractor installed Category 6A or fibre optic patch cords in the network /server closet shall be labeled at both ends of the cable.
- 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.

CABLE PATHWAYS IDENTIFICATION AND LABELING

- All ducting (cable tray or conduit) carrying fibre optic and multi-pair voice backbone cables shall be tagged as "LAN BACKBONE ".
- All ducting (cable tray or conduit) carrying Horizontal cables shall be tagged as "LAN HORIZONTAL" with the source and destination network panels.
- All ducting shall 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.

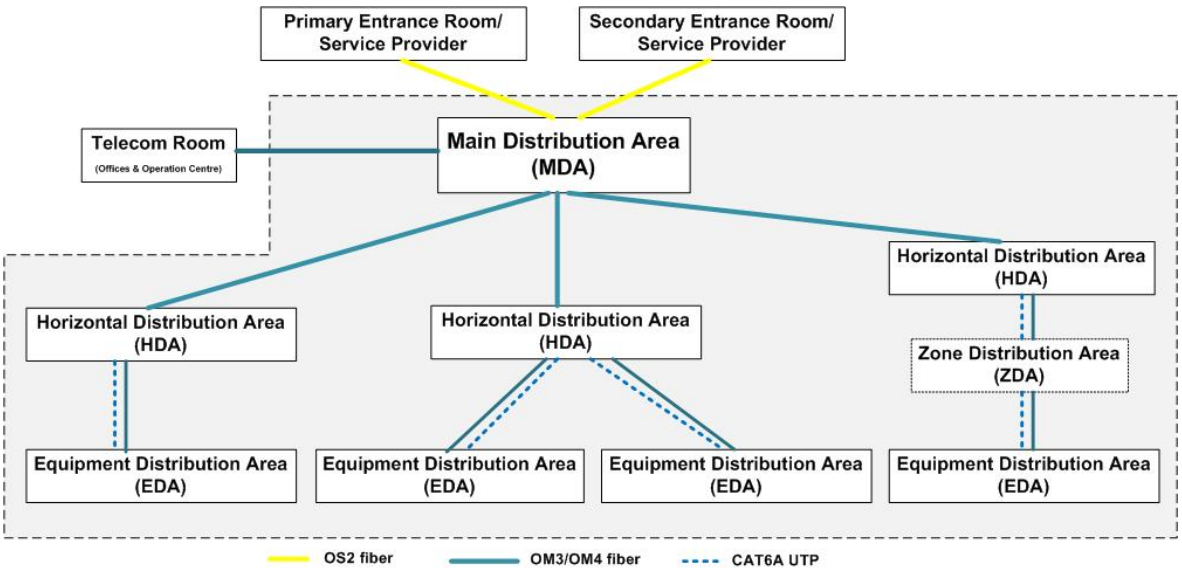
- Use engraved gravoply laminate nameplates using black letters on white background.
- The laminate nameplates shall have a dimension of 210mm W x 50mm H.
- Minimum character height shall be 12 mm. Character lettering shall be centered on each line.

FIRE STOPPING

- Fire stop systems in commercial premises shall meet the requirements of ANSI/TIA-569-D.
- Fire stop systems should be designed to be compatible with the worst-case environment to which they will be exposed (refer to ANSI/TIA-568.0-D for information on environmental classifications).
- Provide EZ PATH solution where cable /cable tray penetrates fire rated walls, floors, partitions and ceilings to ensure that the fire rating is maintained. For conduit penetration, Putty or other type firestop shall be used. Abandoned penetrations shall be properly fire stopped.
- The required fire rating is minimum 2 hours.

DATA CENTER CABLING DESIGN GUIDE

- The data center structure cabling design shall comply with the requirements of ANSI/TIA/EIA-942-A "Telecommunications Infrastructure Standard for Data Centers", ANSI/TIA-942-A-1 “Telecommunications Infrastructure Standards for Data Centers Addendum 1 – Cabling Guidelines for Data Center Fabrics” and ANSI/BICSI-002 "Data Center Design and Implementation Best Practices".
- Basic Data Center Topology and Elements



Basic Data Center Cabling Topology

- The Main Distribution Area (MDA) typically contains the data center's Routers, Backbone Core LAN/SAN Switches, PBX, and Multiplexers. It is also the location of cabling Main Cross-Connect (MC).
- The Horizontal Distribution Area (HDA) is where LAN, SAN, and KVM Switches are located. It is also the location of Horizontal cabling Cross-connect (HC).
- The Equipment Distribution Area (EDA) hosts racks/cabinets and equipment (servers).
- When EDA is implemented by stages or uncertainty for some zone area, the optional Zone Distribution Area (ZDA) design may be considered.
- For large data center, a more sophisticated and flexible data center topology with multiple entrance rooms and IDAs (Intermediate Distribution Area) a distributed data center topology may be used. IDA is optional between MDA and HDA to create an additional distributed level of management.

- Data Center Redundancy

  The redundancy level for the telecommunications, Electrical, Architectural and Mechanical shall be considered and designed and must be reviewed by City staff.

- Recognized Horizontal / Backbone Cabling Media for the Data Center
  - 850nm laser-optimized 50/125µm OM3 or OM4 optical fiber (24-fiber OM4 pre-terminated MPO trunk solution is preferred), typically used in intra-data center.

- Singlemode OS2 optical fiber, typically used for inter-data center Fiber Channel (FC) links and service provider links. It is also usually used by Mainframe deployments for all links within and between data centers.
- Category 6A UTP (option), typically used for "horizontal" HDA to EDA.

- The data center cabling architecture shall be flexible and scalable to adapt to current and future needs.
- Bandwidth needs for computing, network aggregation, core and SAN storage networking will require next generation high speed 40Gb/s and 100 Gb/s Ethernet & FC & FCoE networks, Seamless infrastructure migration plans shall be necessary.
- LC and Multi-strand (base 12, 24) MPO type connector/adapter are mandated for Data center fiber cabling. Base 8 MPO is also accepted if available.
- Pre-terminated MPO trunk cable assemblies and modules can fast installation time and cost, but depend on carefully design and measurement.
- With MPO Parallel infrastructure gender and polarity must be part of the design and implementation process. Method B is recommended per Belden.
- LC and MPO OS2 singlemode connectors shall be Angled Physical Contact (APC), OM3/OM4 connectors shall be flat polished.
- The loss of a single MPO connection/mated pair shall not exceed 0.75 dB; The maximum discrete reflectance shall be =< –20 dB
- Support Maximum length
  - For Category 6A UTP cabling permanent link, the maximum length shall not exceed 90 meters.
  - For OM3/OM4/OS2 fiber link, the maximum length shall not exceed the following :

Applications	Standard	Maximum Channel Length	# Fiber	Connector	Maximum Channel Loss Budget (dB)
10GBASE-SR	IEEE 802.3ae	OM3: 300m; 0M4: 400m	2F	Duplex LC	OM3: 2.6 dB; OM4: 2.6 dB

40GBASE-SR4	IEEE 802.3ba	OM3: 100m 0M4: 150m	12F (8 used)	MPO	OM3: 1.9 dB; OM4: 1.5 dB
100GBASE-SR10	IEEE 802.3ba	OM3: 100m OM4: 150m	24F (20 used)	MPO (1X24 to 2 X12)	OM3: 1.9 dB; OM4: 1.5 dB
100GBASE-SR4	IEEE 802.3bm	OM4: 100m	12F (8 used)	MPO	1.9 dB
40GBASE-IR4	IEEE 802.3ba	OS2: 2km	2F	Duplex LC	4.0 dB
40GBASE-LR4	IEEE 802.3ba	OS2: 10km	2F	Duplex LC	6.7 dB
100GBASE-LR4	IEEE 802.3ba	OS2: 10km	2F	Duplex LC	6.3 dB
16GFC	INCITS FC (T11)	OM3: 100m OM4:125m	2F	Duplex LC	OM3: 1.86 dB OM4: 1.95 dB
32GFC	INCITS FC (T11)	OM3: 70m; OM4: 100m	2F	Duplex LC	OM3:1.87 dB OM4:1.86 dB
Gen 6 Fibre Channel (128GFC)	INCITS FC (T11)	OM3: 70m; OM4: 100m	12F	MPO	OM3: 1.46 dB; OM4: 1.35 dB

- Data Center cabling pathway is typically use cable tray under raised floor or cable tray on top. Passive cabinet cooling shall be arranged with hot and cold aisles. Non-armored fiber cable shall be protected by sleeve or innerduct (plenum) from the cable tray to inside of cabinet.

SUBMITTALS

- Comply with the requirements of Section 01300 - Submittals.
- Shop Drawings shall be submitted to TW DNS 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 TW DNS 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 Toronto Water DNS 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:

- Toronto Water Network — Cable Test Results Manual.
- Operations and Maintenance Manual of any and all electronic equipment to or is installed.
- Revise and annotate Contract Drawings, in AutoCAD, 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 Toronto Water 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.

END OF SECTION

SECTION -2: PRODUCTS

Products and part numbers often change without notice. The Consultant/Contractor shall verify all parts with manufacturer.

Consultant shall practice the procedure of shop drawings / products approval as stated in this section. Shop drawings shall be submitted by the Contractor to the Consultant. The Consultant / Designer shall review and approve the shop drawings submittal before sending it to TW DNS for final review. After receiving the submittal from TW DNS, the Consultant / Designer shall send the final approval or approval with comments / notes to the Contractor.

APPROVED MANUFACTURERS

- All backbone fibreoptic cables, connectors, patch cords, patch panels, cassettes and adaptors shall be from Belden.
- All Category 6A modular jacks, faceplates, UTP patch cords and Category 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.
    - www.belden.com
- All wall mount Telecommunication Enclosures should be from Cabletalk
    - http://cabletalk.com/
- All free standing Paramount Telecommunication Enclosures in the Equipment Room / Telecom Room shall be from Wright-line (Eaton) Manufacturing.
    - www.wrightline.com
- All fire-stopping EZ-PATH components shall be from Specified Technologies Inc.
    - www.stifirestop.com
- For UPS and Power Distribution Unit, Liebert - Emerson and APC shall be the manufacturers.
    - 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 Toronto Water PCS /Divisional Network Service (DNS) Division.

ENTRANCE FACILITY PROTECTION

- Indoor voltage protector to protect entrance terminal to provide voltage and current protection and a disconnect facility at building entry points.
- Integral, 28 AWG (0.32 mm), non-replaceable fuse link wire between the incoming pairs and the protector modules.
- 25-pair connector for single-pair terminations (one pair "IN", one pair "OUT"), compatible with 22 to 26 AWG.
- The protected entrance terminal shall comply with CSA specification C22.2, No. 226-92, "Protectors in Telecommunication Networks," including the high-voltage fault test.
- Protectors to be included with supplied assembly.
- Consultant to use Manufacturer data sheet to specify correct part number for the application.
- Approved Manufacturer: Corning QTPET – 4 Pin Entrance Building Terminal
    - QTPET – *aaa*- HPFL - *bb* – *cdd*
    - Where aaa = 25, 50, 100 pair
    - bb= stub type
    - c= stub length
    - dd= protector type

FIRE RATED BACKBOARD PLYWOOD

- In the Entrance Facility, Equipment Room and Telecom Room Fire Rated plywood shall be provided on the walls or struts such that there is proper cable penetration from behind.
- Plywood shall be void-free and either fire-rated or treated on all sides with at least two coats of fire-retardant light-colored paint.
- Have at least two walls lined with A/C grade or better, 2.4 m (8 ft) high with a minimum thickness of 19 mm (3/4 in). To reduce warping, plywood should be kiln-dried to maximum

moisture content of 15 percent. Mount plywood 200 mm (8 in) AFF to avoid damaging the plywood. Have the plywood with the grade A surface exposed. The plywood should be securely fastened to wall-framing members to ensure that it can support attached equipment.

- All joints screw and nail holes are to be caulked and / or covered.
- The plywood is to be provided for cross-connect fields, security panels, power supplies etc. as may be required and is not intended for cabinet installation.

NETWORK/CABING CABINETS (CORE AND SERVER CLOSETS)

- 44U Floor Standing Cabinets
    - 44U is standard size specified for network core/server/service provider/ cabling cabinet in the Equipment Room/Server Room/Data Center.
    - Cabinets shall be supplied and installed complete with all accessories to provide a complete cabinet as indicated below.
    - Cabinets shall be floor mounted, freestanding and have the ability to be ganged together.
    - Cabinets shall have a rack mounted horizontal grounding bar. Panduit Part No: RGRB19U (for threaded); or RGB19CN (for cage nut).
    - All cabinets shall be bonded to the Telecommunications Bonding System as per the standard. The bonding green cable shall be sized (Minimum AWG 6) according to distance and terminated at the nearest Telecommunications Grounding Busbar.
    - Two-hole mechanical lug or Compression lugs (long barrel) shall be used to connect the bonding cable, horizontal grounding bar and cabinet frame.
    - Cabinets shall be provided with horizontal cable managers, NEATPATCH Part NO: NP2.
    - Cabinets shall be provided with rear internal vertical cable managers and cable lacing bar, Wrightline Part No: JNWVM843; JLB84.
    - Network Cabinet shall be provided with front vertical cable managers for managing patch cables. Cabletalk Part No: CTC3-CMS-11-B (set of 2) or approved equivalent.
    - Appropriated cooling solution shall be designed for the cabinet per installed environment and shall be reviewed by TW - DNS.

- Per cooling solution needs, Server cabinet shall be provided with Tool-less blanking panels for front unused rack space.
- Typically, the rack mounting space is recommend to reserve 6RU empty space from cabinet top for cooing efficiency and covered by the blank panels at front.
- Cabinets shall have a capacity of 44U with mounting holes as per EIA-310-E.
- Each server cabinet shall be black with square hole rails.
- Each network / service provider cabinet shall be black with round hole rails.
- Specified Product: Wrightline Paramount Series,
  - W762mm (30") X D1067mm (42") X H2133mm(84") Cabinet
  - Front Door- Perforated with key
  - Rear Split Door -Solid or perforated with Keys.
  - Solid Side Panels
  - Rackmount rails (square for server and round for network cabinets)
  - 483 mm (19") Mounts with cage nuts or round EIA screws
  - 10-32 Cage nuts and screws (square for server and round for network cabinets)
  - Top Panel
    - Top Panel with ventilating chimney solution
    - Top Panel with ventilating Fan Tray solution
    - Top Panel with Cable Entrance solution
  - Rear Door and Top Panel selection will depend on the environmental ventilation condition, cooling method and requirements and will be determine as per project bases. The cabinet product selection and configuration shall be reviewed by TW-DNS.

- Electrical
  - Contractor is to provide the electrical distribution for each IT Network and Server cabinet as per the related Electrical Distribution drawings and relevant City standards.

- Bond each 19” cabinet to ground.
- Provide each Core and Server cabinet with two (2) minimum 20A, 120 VAC, receptacles (L5-20R) for two separate clean power supply sources or circuits backed up with automatic transfer switch or automatic bypass switching. Terminate each UPS circuit at a 3-wire receptacle (L5-20R) mounted to the rail of the 19” cabinet.
- If feeds from facility UPS are not available, a standalone external, properly sized UPS shall be provided to power core and server cabinets. As minimum, typically 30A, 120 VAC receptacles (L5-30R) shall be provided. The external UPS shall be part of facility UPS maintenance schedule. The UPS shall be monitored by PLC/RPU as part of SCADA alarm system or by network.
- The final power supply design for the Core and Server Cabinet shall be reviewed by TW DNS.
- The receptacles shall be mounted in such a manner as not to interfere with access to or removal of other equipment within the enclosures.
- Power distribution within the enclosure shall be via vertically mounted metered power bars/PDU.
- Redundant power supplies, within the same device, shall not be connected to the same UPS circuit.
- All the electrical component (receptacles, power bars/PDUs, UPS etc.) shall be labelled with source circuit IDs (breaker panel etc.).

- Power Distribution Unit (PDU – Power Bar)
  - The Liebert MPH2 rack PDU shall be managed three-phase power distribution unit that shall be monitoring along with receptacle control.
  - Typically two (2) Liebert MPH2 units shall be mounting in vertical, zero-U configuration in each standard, network /server cabinet. It is recommended to mount two PDUs on one side at the rear of cabinet and a wide PDU mounting bracket should be used. Wirhgtline part no: PDUBRCKTW ---Wide PDU paramount mounting brackets for use with 3" center to center spacing, steel, Black.
  - The output receptacles support equipment requiring connection with NEMA 5-20R and IEC60320-C13 plugs.

- Remote monitoring shall be enabled by the included communication card, the Liebert RPC™, which permits managing the Liebert MPH over a secure Web page and SNMP-based network management system.
- The Liebert RPC shall permit interconnecting multiple Liebert MPH and / or Liebert MPX units for monitoring and management.
- A Liebert MPH2 shall be monitored locally with an RPC BDM™, an optional display module that connects directly to the communication card. The display module can be handheld, mounted in or on the rack or mounted on a nearby wall.
- Multiple Liebert MPH2s can be centrally managed with Liebert Nform™, which adds group-based receptacle management.

- One APC rack mount PDU/Automatic Transfer Switch (AP7750A) shall be provided for the network cabinet for those single source power supply equipment (switch, routers).
- Network /Server Cabinets shall be provided with magnetic mounted under cabinet 17" LED light, 15W, UL listed, with power cord. Recommend Wrightline Part No: Reed1715 or approval equivalent.
- Slide tray for laptop
  - Each network cabinet shall be provided one x 1RU rack mounted slide tray for network laptop user, recommend Hammond part No: RSUS1926BK1 or approved equivalent.
  - The slide tray is recommend to be mounted in position of 19U or 20U height.

TELECOMMUNICATIONS ENCLOSURE (TE)

- Commercial wall mount enclosures are ideal for small and medium sized networks, and are designed for small office/ limited space environments.
- All the enclosure shall prevent from the dust and corrosion and shall be mounted in dry area.
- The wall mounted enclosure shall be lockable swing out door allows front and rear access to rack-mounted components.
- All screws, bolts, fasteners etc. shall be corrosion resistant.
- Provide 1-pair 19” EIA standard 10-32 tapped mounting rail for the mounting of all 19" rack mountable components. The front of the 19" rack is to be recessed 100 mm (4") from the front of the enclosure.

- All wall-mounted panels shall be separated from the wall by stainless steel spacers or galvanized steel struts.
- The enclosure shall provide exhausted FAN options.
- Cable bundles shall be neatly laced, run in ducting or approved cable managers and secured to 19" cabinet or mounting back-panel.
- All enclosure doors shall open through 180 or 120 degrees without restriction from front and the back.
- Enclosure layout and equipment spacing shall be constructed to allow for device removal, calibration and maintenance without disassembly of adjacent devices.
- 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.
- Frame constructed of 16 GA (0.060”) steel, modular construction. 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" mounting rack only.
- There shall be no devices installed on the side plates of the enclosure.
- Conduit accessibility shall be per manufacturer’s guidelines with conduit egress through the bottom and sides but not the top of the enclosure.
- CableTalk wall mounted enclosures is recommended:

  http://www.cabletalk.com/eng/products/W31-wallmount-commercial.php

  Specific enclosure size & load rating /version shall be selected appropriated per current and future project needs. And the final selection shall be reviewed by TW DNS.
- Minimum items in the TE shall include but are not limited to one fibre termination panel (1U), three 24 port (1U) patch panels (1 x Telephone and 2 x Data), two (2) 24 ports or one (1) 48 ports Cisco switch, two (2) 2U Horizontal Cable Manager, one (1) 1U monitored PDU and other optional equipment as may be requested by TW-DNS.
- All TEs components (front door, main enclosure, side and rear panels shall be grounded and bonded using the grounding jumper cables from the respective grounding studs (built-in) to the TE main grounding busbar (built-in or provided).

- All TEs shall be bonded to the Telecommunications Bonding System as per the standard.
- The bonding cable shall be sized according to distance and terminated at the nearest Telecommunications Grounding Busbar and run within conduit.
- The TE shall be CSA approved and sealed.
- Provide the enclosure electrical distribution as per the Telecommunication Enclosure (Typical) - Electrical Distribution drawing.
    - The Telecommunication Enclosure shall be powered by two separate 15 A, 120 VAC supplies (Utility and Network/UPS). The Utility Supply is to power non-critical components (enclosure lighting and power bar). The Network Supply (UPS) is to power the critical network components (Ethernet Switch) and environmental controls (ventilating fans). Contractor shall provide the Utility Supply from the nearest lighting panel as per the TE Installation drawings. The Network/UPS Supply is to be provided by others.
    - Where applicable, the Contractor shall provide a 15A Supplementary DIN rail mounted breaker for termination of the Network Supply. In addition, the Contractor shall provide a knockout for the Network Supply conduit as per the TE Installation drawings. All power distribution installation shall be mounted to the top rear side of the TE.
    - Provide 120 VAC, 3-wire, duplex receptacles, circuit breakers, surge suppressor, wire duct and grounding bar per the Telecommunication Enclosure Layout drawing and associated Component Schedule. The Contractor shall provide rigid-steel conduit and wiring to provide the 15 A, 120 VAC Utility Supply as per the TE Installation drawings. The Utility Supply shall be terminated at a 15 A, DIN rail mounted, circuit breaker and surge suppressor. Distribution of the Utility Supply is as documented in the Telecommunications Enclosure – Electrical Distribution drawing.
    - All power distribution installation shall be mounted to the top rear side of the TE.
- If feeds from facility UPS supply is not available, A standalone external, properly sized UPS shall be provided to power the telecommunication enclosure. The external UPS shall be part of plant UPS maintenance schedule.
- The Contractor shall be responsible for the distribution of the Network Supply within the TE and for providing a 15 A supplemental breaker for termination of the supply by others. The final power supply design for the telecommunication enclosure shall be reviewed by TW DNS.
- Power Distribution Unit (PDU - APC – AP7750A)

- The APC rack mount PDU/Automatic transfer switch (AP7750A) shall be managed three-phase power distribution unit that monitoring along with receptacle control.
- The APC units shall be available for rack-mounting in standard, network enclosures.
- The output receptacles support equipment requiring connections (10) with NEMA 5-15R.
- Remote monitoring shall be enabled with a secure Web page and SNMP-based network management system.
- The APC PDU shall permit interconnecting multiple units for monitoring and management.

WORK AREA OUTLETS FOR OFFICE AREA

- All modular jacks, faceplates and furniture inserts, surface mounted box shall be Belden and performance rated to Category 6A.
- Provide one 4-port, single-gang, work area outlet in each work area for termination of the horizontal Category 6A cables with faceplates or decora module frames.
- The outlet back box depth selection shall meet Belden requirement for their new REVConnect Category 6A jack module. For new construction, it is recommended that the back boxes be 100mm (L) X 50 mm (W) X 54 mm deep, complete with a mud ring cover specifically designed for single gang faceplates intended for flush mounting to the wall. This single gang deep outlet back box aids in the maintaining of Category 6A and higher bend radius requirements. Part Number: IPEX FDS101520 or approved equivalent.
- Where walls are not suitable or have insufficient depth, standard electrical size outlet boxes shall be used, but must ensure the box can accept 4 terminated Belden REVConnect jacks.
- Each manager's office shall have two (2) work area outlets on separate walls.
- One (1) 4-port, work-area outlet shall be associated with as many ports necessary (in groups of 4 or 2) on 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.

- In the majority of cases one (1) 4-port, work-area outlet shall be installed within each systems furniture cubical work area partition.
- In some special situations where the systems furniture is configured fully the work-area outlet shall be installed directly on the wall in the office areas.
- 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.
- In boardrooms and large general office areas, one single gang work area outlet shall be provided every 3.0 metres and within 1.0 metres of an electrical outlet if provided.
- Only two of the four positions shall be terminated with work area jacks and on the patch panels unless otherwise specified.

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 amount of blank inserts as required.
- Belden KeyConnect (same as keystone footprint), 4-Port w/ ID Windows, Single-gang faceplate Part Number: AX102249 (Electrical white); AX102248 (Almond); AX104163 (Black). The color of faceplate shall match with the decoration environment requirement.
- Belden KeyConnect faceplate port blank insert Part Number: AX102262 (White); AX102261 (Almond); AX102263 (Black).

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.
- Each workstation shall be equipped with minimum two (2) RJ45 Category 6A green color jacks.

- 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.
    - Communications Consultant shall verify furniture modular faceplate requirement.
    - Belden Keyconnect modular furniture adapter, 4 port part number: AX102900 (White); AX102901 (Black); AX103926 (Almond)
- 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 KeyConnect, 2-port surface mounted, side entry box, part number: AX105353-EW (White); AX105353-AL (Almond).

RJ45 CATEGORY 6A JACKS

- Belden Eight-position modular jack (RJ45), type Category 6A to TIA-568-C 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.
- UTP cables used for IP voice shall be terminated with the same specified jacks.
- All UTP jack modules shall be Belden REVConnect 10GX UTP type which is compatible with Belden Keyconnect (Keystone) series faceplates and patch panels.
- Belden REVConnec 10GX UTP modular jack, part number: RVAMJKUGN-S1 (Green color, single jack); RVAMJKUGN-B24 (Green color, Bulk pack -24 jacks).
- All unused jack module on the work area faceplate shall be covered by dust cover, Belden part number: RVUDCGN-B24 (REVConnect Dust Cover, Green, Bulk Pack-24 covers).
- To distinguish the different applications, provide color-coded, snap-in icon/ID data tab for each data port (RJ) on the jack module accordingly.

  The following colors will indicate typical network membership:

Color	Membership/Function	Color	Membership/Function
Red	HMI/SCADA	Blue	PLC/SCADA
Green	Business	Purple	Security (iSTAR, CCTV, Intercom)
Orange	BAS (HVAC, Lighting)	Yellow	Maintenance/SCADA
Black	Voice (Analog)	White	Spare
Gray	WAP (phone/data)		

  Examples:

  Green Icon for Business Part Number: RVUICGN-B24 (bulk pack)

  Purple Icon for Security part Number: RVUICPR-B24 (bulk pack)

  Black Icon for Voice Part Number: RVUICBK-B24 (bulk pack)

  Red Icon for HMI /SCADA Part Number: RVUICRD-B24 (bulk pack)

Blue Icons for PLC/SCADA Part Number: RVUICBL-B24 (bulk pack)

COPPER PATCH PANEL (CPP)

- All horizontal Category 6A UTP cabling shall be terminated on 1U, 24 ports, Belden Category 6A modular patch panel.
- All copper patch panels shall be black.
- All modular patch panels shall be populated with Category 6A UTP modules/jacks as required.
- All the patch panel shall be front accessed for the jack modules and rear with a cable manage bar.
- The modular copper patch panel shall mount to standard TIA 482.6 mm (19") rack.
- Contractor to refer to Belden installation instructions provided with the patch panel for proper installation.
- The patch panel termination must maintain appropriated cable slack for future troubleshooting/jack re-termination.
- Belden modular (unloaded) black, Front Access, Keyconnect style Patch Panel accept REVConnect jacks, 24-port, 1U, patch panel part number: AX106288, AX106291 (label holder kit).
- To distinguish the different applications, provide color-coded, snap-in icon/ID data tab for each jack module -port (RJ) accordingly.

  The following colors will indicate typical network membership:

Color	Membership/Function	Color	Membership/Function
Red	HMI/SCADA	Blue	PLC/SCADA
Green	Business	Purple	Security (sitars, CCTV, Intercom)
Orange	BAS (HVAC, Lighting)	Yellow	Maintenance/SCADA
Black	Voice (Analog)	White	Spare
Gray	WAP (Phone/Data)		

For example:

Green Icon for Business Part Number: RVUICGN-B24 (bulk pack)

Purple Icon for Security part Number: RVUICPR-B24 (bulk pack)

Black Icon for Voice Part Number: RVUICBK-B24 (bulk pack)

Red Icon for HMI /SCADA Part Number: RVUICRD-B24 (bulk pack)

Blue Icons for PLC/SCADA Part Number: RVUICBL-B24 (bulk pack)

COPPER CATEGORY 6A HORIZONTAL CABLE (UTP)

- Belden, 10GXS four-pair, 100 ohm balanced unshielded-twisted-pair (UTP) cable, appropriate flame test classification, Category 6A shall be in compliance to TIA-568-C.
- 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)
    - Category6A
    - 23 AWG, spool-in-a-box
    - Belden Part Number for FT6 (CMP) Cable: 10GXS13D15A1000 (blue, non-bonded)
    - Belden Part Number for FT4 (CMR) Cable: 10GXS12006A1000 (blue, non-bonded)
- All Category 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.

COPPER CATEGORY 6A PATCH CORD (UTP)

- Patch cord shall be manufactured of stranded or solid conductor cable (AWG24) with 8-position, 4-pair terminations at both ends.
- All patch cords shall be manufactured by Belden and performance rated to Category 6A.
- All patch cords shall be of the same or higher performance Category and manufacturer of the UTP horizontal cabling system that shall be warranted as part of the end to end solution.
- All patch cords shall be CSA approved and minimum of FT4 rated.
- All patch cords shall be manufactured and certified, 4-pair stranded/solid conductors copper cables, field assembled patch cords are not allowed.
- All patch cords for data shall be gray in color. For analogy voice shall be black.
- The Contractor shall supply patch cords in the following length:
    - At patch panel location, provide 0.6 metres long patch cords for all terminated horizontal cables unless otherwise advised by Consultant or DNS.
    - 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 DNS.
- 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.
- Typical Part Numbers: CA21108002 (0.6 m / 2 ft.), CA21108007 (2.1 meters / 7 ft.) etc.

BACKBONE CABLE FOR VOICE CENTREX ONLY - ISP (CAT5E)

- Category 5e rated wire and cable placed in the inside environment shall be solid, 24 AWG, twisted pair and multi-conductor.
- All cables fully contained within conduit or areas that are not plenum rated shall use CMR rated cable.
- Any cable, regardless of length passing through a return air plenum ceiling and not in conduit shall be rated as CMP.
- Belden 25-PAIR part numbers: CMR: IBDN25R0081000; CMP: IBDN25P0081000

TELEPHONE PATCH PANEL FOR VOICE (TPP)

- Minimum 1U 24 RJ45 UTP ports.
- Belden part number for voice unloaded patch panel black: AX106288 (front access, Keyconnct modular patch panel); AX106291 (label holder kit).
    - Belden Keyconnect jack module for voice unloaded patch panel (Black – Category 5e): AX101310; or REVConnect Category 5e black jack module: RV5MJKUBK-S1.
- Alternative: New Telco 8P2C, 24-port, 1U, (RJ45 Jack to RJ21 Male), Black, Belden Part Number: AX106368.

VOICE CROSS CONNECT AT ENTRANCE FACILITY (EF)

- Voice cross-connect is a system that consists of various sizes of BIX blocks, cable distribution accessories (such as mounded rings and strips) and a BIX tool to terminate wires at the BIX block. The voice cross-connect system is primarily composed of two parts: the mount and the connectors.
- Cross-connect mount is a wall-mounted frame, generally built from 16 gauge steel. The frame feature a rectangular plastic backplate and two plastic brackets that extend from either side of the backplate to fit between two and ten connectors. The connectors shall be oriented horizontally on the mount.
- The connectors are rectangular punch-down blocks used to terminate up to 25 pairs. The connecters shall have a slip-in fitting which automatically strips the wire as it is punched down, eliminating the need for pre-stripping. The connectors shall also have a pair-splitter to facilitate fast arranging of wires on the punch-down block.
- Backbone cables shall be terminated on the backboard (as shown on drawings) unless otherwise specified in this document.
- All cables shall be terminated on IDC connectors complete with associated hardware such as mounts, cable / cross-connect wire managers, etc.
- The IDC connectors shall accept 24 to 26 AWG solid copper conductors.
- The IDC mounts shall accept cables from behind the connector.

- Cross-connect shall be a 5-pair block and include appropriate mounting and number of designation strips and labels.
- Cable management in the form of distribution rings or approved similar shall be provided between columns and rows of IDC mounts to support cross connect management in a manner recommended by the manufacturer.
- Instruction sheets for products are available from Belden.
- Belden part number for 50 pair BIX mount: A0284798
- Belden part number for 25-pair BIX distribution connector – 5 pair marking: A0266828
- Belden accessories such as jumper wires, labels shall be provided to complete the system.

FIBREOPTIC PRODUCTS

INDOOR BACKBONE MULTIMODE OM3/SINGELMODE OS2 FIBREOPTIC CABLE

- The cable is performance rated to OM3 and shall be used only if the backbone link length is less than 300 meters, otherwise , Singlemode OS2 shall be used
- Primary and redundant, minimum 1 x12 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 from the top/bottom cable tray with a black or Orange color flexible conduit/inner duct (plenum).
- Core-locked, tight-buffered, black, indoor/outdoor fiber-express distribution cables.
- 50/125 micron core/cladding.
- 2000 MHz-km bandwidth at 850 nm wavelength (EMB).

- 500 MHz-km bandwidth at 1300 nm wavelength.
- Only cables from Belden shall be accepted.
- All fibreoptics 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 12-strands fiber cable part numbers:
    - OFNR/FT4: B9C042T (OM3); B9W042T (OS2)
    - OFNP/FT6: B9C048T (OM3); B9W048T (OS2)

FIBREOPTICS PATCH PANEL (FPP)

- Fibreoptics cabling shall be terminated in patch panels intended for fibre optic cable management.
- Belden Fibreoptics Rack Mount Enclosure for Telecommunication Enclosures shall be:
    - 1U, 2U or 4U - 19" FX UHD Rack Mount Enclosure/Housing (4U version is typically used in Core network closet cabinet)
    - Durable black powder coat finish
    - Be equipped with cable strain relief and slack storage
    - Part Number: AX105563 (1U); AX105564 (2U); AX105565 (4U)
    - FX UHD Fiber Management Spool kit, includes base plates and eight spool segments, used with FX UHD housing/enclosure, Belden Part Number: AX105700
- Belden FX UHD Blank Fibre Adapter Panel/Strip shall be:
    - Blank Fibre Adapter Panel/strip to fit un-used adapter strip opening in the FX UHD Fibre Patch Panel
    - Durable black powder coat finish
    - Part Number: FFZH00BB
- Belden Fibreoptics LC Fibre Adapter Strip/frame shall be:
    - Loaded with TIA/EIA-604 FOCIS-10 compatible adapters that exceed TIA/EIA-568-C.3

- Split sleeve: Zirconia Ceramic
- Adapter housing colors follow TIA/EIA-568-C.3 suggested color identification scheme.
- Belden part number for 6 LC duplex APC, green, adapter strip/frame: FF3U06LD (for OM3); FFSU06LA (for OS2 APC green adapter, 6 LC duplex).
- Belden Par Number For FX adapter Color-coded Icon Kit: AX104572.

FIBREOPTICS LC CONNECTOR FOR FIELD TERMINATION OF OM3 CABLE

- Optical fibre terminations for OM3 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 fibreoptics cable.
- 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:
  - Typical Insertion Loss is 0.2dB for multimode OM3/OM4
  - Return loss: >25dB (multimode OM3/OM4).
  - 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 Fibreoptics 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
  - Belden FX Brilliance Universal Field terminate OM3 LC connector with 900 µm Boot, 25 per package Part Number: AX105202-B25

FIBREOPTICS LC PIGTAIL FOR FIELD TERMINATION OF OM3/OS2 CABLE

- Optical fibre OM3/OS2 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) rated and stamped 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 part number for standard pigtail kits (LC connector on 900 µm fiber one end, kit contains 12-color-coded 900 µm tight buffer fibers, LC simplex, 2m in length):

  FT3LC900PR12 (OM3); FTSLB900PR12 (OS2 APC)
- Belden part number for fusion splice heat shrink protector sleeves (900 µm to 900 µm, 2.5 mm round x 60 mm long, 25/package): FXFUHS900AB25
- For fashion splice with pigtail termination, a splice tray shall be provided in inside of Fiber panel for the fusion fiber protection.

FIBREOPTICS LC-LC DUPLEX PATCH CORDS – OM3/OM4/OS2

- All patch cords shall be CSA approved and CMR (FT4) rated and stamped accordingly.
- All optical fibre patch cords shall be OM3, OM4 or OS2 to match with backbone fiber cable type accordingly.
- All LC-LC optical fibre patch cords shall be manufactured and certified, 1-pair (duplex, 2 strands) with 2mm Zip Cord. Field assembled patch cord is not allowed.
- The fiber patch cords cable maximum Insertion Loss (IL) shall be no more than 3.25dB/Km for OM3; 3.0dB/Km for OM4; 0.5dB/km for OS2/APC.
- LC patch cords connector maximum insertion loss (IL) shall be no more than 0.25dB/mated pair for OM3, 0.15dB/mated pair for OM4; 0.35dB/mated pair for OS2/APC.
- LC patch cords connector typical polish Return Loss (RL) shall be 30 dB for OM3/OM4 and 65 dB for OS2 APC.

- The Contractor shall supply a minimum two (2) patch cords for every OM3/OS2 backbone cable:
    - At patch panel in the telecom room (TE), provide one (1) 2-meter long patch cord and one (1) 1-meter long parch cords unless otherwise specified by DNS.
    - At patch panel location in the equipment room (ER), entrance facility (EF), or any other space provide one (1) 2 meter long patch cord and one (1) 3 meter long patch cords unless otherwise specified by DNS.
- All singlemode OS2 fiber patch cords shall be APC version.
- Belden OM3 LC duplex to LC duplex FX Zip Cord patch cord Part Number: FP3LDLD001M (1 meter); FP3LDLD002M (2 meters); FP3LDLD003M (3 meter).

  Belden OM4 LC duplex to LC duplex FX Zip cord patch cord Part Number: FP4LDLD001M (1 meter); FP4LDLD002M (2 meters); FP4LDLD003M (3 meter).

  Belden OS2/APC LC duplex to LC duplex FX patch cord Part Number: FPSLADLAD001M (1 meter); FPSLADLAD002M (2 meters); FPSLADLAD003M (3 meter).

PATHWAY SYSTEM – CONDUIT AND CABLE TRAY

- Cable tray shall be used above ceilings in commercial facilities and below raised floor systems as may be found in equipment rooms.
- All pathway (conduit and cable tray) systems shall be designed in accordance with the latest version of the ANSI/TIA 569-D 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-D standard will be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and DNS regarding the areas that are suitable for Electrical Metallic Tubing (EMT).
- Cable tray and conduit shall be labeled every 15 meters (50 ft.) on the outer surface as "LAN BACKBONE" or "LAN HORIZONTAL".
- There shall be small labels identifying the source and destination of cables in case there are multiple cables carried by the cable tray and conduit.

ELECTRICAL METALLIC TUBING CONDUIT - EMT

- To be used within the office areas only (if applicable).

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.

EXPANSION FITTINGS

- Provide expansion fittings with external grounding straps at building expansion joints.
- Minimum 4” movement in either direction.
- At expansion joints in concrete pours, provide deflection/expansion fittings capable of movement of ¾” in all directions from the normal.

WATER PROOFING SEALS

- Provide watertight expanding link-type seals for installation between the conduit and the sleeve or core drilled hole.

WIRE BASKET TRAY

- The wire basket tray shall be 12 - 13 gauge, straight sections shall be powder coated black with an average paint thickness of 1.2mils (30microns) to 3.0mils (75microns).
- Tray shall be designed in such a way as to be secured to the following, but not limited to: wall, ceiling every 1.2 metres.
- Splicing trays shall be accomplished by using a single manufacturer supplied UL classified connector bolt or splice plate.
- Depth: Tray depth shall be (unless otherwise shown on the drawings) 100mm (4 inches).
- Width: Tray width shall be (unless otherwise shown on the drawings) 300mm (12 inches).

- Turning Fences shall maintain approved bend radius and be constructed from sheet steel and plated in accordance with applicable standards.
- Intersections shall be made from high strength steel, welded and plated in accordance with applicable standards.
- Proper manufactured accessories and fittings such as elbows, reduces, crossovers, tees and riser shall be used for any change in direction, height or size of the cable basket tray.
- Support cable tray to suit loading and recommended support requirements in the Canadian Electrical Code Part II.
- Materials bolted or riveted to the cable tray shall be free of burrs and or sharp edges.
- WBT Part Number: WBT4X12

VENTILATED CABLE TRAYS

- All cable tray systems shall be designed in accordance with the latest version of the ANSI/TIA 569-D Standard and BICSI TDMM which exceed the minimum requirements of Canadian Electrical Code. Cable tray systems that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA 569-D Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and DNS regarding the areas that are suitable for cable tray, if suitable, what material type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
- The ventilated cable tray is preferred to be used for horizontal cable distribution.
- The ventilated cable tray shall include but not be limited to the following characteristics:
    - A prefabricated structure consisting of a ventilated bottom with integral longitudinal side rails with no openings exceeding 50mm or 2" in a longitudinal direction.
    - Shall be prefabricated from a pre-punched sheet to produce a one-piece ventilated tray.
    - Shall be available in Aluminum, pre-galvanized Steel, hot dip Galvanized Steel and Stainless Steel 316.
    - Shall be a minimum of 103 mm or 4" in depth or as appropriately designed and approved by Project Consultant and reviewed by TW DNS.

- Proper manufactured accessories and fittings such as elbows, reduces, crossovers, tees and riser shall be used for any change in direction, height or size of the cable tray.
- Spine type cable tray is not acceptable.
- Support cable tray to suit loading and recommended support requirements in the Canadian Electrical Code Part II.
- The support shall be placed within a Maximum of 610 mm on either side of any connection to a fitting.
- Materials bolted or riveted to the cable tray shall be free of burrs and or sharp edges.

JUNCTION BOX

- All junction box applications shall be designed in accordance with the latest version of the ANSI/TIA 569-D Standard and BICSI TDMM which exceed the minimum requirements of Canadian Electrical Code. Application of junction boxes that are only designed to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA 569-D Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Consultant to confirm with both the facility and DNS regarding the areas that are suitable for junction box construction type given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.
- For standard non chemically hazardous environments junction boxes shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed.
- Provide screw-on type cover boxes installed in damp or wet locations shall be of rain-tight construction with gasketed cover and threaded conduit hubs.
- Boxes shall be NEMA approved for the environmental condition of the location where they will be installed.

POKE THROUGH FLOOR BOX

- Where office facilities exist but access for cable distribution from above is not possible it may be practical to serve the floor from the ceiling space below with a Poke Through.
- Aluminum modular fire rated poke-through floor boxes coverings.
- Installs in 4" (101.6mm) diameter core drilled hole through concrete.

- UL listed for use in 1-4 hour rated floors.
- Poke-through fitting and universal cover combination exceed UL514A scrub water exclusion requirements.
- Stationary fire barrier expands during fire conditions to provide upper fire seal with adjustable fire barrier that would accommodate concrete floor thickness from 2-1/4" to 7".
- Dual 1" E.M.T. conduit tubes feed from communications feed and one for the electrical (when needed).
- Furniture feed for both power and communication services to modular furniture systems.
- Poke-through to have dual panels, one to hold four RJ45 Category 6A Data/Voice ports. The other panel will have a blank plate.
- One-Piece Dual Style Line Poke-Through Aluminum Finish.
- Aluminum modular fire rated poke-through floor boxes coverings.
- Installs in 4" (101.6mm) diameter core drilled hole through concrete.
- UL listed for use in 1-4 hour rated floors.
- Poke-through fitting and universal cover combination exceed UL514A scrub water exclusion requirements.
- Stationary fire barrier expands during fire conditions to provide upper fire seal with adjustable fire barrier that would accommodate concrete floor thickness from 2-1/4" to 7".

GROUNDING AND BONDING

- All bonding to ground systems shall be designed and installed in accordance with the latest version of the ANSI/TIA 607-C Standard and BICSI TDMM which exceed the minimum requirements of the Canadian Electrical Code. Grounding and Bonding for Communications that are designed only to the Canadian Electrical Code and do not include all requirements of the ANSI/TIA 607-C Standard and BICSI TDMM shall be considered substandard and removed until such time as they are in compliance.
- Installed "Bonding System" shall be able to provide a low impedance path obtained by permanently joining all non-current-carrying metal parts to assure electrical continuity and having the capacity to conduct safely any current likely to be imposed on it.

- Installed "Grounding System" shall be able to provide a permanent and continuous conductive path to the earth with sufficient ampacity to carry any fault current liable to be imposed on it, and of a sufficiently low impedance to limit the voltage rise above ground and to facilitate the operation of the protective devices in the circuit.
- All metallic parts shall be bonded together mechanically and attached to the approved building ground in accordance with applicable CEC, OESC, ANSI/TIA 607-C, CSA C22.2 NO. 41-13, BICSI TDMM 13th edition.
- All bonding to ground systems shall be designed, certified, tested and approved by registered, qualified and certified Professional Electrical Engineer (Ontario) in good standing.
- A "Certificate of Conformance (CoC) " shall be submitted to the City of Toronto by the City Contract Administrator upon completion of the work. The City Contract Administrator assigned Quality Verification Engineer (registered, qualified and certified Professional Electrical Engineer – Ontario) shall affix his or her seal and signature to the completed Certificate of Conformance confirming that installed Grounding and Bonding Systems are in general conformance with the requirements of the CEC, OESC, ANSI/TIA 607-C, CSA C22.2 NO. 41-13, BICSI TDMM 13th edition, that included but not limited to:
    - Work
    - Material and installations
    - Inspection, testing, and test results
- Bonding conductors shall be continuous and routed in the shortest possible straight-line path. Any bends placed in the conductor shall be sweeping bends.
- Continuous grounding and bonding shall be provided (must) throughout any electrical distribution system. No local grounding shall be permitted. No down-stream bonding of the neutral shall be used.
- At no time should grounded equipment have its connector replaced with a polarized connector, nor should it be plugged into a non-grounded circuit.
- All metallic components including but not limited to, scaffolds, metal grids, pipes, structures, conduits, enclosures, data and electrical wiring etc. used and installed shall be effectively bonded to ground.
- Elements and components required grounding and bonding shall be connected to "Good Ground" at both end (Solid Bonding). In case of Earth Potential Difference, the earth potential difference limit of 1 Vrms (Root-Mean-Square Voltage) between two earths shall be maintained.

- Consultant to confirm with both the facility and DNS regarding the areas that are suitable bonding and grounding points given the impact of certain airborne chemicals (aka Chlorine) that corrode metals.

TELECOMMUNICATIONS MAIN GROUNDING BUSBAR (TMGB)

- An insulated predrilled copper busbar listed by NRTL, electro-tin plated with holes 8 mm diameter for use with standard-sized lugs.
- Dimensions 6 mm thick, 100 mm wide, variable length as applicable.
- Shall be insulated from its support by a minimum of 50 mm.

TELECOMMUNICATIONS GROUNDING BUSBAR (TGB)

- Predrilled copper busbar listed by NRTL, electro tin plated with holes 8 mm diameter for use with standard-sized lugs.
- Dimensions 6 mm thick, 50 mm wide, variable length as applicable.
- Shall be insulated from its support by a minimum of 50 mm.

TELECOMMUNICATIONS BONDING BACKBONE (TBB)

- Cable assemblies shall be UL Listed and CSA Certified and be a minimum of 6 AWG copper conductor, green insulated.
- Telecommunications Grounding and Bonding Conductor Label Kits shall be supplied and installed by the Electrical Contractor at every rack and cabinet as well as one for every Telecommunications Grounding Busbar.
- The bonding conductor size shall be as follows:

TBB Length in Linear metres Metres (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14 – 20)	4

6-8 (21 – 26)	3
8 – 10 (34 – 41)	2
13 – 16 (42 – 52)	1/0
16 – 20 (53 – 66)	2/0
Greater than 20 (66)	3/0

TELECOMMUNICATIONS BONDING CONDUCTOR (TBC)

- Cable assemblies shall be UL Listed and CSA Certified and be a minimum, the same size as the largest TBB copper conductor.
- Shall be green insulated and marked in accordance with ANSI/TIA-607-C.

WARNING LABELS

- Non-metallic warning labels in English: TIA-607-C.
- Identify labels with wording "If this connector is loose, please call the building telecommunications manager or site / area supervisor".

FIRE-STOPPING

- A fire-stop system is comprised of the item or items penetrating the fire rated structure, the opening in the structure and the materials and assembly of the materials used to seal the penetrated structure. Firestop systems comprise an effective block for fire, smoke, heat, vapor and pressurized water stream.
- All penetrations through fire-rated building structures (walls and floors) shall be sealed with an appropriate fire-stop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item such as riser slots and sleeves, cables, cable tray, and raceways etc. shall be properly fire-stopped with EZ-PATH, for conduit penetration, firestop putty pad (3M or equivalent) shall be used.

- Firestop systems shall be UL Classified to ASTM E814 (UL 1479) and shall be approved by a qualified Professional Engineer (PE), licensed (actual or reciprocal) in the state where the work is to be performed. A drawing showing the proposed fire-stop system, stamped/embossed by the Professional Engineer of Ontario (P. Eng.), shall be provided to the Owner's Technical Representative prior to installing the fire-stop system(s).
- EZ-PATH Part Numbers:
    - EZ-PATH Series 22, 33 and 44 (size based on cable quantities.

DATA CENTER CABLING PRODUCTS

CATEGORY 6A COPPER CABLING PRODUCTS FOR DATA CENTER (OPTION)

- Up on request, all horizontal Category 6A UTP cabling shall be terminated on 1U, 24 ports, Belden Category 6A front access modular KeyConnect style patch panel. Belden part number: AX106288, AX106291 (label holder kit).
- Belden REVConnec 10GX UTP modular jack, part number: RVAMJKUGN-S1 (Green color, single jack); RVAMJKUGN-B24 (Green color, BULK pack -24 jacks).
- Belden Part Number for 10GXS four-pair, AWG 23, 100 ohm FT6 (CMP) UTP horizontal cable: 10GXS13D15A1000 (blue, non-bonded). Plenum rated UTP cable shall be used in Data center.
- All patch cords shall be manufactured by Belden and performance rated to Category 6A.

  Typical gray color Category 6A patch cords, Belden Part Numbers: CA21108002 (0.6 m / 2 ft.), CA21108007 (2.1 meters / 7 ft.).

FIBREOPTICS PATCH PANEL (FPP) AND MPO CASSETES/FRAME FOR DATA CENTER

- Belden Fibre optics Rack Mount Enclosure for Telecommunication Enclosures shall be:
    - 1U, 2U or 4U - 19" FX UHD Rack Mount Enclosure /Housing
    - Durable black or titanium color powder coat finish
    - Be equipped with cable strain relief and slack storage

- Belden Part Number for black color fiber FX UHD enclosure/housing: AX105563 (1U); AX105565 (4U).
- FX UHD Fiber Management Spool kit, includes base plates and eight spool segments, Belden Part Number: AX105700.

- Belden MPO/LC cassettes (OM4/OS2)
  - FX ultra Cassettes/Modules or Frame (with 1" pull out) shall be used for manageable density in dynamic patching environments where ease of access and use and speed are critical.
  - Belden FiberExpress Ultra Cassettes are designed specifically for use with the Belden FiberExpress Ultra Patch Panel System.
  - OM3 is minimum requested and OM4 is recommended in data center.
  - Pair a Type-A and Type-A ALT on Type-B MPO trunk link to ensure correct port number and to provide simple upgrade path to SR4 (40G/100G) protocols.
  - FXU CASS, 12P (24-Fiber), MPO12 (F) to LC duplex, OM4 Erika Violet Adapters, Belden Part Number: FC4U12LDMF (Type A); FC4U12LDMF1E (Type A-ALT).
  - FX U CASS, 12P(24-Fiber), MPO(F) to LC duplex, OS2 Singlemode Green APC adapter, Belden Part Number: FCSU12LAMF (Type A); FCSU12LAMF1G (Type A ALT).

- Belden MPO-MPO frame/adapter strip:
  - Used with the Belden FiberExpress Ultra Patch Panel System
  - FX Ultra Frame/Adapter Plate, MPO-MPO, 12-port, OM4 Erika Violet Adapters, key-up/key-down, Belden Part Number: FF4U12MP
  - FX Ultra Frame/Adapter Plate, MPO , 12-port, OS2 singlemode, key-up/key-down, Belden Part Number: FFSU12MP

- Belden FX UHD Blank frame/Adapter Strip
  - Blank frame /Adapter strip to fit un-used adapter strip opening in the FX UHD fiber enclosure
  - Durable black powder coat finish
  - Belden Part Number: FFZH00BB

FIBREOPTICS PRE-TERMINATED MPO-MPO TRUNK CABLE (OM4/OS2) FOR DATA CENTER

- For date center, Pre-terminated MPO trunk cables shall be used for fast and flexible solution.
- OM3 is minimum requested, and OM4 is recommended.
- Maximum MPO connector Insertion Loss (IL) shall be 0.2 dB for OM4 and 0.75 dB for OS2/APC.
- Typical polishing Return Loss (RL) shall be 30 dB for OM3/OM4 and 60 for OS2/APC.
- The MPO trunk cable shall be plenum type and with 0.5 meter fan out length.
- For easier upgradability to 40G and 100G, Polarity (outside) Type B (MPO-Male to MPO-Male) trunk cable is recommended.
- FX MPO Trunk, OM4, MPO-12 (Male to Male), Type-B, 2 MPO (24 fibers), OFNP, Mini-Distribution (3.0 mm Sub-Units), Fan-Out 0.5 m X In-Line, Erika Violet jacket, Belden Part Number: FM4MMB2xxxM (xxx: length in meter).
- FX MPO Trunk, OS2, MPO-12/APC (Male to Male), Type-A, 2 MPO (24 fibers), OFNP, Mini-Distribution (3.0 mm Sub-Units), Fan-Out: 0.5 m X In-Line, yellow jacket, Belden Part Number: FMSMMB2xxxM (xxx: length in meter).

FIBREOPTICS MPO TO MPO PATCH CORDS (OM3/OM4/OS2) FOR DATA CENTER

- The MPO-12 patch cords cable maximum Insertion Loss (IL) shall be no more than 3.25dB/Km for OM3, 3.0dB/Km for OM4; 0.5dB/km for OS2/APC.
- MPO-12 patch cords connector maximum insertion loss (IL) shall be no more than 0.35dB/mated pair for OM3, 0.2dB/mated pair for OM4; 0.75dB/mated pair for OS2/APC.
- MPO-12 patch cords connector typical polish Return Loss (RL) shall be 30 dB for OM3/OM4 and 60 dB for OS2 APC.
- Prevent damage to active equipment, MPO female to female patch cords shall be specified.
- FX PATCH CORD, OM4, MPO-12 (F) - MPO-12 (F), OFNP, Round 3.0 MM, TYPE-B, ERIKA

  Violet jacket, Belden Part Number: FP4MFMFxxxM, xxx length in meter.
- FX PATCH CORD, OS2 singlemode, MPO-12 (F) - MPO-12 (F), 3 M, OFNP, Round 3.0 MM, TYPE-B, yellow jacket, Belden Part Number: FPSMFMFxxxM, xxx: length in meter.

FIBREOPTICS MPO-DUPLEX LC HYDRA CABLES (OM3/OM4/OS2) FOR DATA CENTER

- The hydra (breakout) assemblies is faster deployment at the switch with MPO to LC fanout construction, and easier upgradability from 10G to 40G or 100G with MPO.
- The cable jacket shall be 3.00 mm round for MPO and 2 mm simplex zip cord for LC.
- Belden FX Hydra Assembly, 4 LC Duplex, MPO-12(Female), 40G Polarity, 3 m, Part Number: FP3LD4F003M (OM3); FP4LD4F003M (OM4);
- 10G Transceiver Pinout
    - MPO-12(f) to 6 x LC Duplex, 1 m In-Line Fanout, 3 m in length, Belden Part Number: FP4LDMF003M (OM4); FPSLDMF003M (OS2).
- 40G Transceiver Pinout (40G Polarity)
    - MPO-12(f) to 4 x LC Duplex, 1 m In-Line Fanout, 3 m in length, Belden Part Number: FP4LD4F003M (OM4); FPSLD4F003M (OS2).

END OF SECTION

SECTION – 3: EXECUTION

It is Consultant / Designer responsibility to check the latest version of this document from TW DNS.

GENERAL

- City Eng. Consultant/Contract Administrator assigned RCDD shall perform the design and consulting work.
- Contractors shall have an assigned RCDD as installation Team Lead / Project Manager.
- All Installers and technicians shall be from unionized employers and employees shall have their manufacturers' certifications or are registered apprentices under the NCS program or certified from BICSI.
- All Contractors / Technicians shall be certified with Belden, JDSU 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 either JDSU Certified Cabling Test Technician on NGC-4500 or certified on Fluke DTX / DSX / Versiv CertiFiber Pro and Optifibre OLTS/OTDR equipment.
- Following are the procedures to follow for successful project handing over:
    - Cable Acceptance Testing (CAT) – See Appendix for correct Sample Test Results and Compliance Sheet
    - Site Acceptance Testing (SAT) - See Appendix for Sample SAT Documents
    - As-built Drawings and Documents (ADD)
    - Consultant Review and Comments (CRC)
    - Certificate of Conformance (CoC) – Grounding and Bonding System
    - Manufacturer Extended Product/System Warranty Certificate - Plaque

- DNS Approval of Satisfaction (IAS) – Signing off

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.
- When required, use only Velcro Tapes, use of any other harness system (plastic ties etc.) is strictly prohibited. Consultant shall visually verify this during the TE and cabling SAT.

FIBREOPTIC CABLE INSTALLATION

- All cables and components shall be installed as per the Belden and other specified / unspecified manufacturers' instruction sheets, ANSI/TIA standards and the BICSI Installation Methods Manual to complete the project.
- When required, use only Velcro Tapes, use of any other harness system (plastic ties etc.) is strictly prohibited (no exceptions). Consultant shall visually verify this during the TE and cabling SAT.
- All installed fiber cable and patch cords shall be maintain its bend ratio requirement and avoid the macro bends.

CABLE ACCEPTANCE TESTING

- This section specifies the acceptance testing requirements for structure cabling backbone fibre optic as well as horizontal UTP cabling.
- Supply all labor, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the structured cabling for each cabling link (connector to connector).
- All structured cabling components (outlets, cables, patch panels and associated components etc.) shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work at no cost to City of Toronto.
- Submit acceptance documentation as defined in this section.
    - Manufacturers catalog sheets and specifications for field-test instruments for copper and fiber including:
        - Optical loss test sets (OLTS; power meter and source)

        - Optical time domain reflectometer – OTDR (optional - only if requested)
        - Video Microscope for fiber end face inspection and imaging
        - Copper Cable Analyzer
    - A schedule (list) of all cables to be tested.
    - Detailed and complete/full Test reports.

- Installed Category 6A, Unshielded Twisted Pair (UTP) structured cabling system shall be tested as specified in TIA-568-C.2 for Category 6A, Unshielded Twisted Pair (UTP) using permanent link configuration on the testing equipment. Channel link testing shall not be accepted.
- Installed Fiber-optic cable each strand connector and adapter ferrule end-faces shall be cleaned and inspected before loss testing and final connection along a link, including through any passive connections or splices along the way and shall be free of any scratches, defects and dirt as per IEC-61300-3-35.
- Installed Fiber-optic cable each strand connector and adapter Ferrule end-faces shall be Dry cleaning (such as, using "one click pen"). If that still does not clean, then try wet cleaning (such as hydrocarbon liquid, lint free wipes). Always finish with dry cleaning.
- It shall take care to accommodate the angle when cleaning APC type angled connectors.
- It is also especially important to clean loose contaminants beyond the contact point.
- Damaged connector shall be replaced.
- Installed Fiber-optic structured cabling system shall be tested as per TIA-568.0-D – Tier 1 OLTS: link attenuation testing, link length and polarity check etc.
- Tier 2. OTDR (optional): Trace/Visual Picture of installed condition and its component, event losses, quality of installation etc. shall be an optional requirement and shall be demanded and requested as per project requirement bases by TW-DNS.
- All of the installed cabling must be tested and successfully pass all test criteria.
- Any parameter with Asterisk (PASS*) in pass test result indicating Marginal Pass shall be considered as conditional pass (no exceptions).
- Marginal Pass result/parameter shall be identified and highlighted on the result document. The detailed diagnostic report as an aid to interpret results marked with asterisks shall be provided. A diagnostic report shall be submitted identifying the source of the marginal performance.

- City of Toronto – DNS team after reviewing cause/factor of the marginal pass will determine if the marginal pass result will be accepted and no further action is required. If any corrective actions and retest is required, that shall be done at no cost to City of Toronto and shall be done immediately.

- City of Toronto – DNS reserved the rights to demand to rectify the cause of the marginal pass result and retest. City of Toronto shall not assume any cost associated in rectifying and retest the marginal pass result/link.

- Cable acceptance is strictly governed by standard and guidelines referenced in this section below. All standards, details, instructions and guidelines referenced within the Telecommunications Cabling Standard TIA/EIA-568-C and all below listed standards, where applicable, constitute standard provisions of this specification. They don't have to be explicitly stated in this document.

- Standards referenced in this section include:

    - TIA-568-C or latest: Telecommunications Cabling Standard. All standards referenced within the TIA-568-C, where applicable, constitute standard provisions of this specification.

    - TIA-526-14-C: Optical Power Loss Measurement, Multimode

    - TIA-526-7-A : Optical Power Loss Measurement, Single-mode

    - ANSI/TIA-1152: Requirements for field test instruments and measurements for balanced twisted-pair cabling

    - IEC-61300-3-35: Basic Test and Measurement Procedures Standard for Fiber Optic Interconnecting Devices and Passive Components (Automated End-Face Inspection)

- Design consultant must be acquainted, fully understand and adhere to the details provided in TIA/EIA-568-C, 526-14-C, TIA-526-7-A and TIA-1152, whither they are specifically mentioned or not mentioned in this document. Failing to do so will resulted in noncompliance and will be listed as deficiency and will be corrected at no cost to City of Toronto

- Contractors, installers and technicians must adhere to the details provided in above listed standards, specifically TIA/EIA-568-C, 526-14-C, TIA-526-7-A and TIA-1152, whither they are specifically mentioned or not mentioned in this document or in design document. Failing to do so will resulted in noncompliance and will be listed as deficiency and will be corrected at no cost to City of Toronto.

- Design consultant (for designing and reviewing and accepting part), contractors, installers and technicians shall be certified (in good/valid standing) with Panduit, Corning, JDSU and Fluke Networks to review/accept and perform installations and testing/commissioning.

- All contractors, installers and technicians shall be from unionized employers and employees shall have their Network Cabling Specialist (NCS) or are registered apprentices under the NCS program or certified from BICSI or manufacturers.
- Installers and 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 and technicians performing the testing shall be Certified Cabling Test Technician (in good/valid standing) from the test equipment manufacturer (JDSU or Fluke), being used.
- 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 of Toronto-TW.
- 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 TIA-568-C. 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 of Toronto.

COPPER PERMANENT LINK TESTING – HORIZONTAL CABLING

- All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance to Category 6A. Horizontal cabling shall be tested using a minimum level III test unit for Category 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 TIA-568-C 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 TIA-568-C.2 for Category 6A, Unshielded Twisted Pair (UTP).
- All tests shall be conducted using permanent link configuration on the testing equipment.
- Category 6A Cabling Alien Crosstalk Field Sampling Testing

    1. Belden Category 6A Cabling System Warranty requirement on Alien Crosstalk field sampling testing must be confirmed and followed.
    2. TW DNS typically request at least one longest and shortest sample link for each telecom room/enclosure shall be field tested for Alien Crosstalk.
    3. For practical field certification efforts on Category 6A Alien crosstalk testing, the key is to develop a test strategy that limits the number of links in a bundle to be tested, and focuses those tests on links most likely to be the weakest performing:
        - Select the longest links in the installation as well as shorter links with the shortest distance between connectors at patch panel /faceplate. These are considered the links most likely to have the highest AXT levels as measured by the PSANEXT and PSACCRF parameters.
        - Cables within the same bundle (In general, only links in the same cable bundle) are expected to contribute a measurable amount of alien crosstalk, so testing of links in nearby bundles is not required for Category 6A certification.
        - Per ISO/IEC 14763-2, if three of the shortest, three of medium and three of longest links exceed 5 dB in margin, it can opt to stop testing.
    4. The final Alien crosstalk test strategy shall be reviewed by TW DNS.

COPPER PATCH CORD TESTING (OPTION)

- All supplied and installed Category 6A patch cords shall be from manufacturer /Belden.
- Upon request, as minimum, all twisted-pair copper patch cords shall be tested for continuity/wire map, length, pair reversals, shorts, opens, crossed and performance to Category 6A limits. Patch cord shall be tested for "PASS" result, using a minimum Level III test unit for Category 6A performance compliance, preferably using appropriate patch cord adapters with main and remote test units.

COPPER TEST EQUIPMENT

Category 6A Test Equipment - Category 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 manufacturers are JDSU and 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 JDSU NGC-4500 and Fluke Networks DSX 5000 / 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 III, as indicated by independent laboratory testing.
- Test equipment must be capable of certifying Category 6A to TIA-568-C.2 standards.
- 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 TIA-568-C 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.
- The calibration of equipment shall be valid within one (1) year of the test date.

HORIZONTAL CABLE TESTING DOCUMENTATION - COPPER

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

- Wiremap results that indicate the cabling has no shorts, opens, 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.
- DC Loop Resistance is the total resistance through two conductors looped at one end of the link. This is usually a function of the conductor diameter and varies only with distance. This measurement is sometimes done to ensure there are no gross misconnections which can add significant resistance to the link.
- Length (in meters), propagation delay and delay skew relative to the limit.
- Any individual test that fails the relevant performance specification shall be marked as a FAIL.
- Final Test results that contain an asterisk (PASS*, FAIL*) are not acceptable to TW - DNS.
- The report shall include the plot (graphical) data as well for trouble shooting.
- 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 name.
- Test criteria used.
- Overall pass/fail indication.
- Date and time of test.

BACKBONE CAT5E MULTIPAIR TESTING – VOICE APPLICATION

- Multipair Category 5E copper backbone cable shall be tested for by Permanent link per TAI-568-C. Using Fluke Versiv (DSX-5000), JDSU NGC-4500 or approved equivalent tester.

- The testing shall be conducted from the voice patch panel in the Telecom Enclosure (TE) to the termination wiring blocks at the Entrance Facility.
- For testing the multipair cabling on the termination blocks (BIX series) appropriated test adapters shall be used and shall be reviewed by the PCS/DNS.
- When only 1 or 2-pair of the multipair cable terminated with a RJ45 jack module, the continuity test is requested only.

BACKBONE FIBREOPTIC TESTING

- All testing procedures and field-test instruments shall exceed (meet and comply with) applicable requirements of:
    - ANSI Z136.2, Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
    - ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
    - ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
    - ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.
    - ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
    - ANSI/TIA/EIA-526-7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
    - ANSI/TIA-526-14-C, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fiber-Optic Communications Subsystem Test Procedure- Part 4-1: Installed cable plant- Multimode attenuation measurement
    - TIA-TSB-4979 Practical Considerations for Implementation of Multimode Launch Conditions in the Field (Encircled Flux)
    - ANSI/TIA-568.0-D, Generic Telecommunications Cabling for Customer Premises (Merged/Combined Tier 1 and Tier 2)
    - ANSI/TIA-568-C.3, Optical Fiber Cabling Components Standard (MM and SM)
    - IEC-61300-3-35: Basic Test and Measurement Procedures Standard for Fiber Optic Interconnecting Devices and Passive Components.
    - ANSI/TIA-606-B, Administration Standard for Telecommunications Infrastructure

- Installed Fiber-optic end-faces shall be inspected at 400X magnification as per IEC-61300-3-35. Scratched, pitted or dirty connectors shall be diagnosed and corrected at no extra cost to City of Toronto.
    - End-face images shall be recorded in the memory of the test instrument for subsequent uploading to a PC and shall be reported to TW DNS.
    - The End-face images shall be submitted and incorporated with the test report.
- Installed Fiber-optic structured cabling system shall meet or exceed and shall be tested as per TIA-568.0-D:
    - Tier 1 – OLTS (mandatory): link attenuation testing, link length and polarity check etc.
    - Tier 2 OTDR (optional): Trace/Visual Picture of installed condition and its component, event losses and reflectance, quality of installation etc. shall be an optional requirement and shall be demanded and requested as per project requirement bases by TW-DNS.
- All unused fiber adapter plates and fiber jumper connectors shall be protected with dust cap/cover. All removed dust cap/cover during the testing shall be restored after the testing.
- All tests shall be documented including OLTS dual wavelength attenuation measurements, optical length measurements etc. and only if applicable and requested, optional OTDR traces with event tables as well as OTDR maps shall be part of test report submission.
- Test link attenuation with an OLTS:
    - For multimode fibre, make reference measurements in accordance with TIA-526-14-B, Annex A – Method B (One cord reference method). Measure optical loss on each fibre at 850 nm and 1300 nm. Measure loss on each fibre from each direction (bi-directionally).
    - For singlemode fibre, make reference measurements in accordance with TIA-526-7-A, – One cord reference method. Measure optical loss on each fibre at 1310 and 1550 nm. Measure loss on each fibre from each direction (bi-directionally).
- Measure link length optically or calculate using cable sheath length markings.
- Testing shall be performed on each cabling link (connector to connector).
- Negative losses shall be retested.

- Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as, optical bypass switches, couplers, repeaters, or optical amplifiers.
- Multimode backbone 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 3.5 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 300 meters.
- Singlemode backbone fibre optic cabling shall meet the following loss and length criteria:
    - Attenuation @ 1310 nm shall be less than or equal to: fibre length (km) x 0.5 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
    - Attenuation @ 1550 nm shall be less than or equal to: fibre length (km) x 0.5 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB.
    - Length more than 300 metres and shall be less than or equal to 10000 meters.
- OTDR Testing (optional): shall be an optional requirement and shall be demanded and requested as per project requirement bases by TW-DNS.
    1. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
    2. A launch cord shall be installed between the OTDR and the first link connection.
    3. A tail cord shall be installed after the last link connection.
    4. Reflective events (connections) shall not exceed:
        - 0.75 dB in optical loss when bi-directionally averaged
        - -35 dB Reflectance for multimode connections
        - -40 dB reflectance for UPC singlemode connections
        - -55 dB reflectance for APC singlemode connections
    5. Non-reflective events (splices) shall not exceed 0.3 dB.

- All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- All structured cabling components (outlets, cables, patch panels and associated components etc.) shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work at no cost to City of Toronto.
- Field-test instruments shall have the latest software and firmware installed.
- All the test results shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation may be generated.

BACKBONE FIBREOPTICS TESTING DOCUMENTATION

- Each fiber strand End-Faces shall be inspected at 400X magnification before the loss testing. Scratched, pitted or dirty connectors shall be diagnosed and corrected at no extra cost to City of Toronto.
    - End-face images shall be recorded in the memory of the test instrument for subsequent uploading to a PC and shall be reported to City of Toronto.
    - 400X magnified End-face images shall be submitted and incorporated with the test report.
- Fibreoptics Documentation: As a minimum, test reports shall include the following information for each fibreoptics cabling element (fibre) tested:
    1. 400X magnified fiber connector End-face inspection images.
    2. 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.
    3. The length:
        - OLTS measurements for each optical fiber as calculated by the OLTS tester. (mandatory)
        - OTDR measurements are optional requirements and shall be demanded as per project requirement bases by TW-DNS
    4. The overall Pass/Fail evaluation:

- OLTS measurements of the link-under-test as calculated by OLTS tester. (mandatory)
- OTDR measurements are optional requirements and shall be demanded as per project requirement bases by TW-DNS

5. OTDR link loss and channel traces, tables at the appropriate wavelength(s) are optional requirements and shall be demanded as per project requirement bases by TW-DNS.

   For OTDR loss testing, to resolve the mismatch in backscatter between the test and installed fiber, bi-directional averaging shall be used and submit.

6. Reference method and document test reference cord losses. Test reference cords will "wear out" with use, poor/damage cords will destroy the installation. For 1-jumper reference, the reference cord shall be verified every 288 tests. Verification performance of test reference cords to be saved and submitted.

7. Number of mated connectors.

8. Test limit

9. Limits Version

10. Number of Splices

11. Bi-directional testing

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

13. Link criteria used.

14. Overall pass/fail indication.

15. Date and time of test was conducted and saved in the memory of test equipment.

16. Cable IDs as recorded and reported on the test instrument shall match the actual installed cable IDs of each strand, for example:

    - 2100-FP01-A-01:0100-FP01-F-01 (1st Fiber Strand)
    - 2100-FP01-A-02:0100-FP01-F-02 (2nd Fiber Strand) so on, so forth.

17. Cable Type.

18. SITE/Facility name: Actual site name or acronym (YKP, YCS etc.)

19. Project: Actual Project Name and Contract Number
20. Native File Name for e.g. (Fluke .flw) shall reflect respective TE name for e.g. (xxx-ITS-COM-2100) where XXX is site acronym (TAB, THC etc.)
21. 1st page of the printed test results shall always be Test Result Summary Page.

- Any link or channel that fails the requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation and shall be done at no cost to City of Toronto.

  In special cases, High Bandwidth applications such as, 10GBASE-S and FC1200 impose stringent channel loss limits. Where practical, certification shall consider loss length limits that meet maximum channel (transmitter to receiver) loss budget:

Applications	Standard	Maximum Channel Length	# Fiber	Connector	Maximum Channel Loss Budget (dB)
10GBASE-SR	IEEE 802.3ae	OM3: 300m; 0M4: 400m	2F	Duplex LC	OM3: 2.6 dB; OM4: 2.6 dB
40GBASE-SR4	IEEE 802.3ba	OM3: 100m 0M4: 150m	12F (8 used)	MPO	OM3: 1.9 dB; OM4: 1.5 dB
100GBASE-SR10	IEEE 802.3ba	OM3: 100m OM4: 150m	24F (20 used)	MPO (1X24 to 2 X12)	OM3: 1.9 dB; OM4: 1.5 dB
100GBASE-SR4	IEEE 802.3bm	OM4: 100m	12F (8 used)	MPO	1.9 dB
40GBASE-IR4	IEEE	OS2: 2km	2F	Duplex LC	4.0 dB

	802.3ba				
40GBASE-LR4	IEEE 802.3ba	OS2: 10km	2F	Duplex LC	6.7 dB
100GBASE-LR4	IEEE 802.3ba	OS2: 10km	2F	Duplex LC	6.3 dB
16GFC	INCITS FC (T11)	OM3: 100m OM4:125m	2F	Duplex LC	OM3: 1.86 dB OM4: 1.95 dB
32GFC	INCITS FC (T11)	OM3: 70m; OM4: 100m	2F	Duplex LC	OM3:1.87 dB OM4:1.86 dB
Gen 6 Fibre Channel (128GFC)	INCITS FC (T11)	OM3: 70m; OM4: 100m	12F	MPO	OM3: 1.46 dB; OM4: 1.35 dB

- MPO multifiber testing shall use MPO field tester or using the traditional duplex tester with hydra (fan out) cables. For duplex fiber tester with hydra cable testing, 3 reference jumper method shall be used and following tester manufacturer instruction.

FIBREOPTIC TEST EQUIPMENT

- All test equipment of a given type shall be from the same manufacturer and have compatible electronic results output.
- Test results from the OLTS, OTDR (optional) and end-face images shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- Testing shall be performed on each cabling segment (connector to connector).
- All test equipment shall be able to perform Tier 1 or Tier 1 and Tier 2 (combined) testing and certification.
- Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope shall be used and preferred.
- Sources and meters shall automatically synchronize wavelengths to prevent calibration- related errors.
- Test equipment shall employ a communications port to facilitate uploading of saved information from tester to PC.
- Testing of the cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length.
- If requested, the test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable. (optional requirement)
- Test equipment capable of measuring a Tx/Rx fiber 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.
- Acceptable test equipment manufacturers are Fluke Networks *(Versiv Main and Remote with OptoFiber Pro Quad OTDR Module, CertiFiber® Pro Quad Optical Loss Test Set Module and USB Video Fiber Inspection Camera With Tip Set)* and JDSU.
- Unless the manufacturer specifies a more frequent calibration cycle, calibration date shall not be more than a year from cable test date.

- The calibration of all equipment used (main, remote, modules, adapters etc.) shall be within one (1) year of the test date. Calibration certificate shall be required and provided along with report.
- Fiber optic test equipment shall meet the following minimum criteria:
    - Optical loss test set (OLTS):
        - Multimode:
            - Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-14-C, "Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant."
            - Test equipment shall not include the loss or length of the test jumpers in the cable plant measurements.
            - OLTS shall be able to measure the optical length of the fiber using time-of-flight techniques
            - Multimode test equipment shall incorporate and provide:
                - Dual LED light sources with central wavelengths of 850 nm (±30 nm) and 1300 nm (±20 nm)
                - Output power of –20 dBm minimum.
                - The launch shall meet the Encircled Flux launch requirements of ANSI/TIA-526-14-C.
                - The test reference cords must demonstrate an insertion loss ≤ 0.15 dB when mated against each other.
        - Singlemode:
            - Test equipment shall be capable of measuring relative or absolute optical power in accordance with TIA/EIA-526-7 (2015), “Optical Power Loss Measurement of Installed Single-mode Fiber Cable Plant.”
            - OLTS shall be able to measure the optical length of the fiber using time-of-flight techniques
            - Single-mode test equipment shall incorporate and provide:

- Dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1550 nm (±20 nm).
- Output power of –10 dBm minimum.
- The test reference cords must demonstrate an insertion loss ≤ 0.25 dB when mated against each other.

- Power Meter shall incorporate:
  - Provide 850 nm, 1300 nm, 1310 nm, and 1550 nm wavelength test capability.
  - Power measurement uncertainty of ± 0.25 dB.
  - Store reference power measurements.
  - Save at least 10,000 results to internal memory.
  - PC interface (USB).
- Optical Time Domain Reflectometer – OTDR: (optional requirement, only if applicable)
  - Shall have a bright, color LCD display with backlight.
  - Shall have rechargeable Li-Ion battery for 8 hours of normal operation.
  - Weight with battery and module of not more than 4.5 lb and volume of not more 200 in^3.
  - Internal non-volatile memory with capacity for storing at least 2,000 OTDR bi-directionally tested fiber links.
  - USB port to transfer data to a PC or thumb drive/memory stick.
  - Multimode OTDR:
    - Wavelengths of 850 nm (± 10 nm) and 1300 nm (+ 35 nm / - 15 nm).
    - Event dead zones not to exceed 0.7 m at 850 nm and 1300 nm.
    - Attenuation dead zones not to exceed 2.5 m at 850 nm and 4.5 m at 1300 nm.
    - Distance range not less than 9,000 m.

- Dynamic range at least 28 dB for 850 nm and 30 dB at 1300 nm.
- Allow bi-directional testing without moving the OTDR to the far end.

- Singlemode OTDR: (optional requirement, only if applicable)
  - Wavelengths of 1310 nm (± 25 nm) and 1550 nm (± 30 nm).
  - Event dead zones not to exceed 0.6 m at 1310 nm and 1550 nm.
  - Attenuation dead zones not to exceed 3.7 m at 1310 nm and 1550 nm.
  - Distance range not less than 80 km at 1310 nm and 130 km at 1550 nm.
  - Dynamic range at least 32 dB for 1310 nm and 30 dB at 1550 nm.
  - Allow bi-directional testing without moving the OTDR to the far end.

- Fiber Microscope:
  - Field of view 420 µm x 320 µm
  - Magnification of 400X for end-face inspection
  - Shall be capable of saving and reporting the End-Face image.
  - Video camera systems are preferred.
  - Camera probe tips that permit inspection through adapters are required.
  - Test equipment shall be capable of saving and reporting the end-face image to IEC 613003-3-35 with magnifying power of 400X.
  - For MPO inspection, two types of MPO inspection tips shall be used accordingly for multimode (UPC) and for singlemode (APC).

CABLE TEST RESULTS MANUAL

- Consulting Engineer shall first review and comment on the test report. TW-DNS shall only receive the report after the review and approved comments of the Consulting Engineer. TW-DNS will provide their final review comment.

- The database and test report for the complete project shall be submit in both a hardcopy and electronic format (.pdf and native). Hand-written test reports are not acceptable. Submit electronic files on a CD format disk in a PDF and native format. This CD-ROM shall include the software tools required to view, inspect, and print any selection of the test reports at no cost to City of Toronto.

- Fiber optic backbone cable test results shall be incorporated in the Toronto Water 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.

- Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility (for example, Fluke LinkWare software) that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.

- The test results documentation shall be available for inspection by the City of Toronto or City of Toronto assigned Engineering Consultants during the installation period and shall be passed to the City of Toronto assigned Engineering Consultants within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.

- The Contractor (RCDD) must sign hardcopy reports before submitting it to Consultant (RCDD).

TEST COMPLIANCE SHEET

A compliance sheet shall be prepared for every project by Toronto Water - DNS. The general minimum criteria is summarized as below, but not limited to:

1	Test equipment with latest software and test limit version	11	Test results based on LED for OM2
2	Test equipment with latest test limit version	12	Test results based on LED or Encircled Flux for OM3 MM

3	Tester manufacturer, model, serial number, software version and Calibration date.	13	Test results based on Laser for OS2 SM
4	Test results submitted in PDF and native format	14	MM testing at 850nm and 1300 nm wavelength
5	Test result cable ID in compliance	15	SM testing at 1310nm and 1550 nm wavelength
6	Permanent Link testing and Patch Cord testing performed on copper (Cat5/6)	16	Bi-directional testing done
7	Test result cable type (copper and fiber) in compliance	17	Accurate quantity of adapters and splices
8	Correct reference cable used (Correct Jumper method used)	18	Project: Actual Project Name and Contract Number used
9	SITE: Actual site name or acronym used	19	Test Record Native File Name have reference to TE name (xxx-ITS-COM-2100)
10	Fiber Optic Tested using: Tier 1 - OLTS (mandatory) Tier 2 – OTDR (optional, if applicable and requested)	20	400x Magnified End-face images complete report is provided

Please refer to Appendix-A for TW-DNS Sample Test Result Compliance Sheet.

SITE ACCEPTANCE TEST (SAT)

- Prior to SAT, it is mandatory that City of Toronto assigned Engineering Consultant / Contract Administrator / Consultant shall verify if installed structured cabling system (end to end) is ready qualify for acceptable SAT and any other criteria as may be described in the project tender, the Installation and Layout drawings. This can be achieved by conducting a Pre-SAT between City of Toronto assigned Engineering Consultant / Contract Administrator and contractor / installer.
- SAT date shall be established (no exceptions) only after, City of Toronto assigned Engineering Consultant / Contract Administrator / Consultant have comprehensively reviewed and approved all copper and fiber cabling testing, follow-up with TW-DNS final review and approval.
- Contractor shall develop and provide all the required drawings and documents, SAT document (check list) and provide it to City of Toronto assigned Engineering Consultant / Contract Administrator at least four (4) weeks prior to the test for review
- City of Toronto assigned Engineering Consultant / Contract Administrator shall review all the required drawings and documents, SAT document (check list), Certificate of Conformance (CoC) – Grounding and Bonding System and then shall submit to TW-DNS for final review and approval, at least two (2) weeks prior to SAT date.
- The Contractor shall conduct the test when directed by the Contract Administrator. Contract Administrator shall monitor the SAT and record the results. TW-DNS shall witness the test only.
- The SAT plan shall be sealed by the Installation Project Manager RCDD, followed by the RCDD Consultant.
- 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 for installed structured cabling system (end to end) under the project against the *Installation* and *Layout* drawings.
- 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 TW-DNS as being in conformance with the design as specified.
- Any noted or identified non-compliant items shall be made compliant at no cost to the City of Toronto.
- The term "free-issue" refers to equipment supplied by the City but installed and patched by contractor per the layout drawing and application patching schedule. The Network Switching and Routing Equipment will be freely issued by the City. The network equipment will be configured, tested by Toronto Water PCS DNS staff. The horizontal cabling patching and end device connection must be successfully past the performance field testing and SAT.

- The fiber backbone cabling patching with Switch shall be done by TW DNS staff.
- SAT of Equipment Room / Telecom Room
    - Each facility shall have one or more equipment room / telecom room, which house the server and network core/service provider closets. Each equipment / telecom room shall undergo a witnessed SAT.
    - The Consultant is responsible for the equipment / telecom room UPS, lighting panel, HVAC 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, fiber/copper cabling products and equipment, cable managers, labelling, power supplies to each closet and external cable management (e.g. cable tray) as well as cooling and grounding. For the purpose of the ER/TR SAT the server and core closets shall be empty except for the installation of 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, cooling, conduit and cable tray system, copper and fiber cable routing and installation, fire stop, labelling and grounding etc.
    - 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/copper 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.

Please refer to Appendix-B for TW-DNS Sample SAT Sheets.

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.

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.

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-C.3 for multimode and singlemode fibre.

- The Contractor shall warrant that all permanent twisted pair links meet or exceed the performance requirement of TIA/EIA-568-C.2 for Category 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 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-C 'Transmission Performance Specifications for 100 Ohm 4-pair Category 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.

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, JDSU and Fluke Networks to perform installations and testing.
- Contractors shall have a BICSI qualified RCDD Project Manager assigned to the project all the time, the credential holder shall be in good standing who have demonstrated knowledge in the design, integration and implementation of telecommunications and data communications transport systems and related infrastructure with BICSI, preferably in Industrial Control Systems environment.
- All Installers shall be from unionized employers and employees shall have their manufacturers' certifications or be registered apprentices under the NCS program or BICSI certified.
- 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 on JDSU or CCTT certified on Fluke DTX/Versiv DSX-5000 and/or Optifibre Pro OTLS, OptiFiber Pro OTDR.
- All JDSU and 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/EIA, 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 OLTS and OTDR (Optional).
- 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.

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 (AutoCAD & PDF) 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 (AutoCAD & PDF) 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 (AutoCAD & PDF) form.

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 TW DNS 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:
    - Toronto Water 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)
    - Certificate of Conformance (CoC) – Grounding and Bonding System
    - DNS Approval of Satisfaction (IAS) – Signing off

END OF SECTION

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

TW – DNS CABLE TEST RESULT 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 of Toronto Reviewer	**Date Issued**	**Status** ❑ **Approved** ❑ **Disapproved**	

General

No.	GENERAL	Comply	Does Not Comply	Not Applicable
1	Cable test equipment Fluke Versiv DSX-5000, CertiFiber Pro OLTS, OptiFiber Pro OTDR, JDSU NGC-4500 with latest software version			

2	Cable test equipment Fluke Versiv DSX-5000, CertiFiber Pro OLTS, OptiFiber Pro OTDR, JDSU NGC-4500 with latest limit version			
3	Valid calibration certificate of the all the cable test equipment used			
4	Cable test results supplied 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			
7	Test result cable ID in compliance and as applied in the field			

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 ID in compliance and as applied in the field			
4	Test result cable type in compliance with project specification, TW-TW-DNS Standard - TIA568C Horizontal			

FiberOptics Test Results

No.	FIBER	Comply	Does Not Comply	Not Applicable
1	Test results based on LED for OM2 50/125 um MM fiber cabling			
2	Test results based on LED or Encircled Flux compliant models for OM3 50/125 um MM fiber cabling			
3	Test results based on FP Laser for OS2 9/125 um SM fiber cabling			
4	MM testing at 850nm and 1300/1310 nm modal bandwidth			
5	SM testing at 1310nm and 1550 nm modal bandwidth			
6	Test result cable ID in compliance project specification, TW-DNS Standard - TIA568C Horizontal and as applied in the field			
7	Test result cable type in compliance with project specification, TW-DNS Standard and TIA568C Backbone MM/SM			
8	Test link attenuation in accordance with TIA/EIA-526-14-C or TIA/EIA-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 fiber at 850 nm and1300 nm (for MM) or 1310 and 1550 (for SM).			
9	Measure loss on each fiber from each direction (bi-directionally) as per TW-DNS Standard			
10	Accurate quantity of adapter and splices			

11	Smart Remote mode used for testing dual-fiber strands			
12	400x Magnified End-face images complete report is provided			
13	Fiber Optic Tested using: Tier 1 - OLTS (mandatory) Tier 2 – OTDR (optional, only applicable if requested)			

TW – DNS SAMPLE COPPER & FIBER TEST RESULT SHEET

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID	Summary	Test Limit	Length	Headroom	Date / Time
4500-A-01:4501-WA01-01	PASS	TIA Cat 6 Perm. Link	202 ft	1.9 dB (NEXT)	11/10/2015 12:28 PM
4500-A-02:4501-WA01-02	PASS	TIA Cat 6 Perm. Link	202 ft	1.4 dB (NEXT)	11/10/2015 12:36 PM
4500-A-03:4501-WA01-03	PASS	TIA Cat 6 Perm. Link	202 ft	1.7 dB (NEXT)	11/10/2015 12:53 PM
4500-A-04:4501-WA01-04	PASS	TIA Cat 6 Perm. Link	202 ft	1.7 dB (NEXT)	11/10/2015 12:53 PM
4500-A-05:4501-WA02-01	PASS	TIA Cat 6 Perm. Link	202 ft	1.9 dB (NEXT)	11/10/2015 12:28 PM
4500-A-06:4501-WA02-02	PASS	TIA Cat 6 Perm. Link	202 ft	1.4 dB (NEXT)	11/10/2015 12:36 PM
4500-A-07:4501-WA02-03	PASS	TIA Cat 6 Perm. Link	202 ft	1.7 dB (NEXT)	11/10/2015 12:53 PM
4500-A-08:4501-WA02-04	PASS	TIA Cat 6 Perm. Link	202 ft	1.7 dB (NEXT)	11/10/2015 12:53 PM
4500-FP01-A-01:0100-FP02-F-01	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-02:0100-FP02-F-02	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-03:0100-FP02-F-03	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-04:0100-FP02-F-04	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-05:0100-FP02-F-05	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-06:0100-FP02-F-06	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-07:0100-FP02-F-07	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-08:0100-FP02-F-08	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-09:0100-FP02-F-09	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-10:0100-FP02-F-10	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-11:0100-FP02-F-11	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM
4500-FP01-A-12:0100-FP02-F-12	PASS	TIA-568-C Multimode	1461 ft	1.33 dB (Loss Margin)	08/22/2014 10:09 AM

Page 1
12/30/2015 03:00:15 PM
TAB-ITS-COM-4500.flw

FLUKE networks

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Total Length:	19148 ft
Number of Reports:	20
Number of Passing Reports:	20
Number of Failing Reports:	0
Number of Warning Reports:	0
Documentation Only:	0

LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 4500-A-01:4501-WA01-01
Date / Time: 11/10/2015 12:28:15 PM
Headroom 1.9 dB (NEXT 36-45)
Test Limit: TIA Cat 6 Perm. Link
Cable Type: Cat 6 UTP
Calibration Date: 02/12/2015

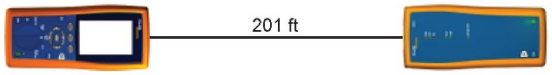
Operator: JON
Software Version: 2.7400
Limits Version: 1.9300
NVP: 69.0%

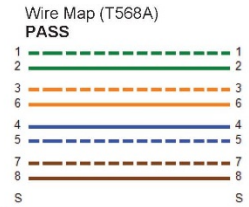
Test Summary: PASS
Model: DTX-1800
Main S/N: 1240071
Remote S/N: 1240072
Main Adapter: DTX-PLA002
Remote Adapter: DTX-PLA002

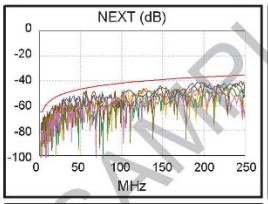
Length (ft), Limit 295	[Pair 12]	201
Prop. Delay (ns), Limit 498	[Pair 45]	313
Delay Skew (ns), Limit 44	[Pair 45]	16
Resistance (ohms)	[Pair 36]	9.3
Insertion Loss Margin (dB)	[Pair 36]	12.2
Frequency (MHz)	[Pair 36]	250.0
Limit (dB)	[Pair 36]	31.1

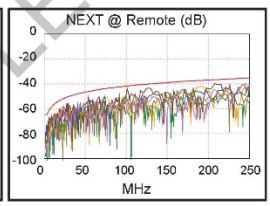
	Worst Case Margin		Worst Case Value	
PASS	MAIN	SR	MAIN	SR
Worst Pair	36-45	36-45	12-78	36-45
NEXT (dB)	2.0	1.9	3.2	2.9
Freq. (MHz)	54.3	101.0	198.5	214.5
Limit (dB)	46.1	41.8	37.0	36.4
Worst Pair	36	36	12	45
PS NEXT (dB)	3.6	3.9	5.0	4.2
Freq. (MHz)	56.5	101.0	226.0	243.0
Limit (dB)	43.4	39.2	33.4	32.9
PASS	MAIN	SR	MAIN	SR
Worst Pair	45-36	36-45	45-36	36-45
ACR-F (dB)	10.8	10.8	10.8	10.8
Freq. (MHz)	250.0	250.0	250.0	250.0
Limit (dB)	16.2	16.2	16.2	16.2
Worst Pair	36	45	36	36
PS ACR-F (dB)	12.7	12.6	12.9	13.0
Freq. (MHz)	1.1	1.1	250.0	250.0
Limit (dB)	60.2	60.2	13.2	13.2
N/A	MAIN	SR	MAIN	SR
Worst Pair	36-45	12-78	36-45	36-45
ACR-N (dB)	6.8	7.5	17.1	16.4
Freq. (MHz)	54.3	6.0	245.0	243.0
Limit (dB)	32.8	57.0	4.7	4.9
Worst Pair	36	36	12	45
PS ACR-N (dB)	8.6	9.3	16.8	16.2
Freq. (MHz)	54.3	12.9	226.0	243.0
Limit (dB)	30.3	47.4	4.1	2.3
PASS	MAIN	SR	MAIN	SR
Worst Pair	12	12	12	12
RL (dB)	5.2	5.1	5.2	5.9
Freq. (MHz)	233.5	85.5	233.5	232.0
Limit (dB)	10.3	14.7	10.3	10.3

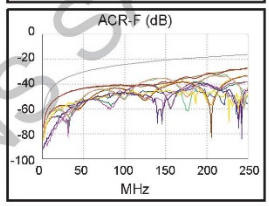
Compliant Network Standards:
10BASE-T, 100BASE-TX, 100BASE-T4, 1000BASE-T, ATM-25, ATM-51, ATM-155, 100VG-AnyLan, TR-4, TR-16 Active, TR-16 Passive

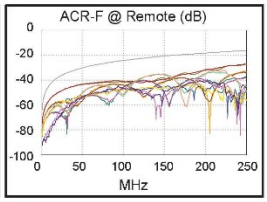


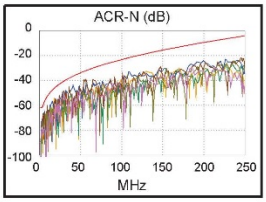


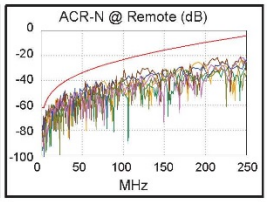


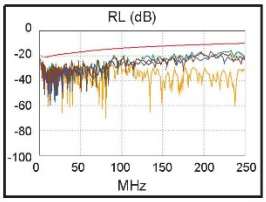


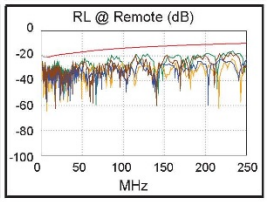












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Project: 04FS-48WP, DIG 1-8 UPGRADES Site: TAB
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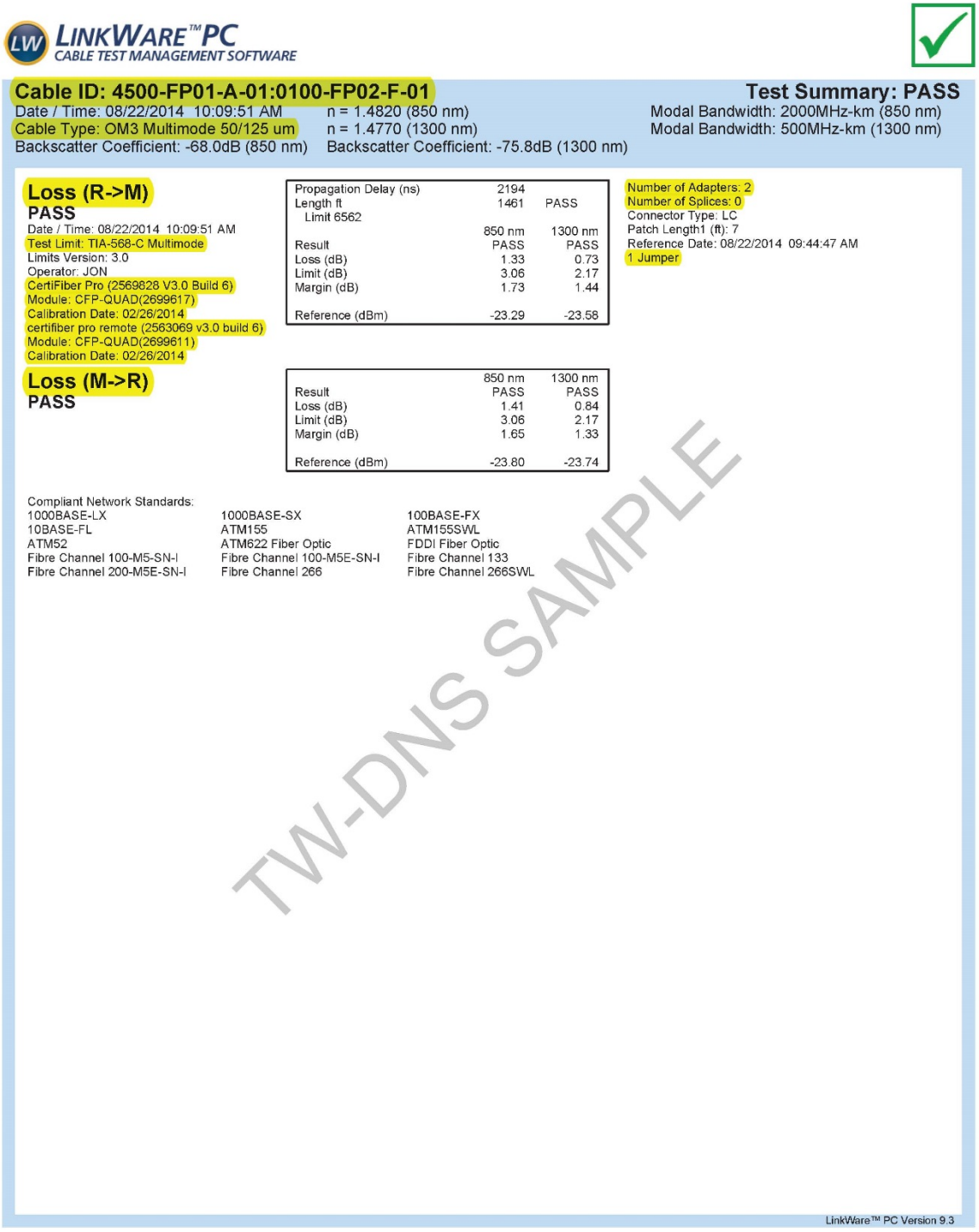
FLUKE networks



LINKWARE™ PC
CABLE TEST MANAGEMENT SOFTWARE

Cable ID: 4500-FP01-A-01:0100-FP02-F-01
Date / Time: 08/22/2014 10:09:51 AM
Cable Type: OM3 Multimode 50/125 um
Backscatter Coefficient: -68.0dB (850 nm)
n = 1.4820 (850 nm)
n = 1.4770 (1300 nm)
Backscatter Coefficient: -75.8dB (1300 nm)

Test Summary: PASS
Modal Bandwidth: 2000MHz-km (850 nm)
Modal Bandwidth: 500MHz-km (1300 nm)

Loss (R->M)
PASS
Date / Time: 08/22/2014 10:09:51 AM
Test Limit: TIA-568-C Multimode
Limits Version: 3.0
Operator: JON
CertiFiber Pro (2569828 V3.0 Build 6)
Module: CFP-QUAD(2699617)
Calibration Date: 02/26/2014
certifiber pro remote (2563069 v3.0 build 6)
Module: CFP-QUAD(2699611)
Calibration Date: 02/26/2014

Propagation Delay (ns)	2194	
Length ft	1461	PASS
Limit 6562		
	850 nm	1300 nm
Result	PASS	PASS
Loss (dB)	1.33	0.73
Limit (dB)	3.06	2.17
Margin (dB)	1.73	1.44
Reference (dBm)	-23.29	-23.58

Number of Adapters: 2
Number of Splices: 0
Connector Type: LC
Patch Length1 (ft): 7
Reference Date: 08/22/2014 09:44:47 AM
1 Jumper

Loss (M->R)
PASS

	850 nm	1300 nm
Result	PASS	PASS
Loss (dB)	1.41	0.84
Limit (dB)	3.06	2.17
Margin (dB)	1.65	1.33
Reference (dBm)	-23.80	-23.74

Compliant Network Standards:

1000BASE-LX	1000BASE-SX	100BASE-FX
10BASE-FL	ATM155	ATM155SWL
ATM52	ATM622 Fiber Optic	FDDI Fiber Optic
Fibre Channel 100-M5-SN-I	Fibre Channel 100-M5E-SN-I	Fibre Channel 133
Fibre Channel 200-M5E-SN-I	Fibre Channel 266	Fibre Channel 266SWL

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Project: 04FS-48WP, DIG 1-8 UPGRADES Site: TAB
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FLUKE networks

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

Checklist for Network/Server Closet

Site Acceptance Test (SAT)

Facility:	**Project Name:**
Contract No.:	**Network/Server Closet Tag:**
Building:	**Sub-Location:**
Consultant:	**Contractor:**
Date:	**TW DNS Staff:**

Network/Server Closet Layout and As-built Drawings

Procedure:

- Verify that the as-built drawings are present.
- Verify the cabinets 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 (fiber panel, power outlets)
- Verify the Rack mounted PDU, FANS operation.
- Verify ESA and CSA compliance
- Verify the grounding/Bonding.

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:

Network/Server closet Cabinet 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, Chimney, FANS, fiber Patch Panels, Power Distribution Components/PDU/ATS, UPS, power outlet etc.)		
5	All wiring labeled as per as-built drawings		
6	Chimney/FAN working properly		
7	UPS/ATS and PDU working properly		
8	CSA approval (label/sticker)		

9	ESA approval (label/sticker)		

Power Supply Verification

Procedure:

Verify that the power feedings are installed and labeled with the indicated rating and source and destination distribution panel, breaker position Id. Refer to as built network/server enclosure wiring diagrams for the required circuit protection and rating. Record the installed protection device rating.

If the indicated installed circuit protection device matches the required rating enter PASS in the test form column.

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:

Installed power feeding rating and receptacle type shall match the required specifications and labeled accordingly.

Network Cabinet AC Power and Tagging/Labeling Verification						
Circuit Breaker / Fuse ID	**Description**	**Required Rating**	**Installed Rating**	**Pass / Fail**	**Source / Destination ID**	**Notes**
120V AC UPS Power Supplementary Protectors						
SP01	UPS Receptacle	20A / L5-20R				
120V AC Hydro Power Supplementary Protectors						
SP01	Utility Receptacle	30A/ L5-30R 20A/5-20R				

Grounding & Bonding Verification

Procedure:

Verify the grounding wiring and connection in the cabinets that the indicated component is properly connected to the ground.

- Switch off system power.
- Verify the installation of the ground connection between the grounding bus or common ground terminal and the indicated component.
- Measure the DC resistance between the grounding bus or common ground terminal and the indicated component.
- Record the measured DC resistance between the ground connection and the component.

If the indicated grounding connection is installed and meets the maximum DC resistance specification enter a PASS in the test form column.

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:

The grounding or bonding conductor is installed and the DC resistance measurement must be less than or equal to 0.2 Ω between termination points.

Network/Server Closet Grounding & Bonding Verification				
Grounding / Termination Point	**Ground Conductor Visual Inspection**	**Resistance Ω Measured**	**Pass / Fail**	**Notes**
UPS Receptacle / Isolated Ground		Ω		
Utility Receptacle		Ω		
Enclosure Door /Side /Top Panel		Ω		
APC Power Bar		Ω		
PDU		Ω		

UPS, and BY pass switch, battery cabinet		Ω		
Rack Mount Ground Bus		Ω		
Conduit/Cable tray		Ω		

Copper and Fiber Cable Installation Verification

Network/Server Cabinet Copper and Fiber Cable Installation Verification			
Item No.	**Description**	**Pass/Fail**	**Notes**
1	Containment System (Conduit/Cable Tray/Pull Box etc.) Installed and Labelled.		
2	Copper Cable Manufacturer Allowed and Specified Minimum Bend Radius Maintained Throughout The Installation		
3	Fiber Cable Manufacturer Allowed and Specified Minimum Bend Radius Maintained Throughout The Installation		
4	Grounding and Bonding of Fiber Optic Cable (copper cabling only if applicable) Done and Tested.		
5	Velcro Cable Management (ties and tapes) used and horizontal and vertical manager provided per drawing		
6	Dust/Weather Proofing and Fire Stopping Done		
7	Others: Conduit Bushing Provided		

Spare Parts, Loose Shipped Components, Network Cabinets - Bill of Material Verification

Procedure:

Verify all spare parts and loose shipped components as required in the as-built drawings and bill of material are present. Typical items may be Fiber Optic Patch Cables etc.

Enter PASS in the test form column if parts are present.

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:

Spare parts and loose shipped components are present as required.

Spare Parts and Loose Shipped Items			
Item No.	**Description**	**Pass / Fail**	**Notes**
1	Drawings		
2	Fiber Optic Patch Cords		
3	Color icons		
4	Labeling		
5			

Network/Server Closet Cabinet Bill of Material					
Item No.	**Part No.**	**Manufacturer**	**Materials**	**Quantity**	**Checked**
1	JW843034	WRIGHTLINE	84"HX30"WX34.5"D WELDED PARAMOUNT FRAME Steel: Black	1	
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Checklist for Telecom Enclosure (TE)

Site Acceptance Test (SAT)

Facility:	**Project Name:**
Contract No.:	**Telecom Enclosure Tag:**
Building:	**Sub-Location:**
Consultant:	**Contractor:**
Date:	**TW DNS Staff:**

Telecom Enclosure (TE) 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 ESA and CSA compliance.
- Verify the horizontal and backbone fibre cable terminations and labeling.
- Verify the cabling pathway

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		
6	CSA approval (label/sticker)		

7	ESA approval (label/sticker)		

Power and Fusing Verification

Procedure:

Verify that the indicated circuit breakers or fuses are installed and labeled with the indicated rating and source and destination distribution panel, breaker position ID. Refer to as built Telecom Enclosure wiring diagrams for the required circuit protection and rating. Record the installed protection device rating.

If the indicated installed circuit protection device matches the required rating enter PASS in the test form column.

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:

Installed fuses and circuit breakers shall match the required specifications and labeled accordingly. The correct equipment is powered by the fuse and/or circuit breaker as shown on the as-built electrical drawings.

TE AC Power, Fusing and Tagging/Labeling Verification						
Circuit Breaker / Fuse ID	**Description**	**Required Rating**	**Installed Rating**	**Pass / Fail**	**Source / Destination ID**	**Notes**
120V AC UPS Power Supplementary Protectors						
SP02	UPS Receptacle and UPS Pilot Light (if applicable)	15A				
120V AC Hydro Power Supplementary Protectors						
SP01	Surge Suppressor and Utility Pilot Light (if applicable)	15A				
SP03	Panel Light	5A				

SP04	Utility Receptacle	15A				

Grounding & Bonding Verification

Procedure:

Verify that the indicated component is properly connected to the ground.

- Switch off system power.
- Verify the installation of the ground connection between the grounding bus or common ground terminal and the indicated component.
- Measure the DC resistance between the grounding bus or common ground terminal and the indicated component.
- Record the measured DC resistance between the ground connection and the component.

If the indicated grounding connection is installed and meets the maximum DC resistance specification enter a PASS in the test form column.

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:

The grounding or bonding conductor is installed and the DC resistance measurement must be less than or equal to 0.2 Ω between termination points.

Telecom Enclosure (TE) Grounding & Bonding Verification				
Grounding / Termination Point	**Ground Conductor Visual Inspection**	**Resistance Ω Measured**	**Pass / Fail**	**Notes**
Surge Suppressor		Ω		
UPS Receptacle / Isolated Ground		Ω		
Utility Receptacle		Ω		
Enclosure Door		Ω		

APC Power Bar		Ω		
Rack Mount Ground Bus		Ω		

Copper and Fiber Cable Installation Verification

Telecom Enclosure (TE) Copper and Fiber Cable Installation Verification			
Item No.	**Description**	**Pass/Fail**	**Notes**
1	Containment System (Conduit/Cable Tray/Pull Box etc.) Installed and Labelled.		
2	Copper Cable Manufacturer Allowed and Specified Minimum Bend Radius Maintained Throughout The Installation		
3	Fiber Cable Manufacturer Allowed and Specified Minimum Bend Radius Maintained Throughout The Installation		
4	Grounding and Bonding of Fiber Optic Cable (copper cabling only if applicable) Done and Tested.		
5	Velcro Cable Management (ties and tapes) Used		
6	Dust/Weather Proofing and Fire Stopping Done		
7	Others: TE Installed Height, NEMA Ratting, Thermoplastic Insulator or Bushing, Conduit Entrance Into TE, Etc.		

Spare Parts, Loose Shipped Components, TE - Bill of Material Verification

Procedure:

Verify all spare parts and loose shipped components as required in the as-built drawings and bill of material are present. Typical items may be Fiber Optic Patch Cables, Copper Patch Cables, etc.

Enter PASS in the test form column if parts are present.

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:

Spare parts and loose shipped components are present as required.

Spare Parts and Loose Shipped Items			
Item No.	**Description**	**Pass / Fail**	**Notes**
1	Drawings		
2	Fiber Optic Patch Cords		
3	Copper Patch Cords		
4	Color snap in ICONS/ ID TABS		
5			
6			
7			

SAT NOTES / COMMENTS

Notes Ref. No.	Notes / Comments

Approvals / Sign Off

Site Acceptance Test

City

Name : _____ Company: _____

Signature: _____ Date: _____

Consultant

Name : _____ Company: _____

Signature: _____ Date: _____

Contractor

Name : _____ Company: _____

Signature: _____ Date: _____

END OF DOCUMENT