

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
INFORMATION TECHNOLOGY
NETWORK & COMMUNICATIONS SERVICES

INFRASTRUCTURE DESIGN & WIRING STANDARDS



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PART 1 - GENERAL SPECIFICATIONS

1.1 SCOPE

This document describes the standards, products and execution requirements relating to furnishing and installing Telecommunications Cabling at new or remodeled buildings for the Washington Metropolitan Area Transit Authority, herein after called WMATA. These standards are provided for use in planning spaces, budgeting for communications infrastructure, and as a technical description suitable for use in Requests for Proposals.

These standards, used in conjunction with published current ANSI/TIA standards represent a structured communications wiring system which will accommodate technological developments over the next several years. As technology changes this document will be amended to provide the most current and effective information available. Any aspects of communications wiring or design, which are not sufficiently addressed in this document, shall be brought to the attention of Network Technology Operations & Infrastructure Design (IT-NCSInfrastructure@wmata.com) in the department of Information Technology, Network and Communications Services.

1. Backbone and horizontal cabling comprised of copper and fiber cabling, and support systems are covered under this document.
2. The Horizontal (workstation) Cabling System shall consist of a minimum of two (2) 4-pair category 6 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.
3. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications contractor/installer as detailed in this document unless otherwise noted.
4. Product specifications, general design considerations, and installation guidelines are provided in this document. Typical installation details, cable routing and outlet types will be provided as an attachment to this document. If bid documents are in conflict, this specification shall take precedence. The contractor/installer shall meet or exceed all requirements for the cable system described in this document.

1.2 REGULATORY REFERENCES:

All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the local Electrical Code and present manufacturing standards.

All materials shall be UL Listed and shall be marked as such. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled. The cabling system described in this document is derived from the recommendations made in recognized telecommunications industry standards. The following documents are incorporated by reference:

1. ANSI/TIA-568-C.0, Generic Communications Cabling for Customer Premises, February 2009
2. ANSI/TIA - 568-C.1, Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
3. ANSI/TIA - 568-C.2, Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components
4. ANSI/TIA - 568-C.3, Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components
5. 5. ANSI/TIA – 569-C, Commercial Building Standard for Telecommunications Pathways and Spaces,
6. TIA-527, Measurement of Optical Power Loss of Installed Single-mode Fiber Cable Plant – OFSTP-7

7. TIA-526-14-A, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant - OFSTP-14A
8. TIA-598-C, Optical Fiber Cable color Coding, January, 2005
9. ANSI/TIA – 570-B, Residential Telecommunications Infrastructure Standard, April 2004
10. ANSI/TIA – 606 - B, Administration Standard for Commercial Telecommunications Infrastructure April 2012
11. ANSI/TIA- 607-B - Commercial Building Bonding and Grounding (Earthing) Requirements for Telecommunications, August 2011
12. TIA– 758-A, Customer-Owned Outside Plant Telecommunications Infrastructure Standard, August 2004
13. BICSI - TDMM, Building Industries Consulting Services International, Telecommunications Distribution Methods Manual (TDMM) – 13th Edition, 2014
14. National Fire Protection Agency (NFPA – 70),
15. National Electrical Code (NEC) -2014
16. National Fire Protection Agency (NFPA-130) Standard for Fixed Guideway Transit and Passenger Rail Systems, 2010

If this document or any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The contractor/installer has the responsibility to determine and adhere to the most recent release when installing or designing for installation.

This document does not replace any code, either partially or wholly. The contractor/installer must be aware of local codes which may have an impact on the design or installation of any cabling.

1.3 APPROVED CONTRACTOR

The Telecommunications contractor must be an approved Legrand/Ortronics Certified Installer at a CIP or CIP-ESP level. A copy of certification documents must be submitted initially to this office (IT-NCSInfrastructure@wmata.com). The Telecommunications contractor/installer is responsible for workmanship and installation practices in accordance with the Legrand/Ortronics Certification Program. Legrand/Ortronics/Superior Essex will extend an nCompass Limited Lifetime warranty to the end user once the Telecommunications contractor/installer fulfills all requirements under Legrand/Ortronics Certification Program. The contractor must be in good standing with a minimum of 30 percent of the technicians on site and at least one manager current with the required training. **See Appendix A, Legrand/Ortronics Certified Installation Contractors.**

1.4 APPROVED PRODUCTS

Superior Essex and Legrand/Ortronics have been listed here as a WMATA preferred solution; however any other manufacture’s solution meeting or exceeding the listed criteria may be submitted for review and approval. Any solution submitted must also be capable of providing a manufacturers warranty equal to, or greater than the preferred Superior Essex-Legrand/Ortronics nCompass solution. **See Appendix B, Approved Material List. This is not an all-inclusive list and represents our most commonly used products.**

1.5 WORK INCLUDED

The work included under this design standard consists of furnishing all labor, equipment, materials, and supplies and performing all operations necessary to complete the installation of this structured cabling system in compliance with the specifications and drawings. The Telecommunications contractor/installer will provide and install all of the required material to form a complete system whether specifically addressed in the technical specifications or not.

The work shall include, but not be limited to the following:

- Furnish and install a complete telecommunications wiring infrastructure
- Furnish, install, and terminate all UTP and Optical Fiber cable
- Furnish and install all wall plates, jacks, patch panels, and patch cords

- Furnish and install all required cabinets and/or racks as required and as indicated
- Furnish any other material required to form a complete system
- Perform link or channel testing (100% of horizontal and/or backbone links/channels) and certification of all components
- Furnish test results of all cabling to the owner on compact disk and paper format, listed by each closet, then by workstation ID
- Adhere and comply with all requirements of Legrand/Ortronics Certification program
- Provide owner training and documentation. (Testing documentation and As-built drawings)

1.6 SUBMITTALS

Under the provisions of this design and wiring standard, prior to the start of work the telecommunications contractor/installer shall:

- Submit copies of the certification of the company and names of staff that will be performing the installation and termination of the installation to provide proof of compliance of this design and installation standard.
- Submit proof from manufacturer of contractor's good standing in manufacturer's program. This certification must be completed annually and submitted to this office (IT-NCSInfrastructure@wmata.com).
- Submit appropriate cut sheets and samples for all products, hardware and cabling.
- Work shall not proceed without the Owner's approval of the submitted items.
- The telecommunications contractor/installer shall receive approval from the Owners on all substitutions of material. No substituted materials shall be installed except by written approval from the Owner and this office.

1.7 QUALITY ASSURANCE

The Legrand/Ortronics CIP / CIP-ESP telecommunications contractor/installer shall be a company specializing in communication cabling installation. The contractor must be in good standing with a minimum of 30% of the technicians on site and at least one manager current with the required training.

IT/NCS Cable Installation Quality Control Process

1. QA Phase 1
 - IT/NCS Cable Installation Practices. Inspections will ensure the following conform to TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
 - Cable bend radius
 - Cable support in ceiling (Hangers/J hooks/ladder racks)
 - Cable slack at the work area and the TR
 - TR Configuration (Proper cable placement based on scope of work)
2. QA Phase 2
 - IT/NCS Cable Termination Practices. Inspections will ensure the following conform to TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
 - Correct type, style and color of work area outlet
 - Correct jack pin out configuration
 - Correct TR termination: Pin out, Hardware and placement
 - Correct backbone termination
3. QA Phase 3
 - IT/NCS Cable Installation Practices. Inspections will ensure the following conform to TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
 - Final check of horizontal / Backbone cable route
 - Correct racks/enclosure installation. Type and placement
 - Overall progress
4. QA Phase 4 (Final)
 - IT/NCS Final Testing and Inspection. Inspections will ensure the following conform to

- TIA/EIA, WMATA Design & Wiring Standards, and all Local codes
- Complete work area installation, including work area outlets, face plates and label
- Complete TR installation. Hardware installation, correct labeling, installation, type and the complete installation of all wire management
- Complete Backbone cable installation, termination and labeling
- View a percentage of the actual field testing to ensure correct procedures are being adhered to and the proper test equipment is being used

Final sign off: IT/NCS will sign a document provided by the telecommunications contractor/installer approving the installation process and materials demonstrated in this project.

1.8 DELIVERY, STORAGE AND HANDLING

- Delivery and receipt of products shall be at the contractor's main place of business/office.
- WMATA will not be responsible for the acceptance or delivery of any materials.
- Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F. minimum) location. If necessary, cable shall be stored off site at the contractor's expense.
- If the telecommunications contractor/installer wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.

1.9 DRAWINGS

- It shall be understood that the electrical details and drawings provided with the specification package are diagrammatic. They are included to show the intent of the specifications and to aid the telecommunications contractor/installer in bidding the job. The telecommunications contractor/installer shall make allowance in the bid proposal to cover whatever work is required to comply with the intent of the plans and specifications.
- The telecommunications contractor/installer shall verify all dimensions at the site and be responsible for their accuracy.
- Prior to submission of any bid package, the telecommunications contractor/installer shall call to the attention of the Engineer of any materials or apparatus the telecommunications contractor/installer believes to be inadequate and to any necessary items of work omitted.

PART 2 – PRODUCTS

2.1 EQUIVALENT PRODUCTS

Due to the nature and type of communications, all products including but not limited to faceplates, jacks, patch panels, racks, 110 blocks, and patch cords, for the purpose of this document, shall be manufactured by Legrand/Ortronics. All copper and optical fiber cable products shall be manufactured by Superior Essex. Substitutions meeting or exceeding the listed criteria may be submitted for review and approval. Any solution submitted must also be capable of providing a manufacturer's warranty equal to, or greater than the preferred Superior Essex-Legrand/Ortronics nCompass solution.

2.2 WORK AREA OUTLETS

Work area cables shall each be terminated at their designated work area location in the connector types described in section 1.4, Approved Products.

The Telecommunications Outlet Assembly shall accommodate:

- A minimum of two (2) modular jacks
- Additional accommodations for specific locations as noted in the plans for optical fiber and/or additional copper cables as necessary.
- A blank filler will be installed when extra ports are not used.
- A dust cap shall be provided on all modular jacks with the circuit number on the identifier strip.
- Multiple jacks that are identified in close proximity on the drawings (but not separated by a physical barrier) may not be combined in a single assembly unless pre-approved through the use of a Request for Information (ROI). The telecommunications contractor/installer shall be responsible for determining the optimum compliant configuration based on the products proposed.
- The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the telecommunications contractor shall submit the proposed configuration for each outlet assembly for review by the Owner.
- The modular jack shall incorporate printed label strip on the dust cap module for the purpose of identifying the outlet. Printed labels shall be permanent and compliant with ANSI/TIA-606-B standard specifications. Labels shall be printed using Legrand/Ortronics label template or using a printer such as a Dymo or Brady hand held printer. Hand printed labels shall not be accepted.

Faceplates: The faceplates shall:

- Be as described in section 1.4, Approved Products
- Be UL listed and CSA certified
- Be constructed of high impact, ABS plastic UL 94V-0 construction (except where noted otherwise)
- Shall match the faceplate color used for other utilities in the building or match the color of the raceway if installed in surface raceway
- Be compliant with the above requirements along with the following when incorporating optical fiber
- Be a low profile assembly
- Incorporate a mechanism for storage of cable and fiber slack needed for termination
- Position the fiber optic couplings to face downward or at a downward angle to prevent contamination
- Incorporate a shroud that protects the optical couplings from impact damage
- Be available as single-gang or dual-gang
- Shall provide easy access for adds, moves, and changes by front removal of jack modules
- Possess recessed designation windows to facilitate labeling and identification
- Shall include a clear plastic cover to protect labels in the designation window
- Have mounting screws located under recessed designation windows
- Comply with ANSI/TIA-606-B work area labeling standard
- Allow for the UTP modules to be inverted in place for termination purposes

Voice / Data Jacks/Outlets

- Voice/Data jacks shall be 8-position modular jacks and shall be Category 6 performance as defined by the references in this document including ANSI/TIA-568-C.2. All pair combinations must be considered, with the worst-case measurement being the basis for compliance
- Be as described in section 1.4, Approved Products
- The modular jack shall be backwards compatible to Category 3, 5, and 5e
- All horizontal category 6 user end outlet cable will be terminated on a category 6 rated patch panel
- User end outlets are utilized for both voice and/or data connectivity
- 568B pin out configuration to be used

2.3 110 COPPER TERMINATION BLOCK

The copper cross connect shall be a passive connection between the horizontal termination patch panels and the backbone termination blocks. The wall mount frames shall be field terminated kits including all blocks, connecting blocks, and designation strips. Management rings shall be mounted between vertical columns of blocks to provide management of cross-connect wire. Backbone blocks shall use 5-pair connecting blocks.

110 Block Kits shall

- Include both the wiring block in a 50, 100 and 300 pair footprint
- Be OR-110ABC6050, OR-110ABC6100 AND OR-110ABC6300
- Be as described in section 1.4, Approved Products
- Support termination of 22-24 AWG solid conductor
- Wiring block shall contain back openings for the feed through of cable
- Have color-coded tips on the wiring block and color coding on the connector blocks for installation identification
- Shall use standard termination practice requiring a single conductor 110 impact tool
- Termination hardware shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires
- Be labeled in compliance with ANSI/TIA-606-B labeling specifications using permanent labels and Ortronics 110 block template (or other labeling software/printer)

110 Cross-Connect System Backboard Channels Shall

- Be available in 300 and 900 pair sizes
- Allow the mounting of 110 100-pair blocks without legs
- Include bottom trough and grounding bar
- Be wall mountable

110 Wall Mount Vertical Trough Shall

- Be available in single channel or dual channel configurations
- Be in dual channel configuration shall be used to provide separation for different wiring media
- Be available in 300 pair and 900 pair sizes
- Be wall mountable
- Be used with wall mountable backboard channels. Acceptable configurations include a 300 pair and a 900 pair

2.4 MODULAR PATCH PANELS

The Modular Patch Panels shall

- Meet category 6 component compliance
- Be as described in section 1.4, Approved Products
- Require standard termination practices using a 110 impact tool
- Use a single piece IDC housing designed to accept larger Category 6 conductors
- Support both T568B and T568A wiring
- Include easy to follow wiring labels
- Include label fields

- Allow for the use of icons
- Include full length metal rear cable management
- Be available in standard or high density
- Be backward compatible to category 3, 5 and 5e

2.5 RACKS

All racks and wire management shall be Legrand/Ortronics specific. The equipment rack shall provide vertical cable management and support for the patch cords at the front of the rack and wire management, support, and protection for the horizontal cables inside the legs of the rack. Waterfall cable management shall be provided at the top of the rack for patch cords and for horizontal cables entering the rack channels for protection and to maintain proper bend radius and cable support. Wire management shall also be mounted above each patch panel and/or piece of equipment on the rack. The rack shall include mounting brackets for cable tray ladder rack to mount to the top of the rack. Velcro cable ties shall be provided inside the rack channels to support the horizontal cable. Rack shall be black in color to match the patch panels and cable management.

Free-Standing Rack

Free-standing rack shall:

- Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA-568-C
- Have top cable trough with waterfall and built in patch/horizontal cable distribution separator
- Have EIA hole pattern on front and rear
- Be available with a 6.5" (165 mm) channel depth
- Be available with hook and loop straps for securing bulk cables inside the vertical U-channels
- Assemble as 19" (483 mm) or 23" (584 mm) with no additional hardware
- Be available with three styles of vertical patch cord management: interbay with latches, cable management rings, or finger duct with covers
- Provide floor and ceiling access for cable management and distribution
- Provide pre-drilled base for floor attachment of rack
- Rack height shall be specified as 7 ft / 2.13 m (44 rack units) or 4.0 ft/1.22 m (22 rack units)
- Be available with vertical cable management rings for cord routing organization and strain relief

Wall Mounted Rack

Wall mount rack shall:

- Provide the necessary strain relief, bend radius and cable routing for proper installation of high performance cross connect products, meeting all specifications of ANSI/TIA-568-C
- Have EIA hole pattern
- Be available with hook and loop straps for securing cables inside the vertical U-channels
- Be available with vertical U-channels to protect and conceal distribution cables
- Provide floor and ceiling access for cable management and distribution
- Have wall mount braces with locator posts for easy wall mounting
- Have side access points that allow for access to manage/install distribution cables in the vertical channels

2.6 HORIZONTAL DISTRIBUTION CABLE

All horizontal distribution cable shall be Superior Essex specific. All horizontal station cable shall terminate on modular patch panels (copper or fiber), or patch/splice cabinets (fiber) in their respective Telecommunications Room or Equipment Room as specified on the drawings. In all instances, unless otherwise specified, all horizontal user end outlet cables will be category 6 and terminate on an appropriate category 6 patch panel.

100 OHM Category 6 UNSHIELDED TWISTED PAIR CABLE (UTP)

Physical Characteristics:

- (For Plenum) shall be plenum rated and meet applicable requirements of ANSI/ICEA S-116-732-2013.
- UL listed and UL Verified Cat 6.
- All 4 pairs must be insulated with FEP.
- Be as described in section 1.4, Approved Products
- The outer jacket shall be flame retardant, low smoke PVC.
- Shall be suitable for the environment in which they are to be installed.

Transmission Characteristics:

- Electrical transmission performance testing of a cabling configuration to the requirements of ANSI/TIA-568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Component Standards for Category 6 Channel.
- Channel Margin Guarantees: Improved channel performance that exceeds the ANSI/TIA-568-C.2 standard. Margins supported over standard compliant channels from 7 to 100 meters.

Parameter	Margin vs. TIA-568-C.2
Insertion Loss	3%
NEXT	5 dB
PSNEXT	5 dB
Return Loss	3 dB
ACRF	5 dB
PSACRF	5 dB
ACR	5 dB
PSACR	5 dB

2.7 HORIZONTAL AND BACKBONE CABLE

Premise Optical Fiber Plenum (OFNP) Tight Buffered With Laser Optimized OM3 50/125 Optical Fibers

Each Multimode Fiber shall be:

- Graded-index Multi-mode optical fiber wave-guide with TeraFlex Bend Resistant Laser Optimized 50/125nm-core/cladding.
- Be as described in section 1.4, Approved Products
- Shall comply with the requirements of the latest revision of ICEA S-83-596.
- Attenuation shall be measured in accordance with the latest revision of TIA-455-78-B.
- Information transmission capacity shall be measured in accordance with the latest revision of TIA-455-220-A.
- Maximum attenuation dB/Km @ 850/1300 nm: Per manufacturer's specifications

Physical Characteristics:

- Shall be suitable for use in intra-building backbone, conduit pathways and service entrance to communication closet applications.
- Shall be suitable for use in risers, plenums and horizontal applications.
- Shall be available with a fiber strand count range from 6 to 144.
- Shall have and be marked with an UL-OFNP (OFCP if armored) and OFN (OFC if armored) FT6 Flame Rating.
- Strength members shall be dielectric aramid yarn.
- Subunits shall be numbered and color-coded in accordance with the latest TIA-598-C with an

- overall aqua jacket.
- Subunits shall be manufactured with a reverse oscillating lay (ROL) stranded around a flexible high-strength glass reinforced rod.
- Suitable for operation between -20°C to +75°C for riser and 0°C to +75°C for plenum
- Shall be available in Aluminum Interlock Armor construction as needed

Premise Optical Fiber Plenum (OFNP) Tight Buffered With Enhanced (Low Water Peak) Single-mode Optical Fibers

Each Single-mode Fiber shall be:

- Class IVa dispersion - unshifted single mode optical fibers with TeraFlex Bend Resistant G657.A1 complying with the latest revision of ANSI/ICEA S-83-596.
- Be as described in section 1.4, Approved Products
- The zero dispersion wavelengths shall be between 1300 nm and 1324 nm. The ANSI/TIA-455-175-B maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm². Dispersion measurements shall be made in accordance with the latest revision of ANSI/TIA-455-175.

Transmission Characteristics:

- Maximum cabled attenuation dB/km @ 1310/1550 nm: 0.5/0.4
- The cabled cutoff wavelength shall be ≤ 1260 nm when measured in accordance with the latest revision of ANSI/TIA-455-80.

Physical Characteristics:

- Shall be suitable for use in intra-building backbone, conduit pathways and service entrance to communication closet applications.
- Shall be suitable for use in risers, plenums and horizontal applications.
- Shall be available with a fiber strand count range from 6 to 144.
- Shall have and be marked with an UL-OFNP and OFN FT6 Flame Rating.
- Shall comply with the requirements of the latest revision of ANSI/ICEA S-83-596.
- Strength members shall be dielectric aramid yarn.
- Subunits shall be numbered and color-coded in accordance with TIA-598-C with an overall aqua jacket.
- Subunits shall be manufactured with a reverse oscillating lay (ROL) stranded around a flexible high-strength glass reinforced rod.
- Suitable for operation between -20°C to +75°C for riser and 0°C to +75°C for plenum
- Shall be available in Aluminum Interlock Armor construction as needed

Indoor/Outdoor Optical Fiber Plenum (OFNP) With Laser Optimized 50/125 Optical Fibers

Each Multimode Fiber shall be:

- Graded-index Multi-mode optical fiber wave-guide with TeraFlex Bend Resistant Laser Optimized 50/125nm-core/cladding.
- Be as described in section 1.4, Approved Products
- Shall comply with the latest revision of ANSI/TIA-492AAAB.
- Shall comply with the latest revision of ANSI/ICEA S-104-696.
- Attenuation shall be measured in accordance with the latest revision of ANSI/TIA-455-78.
- Information transmission capacity shall be measured in accordance with the latest revision of ANSI/TIA-455-220.
- Maximum attenuation dB/km @ 850/1300 nm: Per manufacturer's specifications

Physical Characteristics:

- Shall be available in either tight buffered or loose tube construction for use in both outdoor and

- indoor applications without the use of a transition at the building entrance.
- Shall be suitable for use in risers, plenums and horizontal applications.
- Shall have a dry water blocking system for cable core and buffer tubes.
- Shall be available with a fiber strand count range from 6 to 144.
- Shall have and be marked with an UL-OFNP (OFCP for armored) and OFN (OFC for armored) FT6 Flame Rating.
- Shall comply with the requirements of the latest revision of ANSI/ICEA S-104-696.
- Strength members shall be dielectric.
- Suitable for underground or above ground conduits.
- Cable shall be color coded in accordance with the latest revision of ANSI/TIA-598 with an overall black jacket.
- Suitable for operation between -40°C to +70°C
- Shall be UV resistant
- Shall be available in either aluminum interlock or steel construction armor.

Indoor/Outdoor Optical Fiber Plenum (OFNP) With Enhanced (Low Water Peak) Single-mode Optical Fibers

Each Single-mode Fiber shall be:

- Class IVa dispersion - unshifted single mode optical fibers with TeraFlex Bend Resistant G657.A1 complying with the latest revision of ANSI/ICEA S-104-696.
- Be as described in section 1.4, Approved Products
- The zero dispersion wavelengths shall be between 1300 nm and 1320 nm. The ANS/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm². Dispersion measurements shall be made in accordance with the latest revision of ANSI/TIA-455-175.

Transmission Characteristics:

- Maximum cabled attenuation dB/km @ 1310/1550 nm: 0.5/0.4
- The cabled cutoff wavelength shall be ≤ 1260 nm when measured in accordance with the latest revision of ANSI/TIA-455-80.

Physical Characteristics:

- Shall be available in either tight buffered or loose tube construction for use in both outdoor and indoor applications without the use of a transition at the building entrance.
- Shall be suitable for use in risers, plenums and horizontal applications.
- Shall have a dry water blocking system for cable core and buffer tubes.
- Shall be available with a fiber strand count range from 6 to 144.
- Shall have and be marked with an OFNP (OFCP for armored) and OFN (OFC for armored) FT-6 Flame Rating.
- Shall comply with the latest revision of ANSI/ICEA S-104-696.
- Strength members shall be dielectric.
- Suitable for underground or above ground conduits.
- Cable shall be color coded in accordance with the latest revision of ANSI/TIA-598 with an overall black jacket.
- Shall have a ripcord for overall jacket.
- Suitable for operation between -40°C to +70° C
- Shall be UV resistant
- Shall be available in either aluminum interlock or steel construction armor.

Indoor/Outdoor Optical Fiber Low Smoke Zero Halogen (LSZH) Loose Tube With Laser Optimized OM3 50/125 Optical Fibers - use in NFPA-130 required environments

Each Multimode Fiber shall be:

- Graded-index Multi-mode optical fiber wave-guide with TeraFlex Bend Resistant Laser

- Optimized 50/125nm-core/cladding.
- Be as described in section 1.4, Approved Products
- Shall comply with the latest revision of ANSI/ICEA S-104-696-2013.
- Attenuation shall be measured in accordance with the latest revision of ANSI/TIA-455-78.
- Information transmission capacity shall be measured in accordance with the latest revision of ANSI/TIA-455-220.
- Maximum attenuation dB/Km @ 850/1300 nm: Per manufacturer's specifications

Physical Characteristics:

- Shall be suitable for use in NFPA-130 tunnel, subway passages and passage station environments both outdoor and indoor applications without the use of a transition at the building entrance.
- Shall be suitable for use in low smoke zero halogen applications.
- Shall have a dry, fully water blocked core and buffer tubes water blocked with PFM.
- Shall be available with a fiber strand count range from 6 to 288.
- Shall have and be marked with an UL-1666 and OFNG-LS (OFCG-LS for armored) Flame Rating.
- Shall comply with the requirements of the latest revision of ANSI/ICEA S-104-696.
- Strength members shall be dielectric and may be aramid yarn.
- Suitable for underground or above ground conduits.
- Loose Tube fibers shall be color coded in accordance with TIA-598-C with an overall black jacket.
- Suitable for operation between -40°C to +70°C
- Shall be flame and sunlight resistant
- Shall be available in Corrugated Steel Armor construction as needed.

Indoor/Outdoor Optical Fiber Plenum (OFNP) Loose Tube With Enhanced (Low Water Peak) Single-mode Optical Fibers - use in NFPA-130 required environments

Each Single-mode Fiber shall be:

- Class IVa dispersion - unshifted single mode optical fibers with TeraFlex Bend Resistant G657.A1 complying with the latest revision of ANSI/ICEA S-104-696.
- Be as described in section 1.4, Approved Products
- The zero dispersion wavelengths shall be between 1300 nm and 1320 nm. The ANSI/TIA-455-168 maximum value of the dispersion slope shall be no greater than 0.090 ps/km-nm². Dispersion measurements shall be made in accordance with the latest revision of ANSI/TIA-455-169 or ANSI/TIA-455-175.

Transmission Characteristics:

- Maximum cabled attenuation dB/km @ 1310/1550 nm: 0.5/0.4
- The cabled cutoff wavelength shall be ≤ 1260 nm when measured in accordance with the latest revision of ANSI/TIA-455-80.

Physical Characteristics:

- Shall be suitable for use in NFPA-130 tunnel, subway passages and passage station environments both outdoor and indoor applications without the use of a transition at the building entrance
- Shall be suitable for use in low smoke zero halogen applications.
- Shall have a dry, fully water blocked core and buffer tubes water blocked with PFM.
- Shall be available with a fiber strand count range from 6 to 288.
- Shall have and be marked with an UL-1666 and OFNG-LS (OFCG-LS for armored) Flame Rating.
- Shall comply with the latest revision of ANSI/ICEA S-104-696.
- Strength members shall be aramid/yarn.
- Suitable for underground or above ground conduits.
- Loose Tube fibers shall be color coded in accordance with TIA-598-C with an overall black

- jacket.
- Suitable for operation between -40°C to +70°C
- Shall be flame and sunlight resistant
- Shall be available in Corrugated Steel Armor construction as needed.

2.8 FIBER OPTIC CONNECTORS

Each Fiber Connector shall:

- WMATA's standard multimode and singlemode fiber optic connector is the SC style connector
- Be available in singlemode and multimode versions
- Be as described in section 1.4, Approved Products
- Accept a nominal fiber diameter of 125 micrometers
- Have a typical insertion loss of 0.3 dB for multimode and 0.2 dB for singlemode
- Be stable over an operating range of -40C to +75 degrees C.

2.9 COPPER CABLE PROTECTION UNITS

All copper circuits shall be provided with protection between each building with an entrance cable protector panel. See section 2.11 for additional requirements. All building-to-building circuits shall be routed through this protector. The protector shall be connected with a #6 AWG copper bonding conductor between the protector ground lug and the TC ground point. Approved manufacturer of protection units is Porta Systems.

2.10 PATCH CORDS

The contractor shall provide factory terminated and tested UTP and optical fiber patch cords and equipment cords for the complete cabling system. The UTP patch cables shall meet the requirements of ANSI/TIA/ -568-C for patch cord testing.

Copper (UTP) patch cords shall:

- Be as described in section 1.4, Approved Products
- Be an Ortronics category 6 Clarity patch cord with Paralign 2 Plug Design.
- Use 8 position connector with impedance matched contacts and designed using dual reactance.
- Be constructed of 100 ohm, 4 pair, 24 AWG, stranded conductor, unshielded twisted pair copper per the requirements of the ANSI/TIA-568-C.2 and ANSI/TIA-568-C.2-1 standard.
- Meet TIA category 6 component specifications in ANSI/TIA-568-C.2-1
- 100% factory tested to meet category 6 performance
- Be capable of universal T568A or T568B wiring schemes.
- Modular connector shall maintain the paired construction of the cable to facilitate minimum untwisting of the wires.
- Have a performance marking indelibly labeled on the jacket (by the manufacturer).
- Have the ability to accept color-coded labels and icons to comply with ANSI/TIA-606-B labeling specifications.
- Have "snagless" protection for the locking tab to prevent snagging and to protect locking tab in tight locations and provide bend relief
- Be backwards compatible to Category 3, 5 and 5e

Optical Fiber patch cords shall:

- Contain two (2) optical fibers.
- Be as described in section 1.4, Approved Products
- Include listing of actual loss of patch cord when packaged

2.11 BONDING AND GROUNDING

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-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 bus bars shall be identified and labeled in accordance with the System Documentation Section of this specification.

2.12 FIRESTOP

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. Fire stop 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 i.e., riser slots and sleeves, cables, conduit, cable tray, and raceways, etc. shall be properly fire stopped.
- Fire stop 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 PE shall be provided to the Owner's Technical Representative prior to installing the fire stop system(s).

PART 3- EXECUTION

3.1 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 ANSI/TIA/EIA-568-C.1 document, manufacturer's recommendations and best industry practices.
- Pair untwist at the termination shall not exceed 12 mm (one-half inch).
- Bend radius of the horizontal cable 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.

All Work Area design and installation practices should adhere to the BICSI TDMM 13th Edition Chapter 3.

3.2 TELECOMMUNICATIONS SPACES

Telecommunications spaces are defined as:

- Telecommunications enclosure (TE)
- Telecommunications room (TR)
- Equipment room (ER)
- Entrance facility (EF)

Conduit Pathways between any of these spaces must be at minimum 4in (EMT) in size. The amount of these conduits must be calculated using a 40% fill ratio and maintaining at least 50% vacancy after completion. All design and installation practices should adhere to the BICSI TDMM 13th Edition Chapter 6. This should include but is not limited to location, sizing, conditioning, fire protection, flood protection, floor loading, grounding, lighting, physical protection & EMI.

3.3 HORIZONTAL DISTRIBUTION SYSTEMS

The horizontal distribution system consists of two basic elements—the horizontal pathways and related spaces, and the horizontal cabling system.

Horizontal pathways include:

- Physical pathways (e.g., conduit and cable tray) used for containment of telecommunications cabling.
- Non-physical pathways (e.g., the space between open-top cable supports [J-hooks]) through which cable is placed between physical support or containment components.

Horizontal pathways consist of structures that conceal, protect, support, and provide access to horizontal cables between the telecommunications outlet/connector used to connect work area equipment at the work area and HC (FD) in the serving TR or TE.

All horizontal distribution systems design and installation practices should adhere to the BICSI TDMM 13th Edition Chapter 4.

3.4 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 ANSI/TIA/-569-C 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/installer 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-606-B. The cable label shall be applied to the cable behind the faceplate on a section of cable (within 6" of termination) 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.

All horizontal distribution systems design and installation practices should adhere to the BICSI TDMM 13th Edition Chapter 4 & BICSI ITISM Chapter 4.

3.5 HORIZONTAL CROSS CONNECT INSTALLATION

- Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-C standard, manufacturer's recommendations and best industry practices.
- Pair untwist at the termination shall not exceed 13 mm (0.5 inch). Untwist should be as close to zero as possible.
- 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.

All horizontal distribution systems design and installation practices should adhere to the BICSI

3.6 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 splice 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 spliced in each tray
- All spare strands shall be installed into spare splice trays.
- All connectors shall be mechanically installed. No pigtail splices without prior approval.

All fiber optic termination practices should adhere to the BICSI ITSIM Chapter 6.

3.7 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 backbone 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 wire way, 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.

All backbone distribution systems design and installation practices should adhere to the BICSI TDMM 13th Edition Chapter 5.

3.8 COPPER TERMINATION HARDWARE

- Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA-568-C standard, manufacturer's recommendations and best industry practice.
- Pair untwist at the termination shall not exceed 12 mm (one-half inch). Keep untwist as close to zero as possible.
- 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.

All copper cable termination practices should adhere to the BICSI ITSIM Chapter 6.

3.9 RACKS

- Racks shall be securely attached to the concrete floor using the provided hardware or as required by local codes.
- Isolation pads and/or isolation spacer shall be used in all railway stations, TPSS, and TBS locations.
- Nonmetallic hardware shall be used to secure racks to flooring in all railway stations, TPSS, and TBS locations.
- Racks shall be placed with a minimum of 36 inch 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 2.11 of this document.
- Rack mount screws not used for installing patch panels and other hardware or accessories 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 highest point not to exceed 5'6" above the finished floor and with the lowest edge of the mounting frame 18" from the finished floor.

3.10 FIRESTOP SYSTEM

- All fire stop 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. UL Classified Fire stop Systems are to be included in the submittals.

All fire stopping practices should adhere to the BICSI TDMM 13th Edition Chapter 7 & BICSI ITSIM Chapter 5.

3.11 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 ANSI/TIA-607-B standard, and shall be installed in accordance with best industry practice.
- Installation and termination of the main bonding conductor to the building service entrance ground shall be performed by a licensed electrical contractor.

All Bonding and Grounding design and installation practices should adhere to the BICSI TDMM 13th Edition Chapter 8.

3.12 IDENTIFICATION AND LABELING

- The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme in conjunction with the installer/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.
- Labeling shall follow the guidelines of ANSI/TIA-606-B.
- All label printing will be machine generated with Legrand/Ortronics templates using indelible ink ribbons or cartridges or equivalent.
- Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end.
- Outlet, patch panel and wiring block labels shall be installed on or in the space provided on the device.

All identification and labeling practices should adhere to the BICSI TDMM 13th Edition Chapter 10.

3.13 TESTING AND ACCEPTANCE

General

- All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of ANSI/TIA-568-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.
- All cables shall be tested in accordance with this document, the latest revision of the ANSI/TIA standards, the Legrand/Ortronics Certification Program Information Manual and best industry practice. If any of these are in conflict, the Contractor/Installer shall bring any discrepancies to the attention of this office for clarification and resolution.

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 III test unit for category 6 performance compliance.
- The basic tests required are:
 - Wire Map
 - Length
 - Attenuation
 - NEXT (Near end crosstalk)
 - Return Loss
 - ELFEXT Loss
 - Propagation Delay
 - Delay skew
 - PSNEXT (Power sum near-end crosstalk loss)
 - PSELFEXT (Power sum equal level far-end crosstalk loss)

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-568-C 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 6 Performance

Shall meet the channel requirements outlined below for a 100-meter, 4-conductor channel. Frequency (MHz)	Maximum Insertion Loss (dB)	Minimum NEXT (dB)	Minimum PSNEXT (dB)	Minimum ELFEXT (dB)	Minimum PSELFEXT (dB)	Minimum Return Loss (dB)
1.0	2.1	70.0	67.0	68.3	65.3	24.0
4.0	4.0	68.0	65.5	56.2	53.2	24.0
10.0	6.3	61.6	59.0	48.3	45.3	24.0
20.0	9.0	56.6	54.0	42.2	39.2	24.0
31.25	11.3	53.4	50.7	38.4	35.4	22.1
62.5	16.4	48.4	45.6	32.3	29.3	19.1
100.0	21.2	44.9	42.1	28.3	25.3	17.0
155.0	26.6	41.7	38.8	24.4	21.4	15.1
200.0	31.5	39.8	36.9	22.2	19.2	14.0
250.0	36.0	38.1	35.2	20.3	17.3	13.0

Fiber Testing

- All fiber testing shall be performed on all fibers in the completed end-to-end system.
- There shall be no splices unless clearly defined in an RFI.
- Testing shall be conducted in accordance with the latest revision of TIA-526-7, Method B for single-mode fibers.
- Test shall be conducted in accordance with the latest revision of ANSI/TIA-526-14 Standard for multimode fibers.
- System loss measurements shall be provided at 850 and 1300 nanometers for multimode fibers and 1310 and 1550 nanometers for single mode fibers.
- These tests also include continuity checking of each fiber.
- Backbone multimode fiber cabling shall be tested at both 850 nm and 1300 nm (or 1310 and 1550 nm for single-mode) in both directions.
- Where links are combined to complete a circuit between devices, the Contractor/Installer shall test each link from end to end to ensure the performance of the system. **ONLY LINK TEST IS REQUIRED.**
- The contractor/installer 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 latest revision of the ANSI/TIA Standard.
- Attenuation testing shall be performed with an approved hand held tester from an industry recognized test equipment manufacturer.

All field testing practices should adhere to the BICSI, TDMM 13th Edition Chapter 11.

3.14 SYSTEM DOCUMENTATION

- Upon completion of the installation, the telecommunications contractor/installer shall provide three (3) full documentation sets to the Engineer for approval. Documentation shall include the items detailed in the sub-sections below.
- Manufacturer's original certificate of origin with each fiber's factory attenuation results must be submitted. In the event the "birth certificate" was destroyed or lost the contractor/installer is responsible for contacting the factory of origin for a certified duplicate copy.
- Documentation shall be submitted within ten (10) working days of the completion of each testing phase (e.g. subsystem, cable type, area, floor, etc.). This is inclusive of all test result 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/installer shall provide copies of the original test results.
- The Engineer 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.

3.15 TEST RESULTS

- Test documentation shall be provided on compact 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.
- The field test equipment shall meet the requirements of latest revision of ANSI/TIA-568-C including applicable TSB's and amendments.
- The appropriate Level III tester shall be used to verify Category 6 cabling systems.
- Printouts generated for each cable by the wire (or fiber) test instrument shall be submitted as part of the documentation package.
- The telecommunications contractor/installer must furnish this information in electronic form (CD-ROM) or acceptable pre-approved media.
- 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.
- 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.

3.16 AS-BUILT DRAWINGS

- The drawings are to 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.

- The Owner will provide floor plans in paper and electronic (DWG, AutoCAD rel. 14) formats on which as-built construction information can be added.
- These documents will be modified accordingly by the telecommunications contractor/installer 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 rel. 14) form.

PART 4-WARRANTY AND SERVICES

Warranty

- An Extended Product Warranty shall be provided which warrants functionality of all components used in the system for 25 years from the date of registration. The Extended Product Warranty shall warrant the installed horizontal and/or backbone copper, and both the horizontal and the backbone optical fiber portions of the cabling system.
- The Application Assurance Warranty shall cover the failure of the wiring system to support the applications that are designed for the link/channel specifications of ANSI/TIA-568-C.1. These applications include, but are not limited to, 10BASE-T, 100BASE-T, 1000BASE-T, and 155 Mb/s ATM.
- The contractor/installer shall provide a warranty on the physical installation.

Final Acceptance & System Certification

- Completion of the installation, in-progress and final inspections, receipt of the test and as-built documentation, and successful performance of the cabling system for a two week period will constitute acceptance of the system.
- Upon successful completion of the installation and subsequent inspection, the end user shall be provided with a numbered certificate, from Ortronics or Berk-Tek, registering the installation.

PART 5 - INSTALLATION AND DESIGN PRACTICES

All installation practices will adhere to the Building Industry Consulting Service International (BISCI) Telecommunications Distribution Methods Manual (TDMM) Thirteenth edition, as well as the Information Transport Systems Installation Manual (ITSIM) & Outside Plant Design Reference Manual (OPDRM). These BISCI manuals shall take precedence in any situation regarding design and installation practices.

PART 6 - SAFETY

It is the responsibility of the user of this document to determine the use of applicable safety and health practices (e.g., WMATA's MSRPH [Metrorail Safety Rules and Procedures Handbook], Occupational Safety and Health Administration [OSHA], *National Electrical Code*® [NEC®], *National Electrical Safety Code*® [NESC®] associated with telecommunications systems installation and design practices. No project is so important nor any completion deadline so critical as to justify nonconformance to industry safety standards.