

EDUCATIONAL SERVICE UNIT #13
HORIZONTAL CABLING SYSTEM
SPECIFICATION
APPENDIX A

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HORIZONTAL CABLING REQUIREMENTS

Part 1 - General

1.1 Work Included

- A. Provide all labor, materials, tools and equipment required for the complete installation of work called for in the Construction Documents

1.2 Scope of Work

- A. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling for the Educational Service Unit #13 (ESU13) Sidney NE, brand office Project. Horizontal cabling comprised of Copper and Optical Fiber Cabling, and support systems are covered under this document.
- B. The Horizontal (Telecommunications room and workstation) Cabling System shall consist of a minimum of (2) 4-pair Unshielded Twisted Pair (UTP) Copper Cables to each work area outlet unless otherwise noted for specific locations. The cables shall be installed from the Work Area Outlet to the Telecommunications Room (TR) located on the same floor and routed to the appropriate rack serving that area and terminated as specified in this document.
- C. This section includes minimum requirements for the following:
- UTP Cable from TR to Work Area
 - Optical Fiber from TR to Work Area
 - UTP/Fiber/Coax WA Patch Cords
 - Category 6 and 6A UTP Connector Modules
 - Optical Fiber Connector Modules
 - Faceplates and Modules
- D. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications contractor as detailed in this document.
- E. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types will be provided as an attachment to this document. If the bid documents are in conflict, this specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cable system described in this document.

1.3 Regulatory References

The following industry standards are the basis for the structured cabling system described in this document: TIA/EIA

- TIA/EIA-568-B Commercial Building Telecommunications Cabling standard
- TIA/EIA-568-B.1 General Requirements

- TIA/EIA-568-B.2 Balanced Twisted Pair Cabling Components Standard
- TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard
- TIA/EIA-569-A Commercial Building Standard for Telecom Pathways and spaces

Telecommunications

TIA/EIA-606 Administration Standard for the
Infrastructure of Commercial Buildings
TIA/EIA-607 Commercial Building Grounding/Bonding
Requirements

1. NFPA
 - NFPA 70 National Electric Code(NEC)
 2. ISO/IEC
 - ISO 11801 Generic Cabling for Customer Premises
- B. If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- C. This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

1.4 Quality Assurance

A. PANDUIT® **CERTIFICATION PLUS**SM System Warranty

1. A **CERTIFICATION PLUS** System Warranty shall provide a complete system warranty to guarantee end-to-end high-performance cabling systems that meet application requirements. The guarantee shall include cable and connectivity components and have one point of contact for all cabling system issues. The system shall be warranted for a period of at least 25 years.

B. PANDUIT® **Partner** Contractor Agreement

1. A current Panduit factory registered partner in good standing, with no less than 5 years of similar work in size shall complete network installation. The contractor shall have completed BCSI product and installation training. A copy of the Panduit current Contractor Registration Certificate and the contractors RCDD on staff certificate must be sent in with submittals.

C. Product Guarantee

1. All **PANDUIT PAN-NET**™ non-consumable products have a 25-year warranty. Cabling System will operate the application(s) for which the system was designed to support. Applications may include, but are not limited to:
 - 10/100/1000 Mbps Ethernet (IEEE 802.3)
 - 10 Gig Mdps Ethernet
 - SONET
 - FDDI/CDDI
 - Appletalk ISDN

2. In order to qualify for the guarantee, the structured cabling system must be installed per the following:

Meet all TIA/EIA commercial building wiring standards
Panduit categorized products must be used
Products must be installed to Panduit instruction sheets

Note: All Networks shall be installed per applicable standards and manufacturer's guidelines.

If any *PANDUIT PAN-NET™* product fails to perform as stated above, *PANDUIT* will provide new components at no charge.

THIS GUARANTEE IS MADE IN LIEU OF AND EXCLUDES ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED. THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR USE ARE SPECIFICALLY EXCLUDED. NEITHER SELLER NOR MANUFACTURER SHALL BE LIABLE FOR ANY OTHER INJURY, LOSS OR DAMAGE, WHETHER DIRECT OR CONSEQUENTIAL.

1.5 Approved Products:

- A. Approved UTP 4-pair cable manufacture Panduit Cables: PUP6C04**-W PUP6AV04**-W
- B. Approved high pair count UTP Cable manufacturer: General
- C. Approved Optical Fiber Cable manufacturer: Panduit/General
- D. Approved UTP connector product manufacturer: Panduit
- E. Approved Fiber Optic cabinet product manufacturer: Panduit
- F. Approved Fiber Optic connectors/splices/couplers: Panduit
- G. Approved Rack and Cabinet manufacturer: Panduit
- H. Approved Patch Panel manufacturer: Panduit
- I. Approved UTP Patch Cord manufacture: Panduit

1.6 Equivalent Products

- A. Panduit shall manufacture all products, including but not limited to cable management, faceplates, copper and fiber modules, patch panels, racks, 110 blocks, patch cords, labels and grounding lugs, for the purpose of this document. Panduit is the preferred manufacture of

all copper and optical fiber cable products. There will be no substitutions allowed at this time.

1.7 Work Area Subsystem

The Work Area shall consist of the connectivity equipment used to connect the horizontal cabling subsystem and the equipment in the work area. Both copper and fiber media shall be supported. The connectivity equipment shall include the following options:

- Patch (equipment) cords and modular connectors
- Outlets and surface mount boxes
- Surface raceway and outlet poles

1.8 Horizontal Structured Cabling

1. Copper

The **PANDUIT MINI-COM® Network Cabling System or equivalent** shall be used for the Work Area subsystem, including all modular connectors. The network cabling system shall be comprised of modular connectors in support of high-speed networks and applications designed for implementation on copper cabling. All outlets shall utilize fully interchangeable and individual connector modules that mount side-by-side to facilitate quick and easy moves, adds and changes.

2. The modular connectors and patch cords will be chosen to match the horizontal cabling medium and rating. The same manufacturer shall provide the modular connectors and patch cords. The total patch cord length at the work area is not to exceed 3 meters (10 ft). Exception: When implementing an open office cabling system as specified under TIA/EIA TSB-75 (see section 3.4).

1.9 Copper Cables Category 6 and Category 6A UTP and Jacks

MINI-COM® Modules shall be Category 6 or 6A modules featuring *GIGA-TX™* Technology. The eight position modules shall be used in all work areas and shall exceed the connector requirements of the TIA/EIA Category 6 and 6A standard. Termination shall be accomplished by use of a forward motion termination cap and shall not require the use of a punch-down tool. The termination cap shall provide strain relief on the cable jacket, ensure cable twists are maintained to within 1/8" (3.18 mm) and include a wiring scheme label. The wiring scheme label shall be available with both T568A and T568B wiring schemes. All terminations for this project shall use the T568B(A) wiring scheme. The modules shall be universal in design, including complying with the intermateability standard IEC 60603-7 for backward compatibility. Category 6 and 6A modules shall have UL and CSA approval. The modules shall have ETL verified to performance and ISO Class E performance (as defined in ISO/IEC 11801) in both the basic and channel links. They shall be universal in design, accepting 2, 3, or 4 pair modular plugs without damage to the outer jack contacts. The modules shall be able to be re-terminated a minimum of 10 times and be available in 11 standard colors for color coding purposes. The jack shall snap into all *MINI-COM* outlets and patch panels. The module shall include a black base to signify Category 6A 500 MHz performance.

Approved Connectors:

- A. CJ688TG**
- B. CJ6X88TG**
- C. FP6X88MTG

** designates color

Note:

Cat 6A will be used for Cameras and all Wireless Access Points

Cat 6 will be used for all other

1.10 Copper Patch Cables Category 6 and Category 6A

Category 6 and 6A Patch Cords shall be factory terminated with modular plugs featuring a one-piece, tangle-free latch design and black strain-relief boots to support easy moves, adds and changes and be 100% factory tested to component limits. They shall be constructed of 28 AWG to support 96 meters of channel when using 6m of patch cord; derating factor: 1.9. Must meet current TIA/EIA standards. The patch cords shall come in standard lengths of 3, 5, 7, 9 14, and 20 feet and 6 standard colors of Off White, Black, Blue, Green, Red and Yellow.

1.11 Additional Copper Cabling Connectors

Additional *MINI-COM*® Modules for copper shall include the following:

- 50 and 75 Ohm BNC coax coupler modules, male-male
- F-Type coax coupler module, male-male threaded
- RCA connector modules with black, red, yellow, and white inserts
 - Solder, pass through and punch-down termination types
- S-Video connectors modules - coupler and punch-down termination types
- Blank module to reserve space for future additions

The connectors shall snap into all *MINI-COM* outlets and patch panels.

Approves Connects:

- A. CMHDM**
- B. CMUSBAA**
- C. CM35MSC**Y
- D. CM35MSS**
- E. CMF**
- F. CMFSR**Y

** - designates color

1.12 Fiber Optics Cable, Fiber Adapter Panels and Connectors

The PANDUIT Opti-Core in building fiber network shall be used for all areas requiring a fiber backbone. The network cabling system shall be comprised of PANDUIT Optic-Core Fiber and Panduit connectors, fusion splice connectors and pigtails to provide an end to end Panduit solution. This fiber system will support a high-speed networks and applications designed for implementation on

multimode 50/125 μm OM4 glass fiber cabling to support speeds of the network of 10 Gig per IEEE 802.3ae 10 GbE standards; backwards compatible for use with all 50/125 systems. Fiber adapter panels must meet TIA/EIA-604 FOCIS-3 and Exceed TIA/EIA-568C requirements. All fiber adapter panels will be marked for quick traceability. All Opti-Core Pigtail tails connectors shall be tested 100% with a max insertion loss of 0.30dB. See TIA/EIA-568-C.3 for suggested color and identification scheme. Panduit® Fusion Splice-On Connectors can be used in place of the the fusion splice pigtails. The Panduit Fusion splice connectors are designed for ease of use and speedy termination. These products enable technicians to create custom fiber links with minimal labor and no risk of shortages or excessive cable to be managed.

Approves Connects and fiber solution:
A. FOPPZ12Y

Note: Fiber run will be the only backbone between closets Room #119-
Room #109

1.13 Outlets and Surface Mount Boxes

The outlets and surface mount boxes shall support the network system by providing high-density in-wall, surface mount or modular office furniture cabling applications. The outlets consist of faceplates for flush and recessed in-wall mounting as well as mounting to the modular office furniture systems. The surface mount boxes can be mounted where in-wall applications are not possible or to support applications where surface mount is the best option.

All outlets shall utilize fully the interchangeable and individual *MINI-COM*® connector modules that mount side by side to facilitate quick any easy moves, adds and changes. All outlets shall be manufactured from high-impact thermoplastic material with a U.L. flammability rating of 94 HB or better. All outlets and surface mount boxes shall be available in 5 colors including Off White (IW), Electrical Ivory (EI), White (WH), International Gray (IG) and Black (BL).

1.14 Stainless Steel Outlets & Surface Mount Boxes

MINI-COM Stainless Steel Faceplates shall be **2, 4 and 6 port vertical single gang** faceplates with combination head stainless steel screws. The faceplates shall mount to standard U.S. NEMA boxes and adapters with screw to screw dimensions of 3.28" (83.3mm). Faceplates shall be flush mounted for clean look. Stainless steel material shall be riveted to high impact ABS backing to provide a durable faceplate with brush finish. Each faceplate shall accept individual copper and fiber optic connector modules that can be individually inserted and removed as required. Surface Mount Boxes

Approved Stainless Steel Face Plates

- A. CFPL2SY
- B. CFPL4SY
- C. CFPI6SY

Approved Surface Mount Box

- A. CBXQ2**-A

** - designates color

1.15 Patch Panels

MINI-COM® Modular Patch Panels shall be modular in design, fully populated, accepting all *MINI-COM* modules. I

Approved Patch Panels

- A. CPPL24WBLY
- B. CPPL48WBLY

1.16 Fiber Enclosures Connectors

OPTICOM™ Rack mounted fiber optic enclosures shall be designed to manage and organize fiber optic cable to and from the equipment or cabling plant. Enclosures shall protect fiber optic connections for patching or splicing requirements. Enclosures shall accommodate up to 96 fibers with LC jack per rack 1RU space and shall be constructed of steel material. Enclosures shall have removable front and rear covers and top and bottom pass through holes.

Approved Fiber Enclosures

- A. FRME1U
- B. FRME2U

1.17 Rack System and Cable Management Systems:

Cable Racking Systems shall be provided using the Panduit 2 and 4 post racks with vertical cable management systems and accessories that supports heavy equipment and high capacity cable for cross connect or interconnect applications in a telecommunications closet. The Rack system shall be modular and support copper and fiber cables. The rack system solution shall be constructed of steel material and support up to 1500 pounds of load and accommodate 19" components. The 4-post and the 2 post rack systems shall have independent rails front and rear, printed Rackspace identification on the rails per TIA 606. Paint piercing washers must be installed to ensure electrically bond is created to simplify grounding of the racks. The Rack system shall meet all EIA requirements as defined in EIA-310-D.

Approved Racks and Cable Management Systems

- A. R4P
- B. N8512B

1.18 Vertical and Horizontal Cable Management

Vertical cable managers shall have push to close doors, with curved fingers to supports cables as they transition to vertical pathways. The

individual fingers must align with rack spaces to simplify cable routing changes. The integral bend radius must help control cable management to help ensure network performance and system reliability. The Vertical cable management system must have the ability to accept optional snap on vertical retainers and optional slack management spools to help organize and manage patch cords.

Horizontal cable managers shall include components that aid in routing, managing and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases with PVC duct attached. The duct fingers shall include retaining tabs to retain the cables in place during cover removal. The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.

Approved Vertical and Horizontal Cable Managers

A. PR2VD08

B. WMP1E

**designates size of manager 06, 08, 10, 12 inches

1.19 Grounding and Bonding

The facility shall be equipped with a Telecommunications Bonding Backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.

The main entrance facility/equipment room in each building shall be equipped with a telecommunications main grounding bus bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bus bar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.

All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TR or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors.

All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the System Documentation Section of this specification.

1.20 Firestop

A firestop 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 firestop system. This requirement applies to through penetrations (complete penetration) and membrane penetrations (through one side of a hollow fire rated structure). Any penetrating item i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly firestopped.

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 firestop system, stamped/embossed by the PE shall be provided to the Owner's Technical Representative prior to installing the firestop system(s).

Part 2 - Execution

2.1 Work Area Outlets

Cables shall be coiled in the in-wall or surface-mount boxes if adequate space is present to house the cable coil without exceeding the manufacturer's bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12" of UTP and 36" of fiber slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack shall be loosely coiled and stored in the ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-A document, manufacturer's recommendations and best industry practices. Pair untwist at the termination shall not exceed 3.18mm (0.125 inch).

Bend radius of the cable in the termination area shall not be less than 4 times the outside diameter of the cable.

The cable jacket shall be maintained to within 25mm (one inch) of the termination point.

Data jacks, unless otherwise noted in drawings, shall be located in the bottom position(s) of each faceplate. Data jacks in horizontally oriented faceplates shall occupy the right-most position(s).

Voice jacks shall occupy the top position(s) on the faceplate. Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).

2.2 Horizontal Distribution Cable Installation

Cable shall be installed in accordance with manufacturer's recommendations and best industry practices.

A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

Cable raceways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular raceway type or 40%.

Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.

Where transition points, or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

The cable's minimum bend radius and maximum pulling tension shall not be exceeded.

If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 to 60 inch (1.2 to 1.5 meter) intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.

Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.

Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.

Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the contractor prior to final acceptance at no cost to the Owner.

Cables shall be identified by a self-adhesive label in accordance with the System Documentation Section of this specification and ANSI/TIA/EIA-606. The cable label shall be applied to the cable behind the faceplate on a section of cable that can be accessed by removing the cover plate.

Unshielded twisted pair cable shall be installed so that there are no bends smaller than four times the cable outside diameter at any point in the run and at the termination field.

Pulling tension on 4-pair UTP cables shall not exceed 25-lbf for a four-pair UTP cable.

2.3 Horizontal Cross connect Installation

Cables shall be dressed and terminated in accordance with the recommendations made in the TIA/EIA-568-A standard, manufacturer's recommendations and best industry practices.

Pair untwist at the termination shall not exceed 3.18 mm (0.125 inch).

Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

The cable jacket shall be maintained as close as possible to the termination point.

Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

2.4 Optical Fiber Termination Hardware

Fiber slack shall be neatly coiled within the fiber splice tray or enclosure. No slack loops shall be allowed external to the fiber panel.

Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.

Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.

Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.

A maximum of 12 strands of fiber shall be terminated by the way of fusion splicing

2.5 Backbone Cable Installation

Backbone cables shall be installed separately from horizontal distribution cables

A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.

Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits

Where cables are installed in an air return plenum, riser rated cable shall be installed in metallic conduit.

Where backbone cables and distribution cables are installed in a cable tray or wireway, backbone cables shall be installed first and bundled separately from the horizontal distribution cables.

All backbone cables shall be securely fastened to the sidewall of the TR on each floor.

Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip and on alternating floors or as required by local codes.

Vertical runs of cable shall be supported to messenger strand, cable ladder, or other method to provide proper support for the weight of the cable.

Large bundles of cables and/or heavy cables shall be attached using metal clamps and/or metal banding to support the cables.

2.6 Copper Termination Hardware

Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-A standard, manufacturer's recommendations and best industry practice.

Pair untwist at the termination shall not exceed 3.18mm (0.125 inch).

Bend radius of the cable in the termination area shall not exceed 4 times the outside diameter of the cable.

Cables shall be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.

The cable jacket shall be maintained to within 25 mm (one inch) of the termination point.

Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within the bundle, where the label is obscured from view shall not be acceptable.

2.7 Racks

Racks shall be securely attached to the concrete floor using minimum 3/8" hardware or as required by local codes.

Racks shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks and from the wall at each end of the row.

All racks shall be grounded to the telecommunications ground bus bar in accordance with Section 2.4 of this document.

Rack mount screws not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.

Wall mounted termination block fields shall be mounted on 4' x 8' x .75" void free plywood. The plywood shall be mounted vertically 12" above the finished floor. The plywood shall be painted with two coats of white fire retardant paint.

Wall mounted termination block fields shall be installed with the lowest edge of the mounting frame 18" from the finished floor.

2.8 Firestop System

All firestop systems shall be installed in accordance with the manufacturer's recommendations and shall be completely installed and available for inspection by the local inspection authorities prior to cable system acceptance.

2.9 Grounding System

The TBB shall be designed and/or approved by a qualified PE, licensed in the state that the work is to be performed. The TBB shall adhere to the recommendations of the TIA/EIA-607 standard and shall be installed in accordance with best industry practice.

A licensed electrical contractor shall perform installation and termination of the main bonding conductor to the building service entrance ground.

2.10 Identification and Labeling

- A. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
- B. All label printing will be machine generated by Panduit TDP43ME printers or equivalent using indelible ink ribbons and/or cartridges. Faceplate labels should be polyester, non-adhesive, and white in color. Patch panel label shall be polyester non-adhesive, white in color. Wrap around labels should be thermal transfer self-laminating, vinyl, and white in color.

Approved Panduit Labeling:

- C061X030YPT
- C261X035Y1T
- S100X150VATV

2.11 Testing and Acceptance

A. General

1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA/EIA-568-A Addendum 5, TSB-67 and TSB-95. 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.
2. All cables shall be tested in accordance with this document, the ANSI/TIA/EIA standards, the PANDUIT® **CERTIFICATION PLUS**SM System Warranty guidelines and best industry practice. If any of these are in conflict, the Contractor shall bring any discrepancies to the attention of the project team for clarification and resolution.

B. Copper Channel Testing

All twisted-pair copper cable links shall be tested for continuity, pair reversals, shorts, opens and performance as indicated below. Additional

testing is required to verify Category performance. Horizontal cabling shall be tested using a level IIe or level III test unit for category 5e or category 6 performance compliance, respectively.

Continuity - Each pair of each installed cable shall be tested using a test unit that shows opens, shorts, polarity and pair-reversals, crossed pairs and split pairs. Shielded/screened cables shall be tested with a device that verifies shield continuity in addition to the above stated tests. The test shall be recorded as pass/fail as indicated by the test unit in accordance with the manufacturers' recommended procedures and referenced to the appropriate cable identification number and circuit or pair number. Any faults in the wiring shall be corrected and the cable re-tested prior to final acceptance.

Length - Each installed cable link shall be tested for installed length using a TDR type device. The cables shall be tested from patch panel to patch panel, block to block, patch panel to outlet or block to outlet as appropriate. The cable length shall conform to the maximum distances set forth in the ANSI/TIA/EIA-568-A Standard. Cable lengths shall be recorded, referencing the cable identification number and circuit or pair number. For multi-pair cables, the shortest pair length shall be recorded as the length for the cable.

Category 5e & 6 Performance

Follow the Standards requirements established in:

- ANSI/TIA/EIA-568-A -TSB-67
- ANSI/TIA/EIA-568-A -TSB-95
- ANSI/TIA/EIA-568-A, Amendment 5.

A DSX2-8000QOI or equivalent test unit is required to verify category 6 performances.

The four basic tests required in TSB-67 are:

- Wire Map
- Length
- Attenuation
- NEXT (Near end crosstalk)

Four additional tests are required per TSB-95:

- Return Loss
- ELFEXT Loss
- Propagation Delay
- Delay skew

In Amendment 5, two additional tests are required:

- PSNEXT (Power sum near-end crosstalk loss)
- PSELFEXT (Power sum equal level far-end crosstalk loss)

C. Fiber Testing

1. All fiber testing shall be performed on all fibers in the completed end-to-end system. Test unit to be **Fluke OptiFiber Pro OTDR** or equivalent. Testing shall consist of an end-to-end power meter test performed per TIA/EIA-455-53A. The system loss measurements shall be provided at 850 and/or 1300 nanometers for multimode fibers and 1310 and/or 1550 nanometers for single mode fibers. These tests also include continuity checking of each fiber.

For horizontal cabling system using multimode optical fiber, attenuation shall be measured in one direction at either 850 nanometer (nm) or 1300 nm using an LED light source and power meter.

Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for singlemode) in one direction.

Test set-up and performance shall be conducted in accordance with ANSI/TIA/EIA-526-14 Standard, Method B.

Where links are combined to complete a circuit between devices, the Contractor shall test each link from end to end to ensure the performance of the system. ONLY BASIC LINK TEST IS REQUIRED. The contractor can optionally install patch cords to complete the circuit and then test the entire channel. The test method shall be the same used for the test described above. The values for calculating loss shall be those defined in the ANSI/TIA/EIA Standard.

Attenuation testing shall be performed with a stable launch condition using two-meter jumpers to attach the test equipment to the cable plant. The light source shall be left in place after calibration and the power meter moved to the far end to take measurements.

2.12 System Documentation

- A. Upon completion of the installation, the telecommunications contractor shall provide three (3) full documentation sets to the Owner for approval. Documentation shall include the items detailed in the sub-sections below.
- B. Documentation shall be submitted within ten (30) working days of the completion of each testing phase. This is inclusive of all test results and draft as-built drawings. Draft drawings may include annotations done by hand. Machine generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the Engineer, the telecommunications contractor shall provide copies of the original test results.
- C. The owner may request that a 10% random field re-test be conducted on the cable system, at no additional cost, to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the telecommunications contractor, additional testing can be requested to the extent determined necessary by the Engineer, including a 100% re-test. This re-test shall be at no additional cost to the Owner.
- D. **Test Results** documentation shall be provided on disk within three weeks after the completion of the project. The disk shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or outlet) I.D., measurement direction, reference setup, and crew member name(s). The test equipment name, manufacturer, model number, serial number, software version and last calibration date will also be

provided at the end of the document. Unless the manufacturer specifies a more frequent calibration cycle, an annual calibration cycle is anticipated on all test equipment used for this installation. The test document shall detail the test method used and the specific settings of the equipment during the test as well as the software version being used in the field test equipment.

- E. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-A including applicable TSB's and amendments. The appropriate level IIe tester shall be used to verify Category 5e cabling systems. The appropriate level III tester shall be used to verify Category 6 cabling systems.
- F. Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package. Alternately, the telecommunications contractor may furnish this information in electronic form of USB flash drive. It shall contain the electronic equivalent of the test results as defined by the bid specification and be of a format readable as a PDF.
- G. When repairs and re-tests are performed, the problem found and corrective action taken shall be noted, and both the failed and passed test data shall be documented.
- H. The **As-Built** drawings are to include cable routes and outlet locations. Their sequential number as defined elsewhere in this document shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic formats on which as-built construction information can be added. These documents will be modified accordingly by the telecommunications contractor to denote as-built information as defined above and returned to the Owner.
- I. The Contractors shall annotate the base drawings and return a electronic form.

END OF SECTION