Appalachian State University Structured Cabling Standards

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1.0 INTRODUCTION

1.1 PURPOSE

The intent of this document is to provide a standard specification that will be used for all Appalachian State University facilities requiring cabling installation. This document provides the

minimum performance criteria for the components and sub-systems comprising a complete cabling system that shall accommodate Appalachian State University's requirements.

Product specifications, general design considerations, and installation guidelines are provided in this written document. The successful contractor shall meet or exceed all requirements for the cabling system described in this document.

Appalachian State University's cabling infrastructure requires a CommScope Uniprise Cabling Systems performance warranty or equivalent Single Manufacturer Solution. The Category 6 and Cat6A portion of the cabling system shall comply with the link and channel performance requirements of the latest revision and addendum of TIA-568-C.1, "Commercial Building Telecommunications Cabling Standard" and 568-C.2, "Balanced Twisted-Pair Telecommunications Cabling and Components Standard".

The successful contractor must have a BICSI® certified RCDD review the drawings and meet with University representatives from Facilities and the Information Technology Services (ITS) to discuss the project and to ensure that a structured cabling system is installed that provides a comprehensive telecommunications infrastructure.

1.2 Scope

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware, and miscellany to install a complete telecommunications system supporting voice and data. The intent of this document is to provide all pertinent information to allow the contractor to bid the materials, labor, supervision, tooling, and miscellaneous mounting hardware and consumables to install a complete system. However, it is the responsibility of the contractor to identify any and all items required for a complete system not identified in this specification.

1.3 Applicable Documents

The cabling system described in this specification is derived in part from the recommendations made in industry standard documents. The documents below are incorporated by reference.

1) This Technical Specification and Associated Drawings
2) ANSI/J-STD-607-A, *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*
3) TIA-568-C.2 *Balanced Twisted-Pair Telecommunications Cabling and Components Standard*
4) TIA-568-C.1, *Commercial Building Telecommunications Cabling Standard*
5) TIA-569-D, *Commercial Building Standard for Telecommunications Pathways and Spaces*
6) TIA-606-C, *Administration Standard for Telecommunications Infrastructure*
7) TIA-607-B, *Telecommunications Grounding and Bonding*
8) TSB-140, *Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems*
9) Building Industries Consulting Services International (BICSI) *Telecommunications Distribution*

Methods Manual (TDMM) – latest edition

10) National Fire Protection Agency (NFPA) – NFPA 70, *National Electrical Code* (NEC)

If a conflict exists between applicable documents, then the order in the list above shall dictate the order of precedence in resolving conflicts. This order of precedence shall be maintained unless a lesser order document has been adopted as code by a local, state or federal entity, and is therefore enforceable as law by a local, state or federal inspection agency.

2.0 Telecommunications System Requirements

2.1 Facilities Description

Appalachian State University's facilities vary in function and size. Most buildings have individual offices for faculty and staff; in certain areas, personnel may be situated in modular office furniture with hard wall offices around the exterior of the floor. Classrooms may have fixed seating or be large open rooms. Generally, a ceiling distribution cabling system using cable trays and conduits is used. These specifications apply primarily to new buildings and major renovations, but should be followed as closely as possible for all telecommunications cabling installations.

Multi-mode fiber (50/125µm) and single mode fiber optic backbone shall be employed between the data Main Cross-Connect (MC) and each telecommunications room (TR) for data connectivity in all new buildings. When applicable, high pair-count Category 3 CMR riser cables are employed between the voice MC and each TR for voice connectivity. Within the data MC and the each TR, backbone fiber strands shall be terminated and housed in rack-mount fiber optic enclosures. Within the voice MC and each TR, backbone copper pairs shall be terminated using 66-blocks mounted on 4' x 8' x .75" virgin fire retardant plywood.

2.2 Telecommunications System Description

Appalachian State University's data distribution network is based on a star topology. As a standard configuration, each work area communications outlet contains two Category 6 jacks, all jacks are terminated using Category 6 horizontal cables pulled and terminated on Category 6 insulation displacement connector patch panels in the telecommunications room. Patch cords/equipment cords are used to connect each jack to the appropriate service connector. Generally, high pair count Category 3 CMR or CMP backbone/riser cables are employed between the Entrance facilities or Main telecommunications room and each telecommunications room for voice connectivity. Category 6 cables, single mode, and 50/125 µm multi-mode fiber optic cables are used as backbone/riser cables for data.

2.3 Special Requirements

While standards are carefully monitored to ensure that the components and practices are

technologically current, it is possible that some applications may require special consideration. Many buildings contain special purpose facilities and equipment with unique telecommunications requirements. Special telecommunications requirements may require deviation from these specifications. Information Technology Services needs to be notified of these special requirements as early in the design process as possible.

The following list contains some of the facilities that typically require special telecommunication consideration.

- Computer labs or classrooms
- Video conference rooms
- Laboratories
- Research or Science equipment
- Areas containing E-Boards (Digital Signage)
- Information Kiosks
- Data centers or server rooms
- Offices requiring CCTV or video playback

Items not specifically identified in this document as a standard should obtain approval from appropriate Information Technology Services staff prior to implementation.

3.0 Building Entrance Facilities

The entrance facility is the location where the pathways for communications services penetrate the building to connect to the voice and data systems within the building. The entrance facilities are generally 4-inch rigid steel conduit that extends from the perimeter of the building to the telecommunications main equipment room.

3.1 Conduit Routing

Appalachian State University representatives shall designate the shortest practical route for the communications cable to connect from the building to the point of connection with the university telephone and network cabling systems. Conduit shall be installed from the facility points of entry to the telecommunications infrastructure as determined by Information Technology Services.

3.2 Facilities Entrance Diversity

Special facilities entrance requirements may be necessary for some new buildings that will house voice and data equipment when Appalachian State University representatives determine that the scope and importance of the facility require it.

In the event that diverse cable facility entrances are not deemed necessary, provisions shall be made for no less than four 4-inch conduits for access from the university cable system to the

telecommunications main equipment room. No less than two 4-inch conduits should exit the building from different locations for the purpose of providing redundant routes. Each of these conduits must be labeled "TELE MDF ONLY" and connect to the university telecommunications infrastructure.

Entrance facilities must adhere to all BICSI requirements. Information Technology Services must approve any deviations from the BICSI TDMM.

4.0 Interbuilding Backbone Riser Facilities

4.1 Design Considerations

• The interbuilding backbone shall be comprised of both copper and optical fiber. Cable sizing shall be in consultation with Information Technology Services for specific building requirements.

• Interbuilding backbone fiber and copper cables shall be sized to include no less than 50% spare for future use. Consult with Information Technology Services for cable sizing requirements on a per building basis.

• Interbuilding backbone cables comprised of steel or metallic parts must be grounded on both ends of the cable as specified in section 11.0, —Grounding and Bonding.

• Proper firestopping of all backbone pathways shall be maintained as specified in section 10.0, —Firestop Systems.

• Interbuilding copper and backbone cables shall be installed without exceeding the minimum bend radius and the maximum vertical rise recommended by the cable manufacturer and must not exceed the maximum allowed pulling tension of the cable(s).

4.2 Interbuilding Backbone Copper (Riser)

4.2.1 CABLING

- The interbuilding copper backbone cable(s) shall be 100-ohm unshielded, balanced,
- twisted-pair, Category 3 cable with round solid conductors. It shall also be armored.
- The cable shall be UL® tested and listed, and it shall meet or exceed the requirements of Category 3 cable as specified in TIA-568-C and all applicable national and municipal fire codes.

4.2.2 Terminations

o Interbuilding backbone copper cabling shall be terminated on 66 protected termination

blocks in the telecommunications riser rooms. Main Communication room terminations must be done in accordance with Information Technology Services standards.
o The cable shall be continuous without splices, unless required by code or specified differently by Information Technology Services.
o Interbuilding copper backbone cables must be properly secured to the walls to prevent horizontal movement as specified in BICSI TDMM Chapter 4, the NEC, and all applicable national and municipal codes.

4.3 Interbuilding Backbone Fiber Optic

4.3.1 Cabling

- The interbuilding optical fiber backbone cable(s) shall be single mode and multi-mode cables consisting of 8.3/125 µm single mode and 50/125 µm multi-mode optical fiber. There shall be no fewer than 12 strands of single mode and 12 strands of multi-mode.
- Actual cablesizing shall be determined after consultation with Information Technology Services.
- Optical fiber cables shall meet or exceed all applicable national and local building fire codes.

4.3.2 Fiber Terminations

- The interbuilding optical fiber backbone cable(s) shall be installed with a service loop of no less than 25 feet at each end.
- Interbuilding fiber backbone cables must be properly secured to the walls to prevent movement as specified in BICSI TDMM Chapter 5 (latest edition), the NEC, and all applicable national and local building codes.
- Velcro cable ties shall be used for securing fiber optic cable. o All fiber optic cables are to be continuous without splicing, unless otherwise specified by Information Technology Services.
- The single mode strands of each interbuilding backbone fiber optic cable shall be placed first in the fiber optic cabinet, followed by the multi-mode strands of the corresponding cable. All terminations should be made using LC connectors unless otherwise noted in this document or in writing from an Appalachian State University representative.
- Fiber optic cabinets shall be labeled according to Information Technology Services labeling scheme. Contact Information Technology Services for the correct designation.

4.3.3 Fiber-Optic Enclosures

- Fiber-optic rack-mounted enclosures shall consist of an EIA-approved 19-inch enclosure (with optional extensions to fit in a 23-inch rack) that is four rack units tall (7 inches) with a minimum of 72 duplex port capacity.
- Individual fiber couplers must be removable from the panel.

- Individual couplers must be replaceable without causing interruption of service to adjacent fiber strands.
- Dust covers must be provided for any unused couplers in each enclosure.
- The enclosure shall be black.
- Enclosures shall be labeled per Information Technology Services specifications.

4.4 Interbuilding Backbone Routing

• Interbuilding backbone conduit routes shall be determined by Information Technology Services as close to project completion as possible to most adequately connect to infrastructure existing at that time.

5.0 Horizontal Distribution Subsystem

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

5.1 Telecommunications Pathways and Spaces

Electrical contractors will generally be the installer of the telecommunications pathways, primarily cable tray, conduit and outlet boxes. The drawings must clearly define the pathways and spaces. The BICSI® Telecommunications Distributions Methods Manual covers all parts of the telecommunications structured cabling system and will be used by Appalachian State University representatives to ensure proper installation. It should also be referenced by the designer and the contractors to determine: Telecommunications room location, dimensions, equipment layout and furnishings. Heating, cooling, lighting, fire protection, power and grounding requirements.

The number and size of slots, sleeves, and conduits needed to provide pathways for backbone cabling and determine fill ratios. These pathways and spaces are designed to be used for the life of the building and should be sized accordingly. There must be at least one telecommunications room per floor in all buildings and they must be stacked vertically in multi-floor buildings. These telecommunications rooms are designed to be secure designated spaces for housing specialty equipment and devices and should not be used or combined with any other services such as plumping, electrical, HVAC, housekeeping or storage. .

5.2 Telecommunications Cabling System

The telecommunications contractor will be responsible for pulling and terminating the cables following all federal, state and local codes, accepted industry standards and the manufacturer’s instructions. The telecommunications contractor must work closely with the electrical contractor to ensure that the pathways are installed correctly and that they will allow for proper installation of the cabling system. Visual inspections and upon completion of the project test results will be used

to verify proper installation practices were followed.

Each telecommunications outlet (TO) location, unless otherwise noted, shall be provided with two Category 6 cables. Each Category 6 cable shall be terminated on an 8-position, 8-conductor Category 6 jack to the T568B color code in the work area and in the telecommunications room.

5.2.1 Work Area Telecommunications Outlets

No less than one work area communications outlet should be placed per 100 square foot increment of useable floor space and sized to accommodate two Category 6 cables and connectors *(e.g. A 90 square foot room should have at least one, a 101-square foot. room should have at least two)*. Outlets should be within 3' of an electrical outlet and installed at the same height, unless otherwise specified. Outlets should be placed so that the work area or workstation cable does not exceed 5 meters (16 ft) in length. This length is figured into the total horizontal cabling length and must not be exceeded.

Office Outlets

No less than two multiport faceplates in each office. Each faceplate shall contain no less than two Category 6 cables terminated on two Category 6, 8-position, 8-conductor jacks. Faceplates shall be constructed of ABS molding compound. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each. Faceplates shall be ivory in color unless otherwise noted.

Academic Room Outlets

No less than two multiport faceplates in each academic room. Each faceplate shall contain no less than two Category 6 cables terminated on Category 6, 8-position, 8-conductor jacks. Faceplates shall be constructed of ABS molding compound. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each. Faceplates shall be ivory in color unless otherwise noted.

Dorm Outlets

No less than two multiport faceplates in each dorm room. Each faceplate shall contain no less than two Category 6 cables terminated on two Category 6, 8-position, 8-conductor jacks. Faceplates shall be constructed of ABS molding compound. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each. Faceplates shall be ivory in color unless otherwise noted.

Wireless Outlets

Two Category 6 cables terminated on Category 6, 8-position, 8-conductor jacks. Faceplates shall be constructed of ABS molding compound. Faceplates shall accommodate two labels and provide a clear polycarbonate cover for each. Where wireless access points are located on an accessible lay-in style ceiling surface, two Category 6 cables terminated on Category 6, 8- position, 8-conductor jacks shall be left at each location with 10’ excess neatly coiled and supported above the ceiling.

5.2.2 Product Specifications

Category 6 Cabling – Non-plenum

Horizontal cabling shall be 23 AWG, 4-pair UTP, UL/NEC CMR rated, with a blue PVC jacket. Cable jacketing shall be lead-free.

Category 6 Cabling – Plenum

Horizontal cabling shall be 23 AWG, 4-pair UTP, UL/NEC CMP rated, with a blue plenum-rated PVC jacket. Individual conductors shall be FEP insulated. Cable jacketing shall be lead-free.

Modular Jacks

All modular jacks shall be wired to the T568B wiring pattern. Modular jacks shall be constructed with a housing of polyphenylene oxide, 94V-0 rated. Modular jacks shall be terminated using a 110-style pc board connector (made of 94V-0 rated polycarbonate), color-coded for both T568A and T568B wiring. The 110-connector shall terminate 22-24 AWG solid conductors with a maximum insulation diameter of .050 inches. The modular jack contacts shall be plated with a minimum of 50 micro-inches of gold in the contact area over a 50 micro-inch minimum nickel underplate.

Category 6 modular (data) jacks shall be unkeyed 4-pair and shall fit in a .760” X .582” opening. Modular jacks shall be terminated using a 110-style pc board connector, color-coded for both T568A and T568B wiring. Each jack shall be wired to T568B.

5.2.3 Work Area Communications Outlet Installation

All outlets shall be installed in the following manner:

• 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 manufacturers bend radius. In hollow wall installations where box-eliminators are used, excess wire can be stored in the wall. No more than 12” of slack shall be stored in an in-wall box, modular furniture raceway, or insulated walls. Excess slack may be neatly 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.
In addition, each cable type shall be terminated as indicated below:
• Cables shall be dressed and terminated in accordance with the recommendations made in the BICSI® Telecommunications Distributions Methods Manual, manufacturer’s recommendations and/or best industry practices.
• Pair untwist at the termination shall not exceed .25 inch for Category 6 connecting hardware. Rev 02/13/2018
• 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 as close as possible to the termination point.

5.3 Horizontal Distribution Cable Installation

• Cable shall be dressed and installed in accordance with manufacturer’s recommendations and best industry practices
• Cable raceways shall not be filled greater than the NEC maximum fill for the particular raceway type
• Cables shall be installed in continuous lengths from origin to destination (no splices) unless specifically addressed in this document
• Where cable splices are allowed, they shall be 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 four-foot intervals - at no point shall cable(s) rest on acoustic ceiling grids or panels
• Horizontal distribution cables shall be bundled in groups of not greater than 40 cables (cable bundle quantities in excess of 40 cables may cause deformation of the bottom cables within the bundle)
• Panel terminations shall be fed by and individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
• Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware
• The cabling 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 support wires

• Where light support for drop cable legs is required, the Contractor shall install clips 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

• 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. Cable labels shall not be obscured from view.

• Unshielded twisted pair cable shall be installed so that there are no bends less than four times the cables outside diameter (4 X cable O.D.) at any point in the run

• Pulling tension on 4-pair UTP cables shall not exceed 25-pounds for a single cable or cable bundle

5.4 Horizontal Cable Termination

5.4.1 Patch Panel Termination Specifications

All horizontal cables will be terminated on Category 6 patch panels in the telecommunications room. The horizontal cables termination patch panels shall be contained in standard 19” x 7’ rack(s), wall-mount racks or equipment cabinets as specified by the project drawings. All equipment racks shall be properly secured to the floor or wall and augmented with horizontal and vertical management hardware, both front and rear, to properly dress horizontal cables. Patch panels shall provide 48 modular jack ports, wired to T568B. The front of each module shall be capable of accepting 9mm to 12mm labels.

Patch panels shall terminate the building cabling on 110-style insulation displacement connectors.

Each patch panel shall be separated vertically on the rack by a 2U horizontal finger duct cable management panel.

5.4.2 Horizontal Cable Support

A 12” ladder rack system shall be installed in the telecommunications room to support the cables. The ladder should encompass the room allowing the cables to be properly dressed and supported. Secure the top of all freestanding equipment racks using 12” ladder racks to the wall or intersect with the ladder system encompassing the room.

5.4.3 Cross-Connect System

All horizontal cables will be terminated on Category 6 patch panels. This allows any cable to be used for voice, data or other purpose. Cross-connects will be done by using patch

cords in the telecommunications room to connect a jack on the horizontal cabling system Category 6 patch panel to either network equipment or a patch panel designated for voice or other use in the equipment racks. For voice applications, the cable will be terminated using 66 type cross-connect block on the telecommunications back board (TBB) adjacent to the phone demark. Voice cross-connects for dial tone will be made here using standard cross connect wire. By using backbone cables between telecommunications rooms, voice connections can be made throughout the building using this system. Appalachian State University Network Services will provide and install all equipment cables and patch cords used in the telecommunication room for data connectivity and install them along with the network equipment. All voice or other system cross-connect cables must be provided by that system provider. All patch cords other than voice or data must be clearly labeled and identified by the installer.

6.0 Backbone Distribution System

The MC and each TR, unless otherwise noted, shall house both voice and data backbone cabling and active equipment to support networking requirements. The MC shall be the main point of entry for outside services as well as main distribution point for all backbone cabling. Each TR will receive both voice and data cabling from the MC. The data backbone shall consist of one or more of the following types of cable:

Category 6, 100ohm, UTP as described in the horizontal distribution section for distances up to 295’. Single-mode fiber optic cable 50/125µm multi-mode fiber optic cable

The types and number of cables used for backbone systems will vary for each project and must be documented in the project specifications and documented on the drawings. Any termination or splice enclosures used for optical fiber will be listed in the specifications and documented on the drawings.

6.1 Main Cross-Connect and Telecommunications Rooms

All copper backbone cables shall be installed in the following manner:

- Backbone cables shall be installed separately from horizontal distribution cables.
- Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits or in separate innerduct within conduit.
- Where cables are installed in an air return plenum, the cable shall be installed in conduit, or plenum cable shall be installed in a plenum innerduct to provide protection to the cable.
- 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.

For optical fiber backbone cables:

• Do not exceed the cable's minimum bend radius. Bending cable tighter than the minimum bend Radius may result in increased optical fiber attenuation or fiber breakage.
• The minimum bend radius for indoor backbone optical fiber cable is 10 times the cables outside diameter under no load conditions and 15 times the cables outside diameter when being pulled.
• Do not exceed the cables maximum vertical rise and tensile rating.
• Where cables are installed in an air return plenum, the cable shall be installed in conduit, or plenum cable shall be installed in a plenum innerduct to provide protection to the cable
• 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 use innerduct whenever possible.

NOTE: Do not locate backbone cable pathways in elevator shafts. Do not over fill conduits, ducts or sleeves. Refer to the BICSI® *Telecommunications Distributions Methods Manual*, latest edition for more information.

7.0 TELECOMMUNICATIONS SPACES

The telecommunication closets shall house racks, voice termination fields, and required cable routing hardware. Racks shall be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side. If one mounting rail of the rack is placed against a wall, the mounting rail shall be no closer than 6" to the wall to allow room for vertical management. Where there is more than one rack, the racks shall be ganged with vertical management hardware to provide interbay management. Ganged rack frames will be placed in a manner that will allow a minimum of 3 feet of clearance from the front and rear mounting surfaces and on one side of the ganged assembly.

In all closets the racks shall be on the opposite side of the room from the voice termination fields. Voice termination fields shall be mounted on 4' x 8' x .75" virgin fire retardant plywood, unless otherwise noted in drawings, and shall be on the opposite side of the room from the room entrance. Backbone termination fields shall be mounted to the left of the horizontal voice fields. Conduits with 4" minimum diameter shall be used in all closets. Conduits for data backbone shall be located adjacent to the racks and conduits for voice shall be located adjacent to the voice termination fields. The Contractor shall provide innerduct for all backbone fiber runs. Contractor shall provide required ladder and wall-mount management rings to properly support and dress cables from conduits to racks and frames.

7.1 INSTALLATION SPECIFICATIONS

Racks shall be installed in the following manner.

• Racks shall be securely attached to the concrete floor using 3/8" hardware

• All racks shall be grounded to the telecommunications ground bus bar in accordance with Section 11.0 of this document
• Rack mount screws (#12-24) not used for installing fiber panels and other hardware shall be bagged and left with the rack upon completion of the installation
• Voice termination fields shall be mounted on 4’ x 8’ x .75” virgin fire retardant plywood that is mounted vertically at 12” A.F.F.

7.2 Power Requirements

The MC and each TR shall have the following minimum power configuration:

• One set of Quad 20A 250V NEMA 6-20 receptacles mounted horizontally within 12” of the hardware rack for each 200 data terminations. Each quad receptacle shall consist of two dedicated circuits.
• Two sets of Quad 20A 120V NEMA 5-20 receptacles mounted horizontally within 12” of the hardware rack for each 200 data terminations. Each set of quad receptacles shall be on a dedicated circuit.
• Two sets of Quad 20A 120V NEMA 5-20 receptacles at each voice termination plywood. Each set of quad receptacles shall be on a dedicated circuit.

8.0 Cabling System Testing

All cables and termination hardware shall be 100% tested for defects in installation and to verify cable performance under installed conditions. All conductors and fibers of each installed cable shall be verified useable by the Contractor 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 installed cables.

All cables shall be tested in accordance with this document, the ND&I Contract agreement, and best industry practices. If any of these are in conflict, the Contractor shall be responsible to bring any discrepancies to the attention of the project team for clarification and/or resolution.

8.1 Performance Verification

8.1.1 Copper

Category 6 data cable shall be performance verified using an automated test set. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA Standard currently TIA-568-C, and the result shown as pass/fail. Test results shall be printed directly from the

test unit or from a download file using an application from the test equipment manufacturer. The printed test results shall include all tests performed, the expected test result and the actual test result achieved.

8.1.2 Fiber

All 50/125 μm multi-mode optical fiber and/or Single mode optical fiber must be manufactured by CommScope Cable Systems or equivalent manufacture. After installation, it must be performance verified using an automated test set. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA Standard currently TIA-568-C, and the results shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The printed test results shall include all tests performed, the expected test result and the actual test result achieved.

9.0 Firestop Systems

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 used to seal the penetrated structure. Firestop systems comprise an effective block for fire, heat, vapor and a pressurized water stream.

Firestop methods should be employed that meet the requirements of all applicable codes and/or laws.

10.0 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 for acting as a current-carrying conductor. The TBB shall be installed independently of the building electrical ground and shall be designed in accordance with the recommendations contained in the TIA-607-B, 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 closet shall be provided with a telecommunications grounding 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.

10.1 Product Specifications

All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the TC or ER shall be grounded to the respective TGB or TMGB using a minimum #6 AWG stranded copper bonding conductor and compression connectors. Where metallic panels attached to the rack to not have sufficient metal to metal contact to provide an adequate path to ground, they shall be bonded to the rack using a minimum #14 AWG copper conductor. The copper conductor size shall be upgraded based on the largest power conductor feeding any rack- mount equipment. The conductor shall be continuous, attaching all isolated components in a daisy chain fashion from top to bottom and bonded to the rack using an appropriate compression connector.

All wires used for telecommunications grounding purposes shall be identified with 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.

10.2 Ground System Installation

The TBB shall adhere to the recommendations of the TIA-607-B standard, and shall be installed in accordance with best industry practices. Installation and termination of the main bonding conductor to the building service entrance ground, at a minimum, shall be performed by a licensed electrical contractor.

11.0 Raceway/Tray Systems

The general requirements for raceway/tray systems are as follows:

• Communication tray systems shall be for exclusive use by Information Technology Services and Media Services.

• The systems shall be designed for no more than 40% fill for the expected life of the building.

• The systems must be metallic and continuous, and all separate pieces must be bonded where they are joined.

• The systems must be grounded to the building grounding system with a minimum 6 AWG copper conductor. Refer to Section 11.0 for specific Grounding and Bonding requirements.

• Use insulated metallic bushings for attached metallic conduits. Ground and bond the conduits to the tray (Figure A at the end of this document).

• The tray shall be ladder or wire basket style.

• Ladder-style tray must not be center hung.

• The wire basket-style tray shall be U shaped and constructed of round wire mesh. The basket tray shall be installed trapeze-style or wall-mounted. It must not be center hung. Snaketray or an Information Technology Services approved manufacturer shall be used.

• End-of-tray cable waterfalls must be used where wire drops down to prevent abrasions and cuts from metal tray edges.

• The tray must be no closer than 6 inches from the structural ceiling, ducts, pipes, or any other possible obstructions. A minimum separation of 5 inches from lighting, especially fluorescent lighting, is required.

• The tray must maintain 18-inch clearance from sprinkler heads.

• Compliance to this standard requires that the end of rigid or flex conduit must:

- Have a bushing
- Lie within the side and end planes of the cable tray
- Lie within the tolerated distance as illustrated (Figure B)
- Be anchored to a rigid support

12.0 System Documentation

The following section describes the installation, administration, testing, and as-built documentation required to be produced and/or maintained by the Contractor during the course of the installation.

12.1 Cabling System Labeling

The contractor shall develop and submit for approval a labeling system for the cable installation. Appalachian State University 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 cabling system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme. All label printing will be machine generated using indelible ink ribbons or cartridges. 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 labels will be the manufacturer’s labels provided with the outlet assembly.

12.2 As-Built Drawings

The Contractor shall provide a detailed as-built drawing to the Owner at the conclusion of the project. The marked-up drawing set will accurately depict the as-built status of the system including termination locations, cable routing, and all administration labeling for the cabling system. In addition, a narrative will be provided that describes any areas of difficulty encountered during the installation that could potentially cause problems to the telecommunications system.

12.3 Test Documentation

Test documentation shall be provided in pdf electronic format within three weeks after the completion of the project. Test documentation shall include scanner test results (Enhanced Category 5 or Category 6), fiber optic attenuation test results, and OTDR traces (if any). Test data within each section shall be presented in the sequence listed in the administration records. The test equipment name, manufacturer, model number and last calibration date will also be provided at the end of the document. The test document shall detail the test method used and the specific settings of the equipment during the test.

13.0 Warranty and Services

The Contractor shall provide a system warranty covering the installed cabling system against defects in workmanship, components, and performance, and covering follow-on support after project completion.

13.1 Cabling System Warranty

The Contractor shall facilitate a 25-year CommScope Uniprise system performance warranty or industry equivalent between the Manufacturer and the Owner. An extended system performance warranty shall be provided which warrants functionality of all components used in the system for 25 years from the date of acceptance. The system performance warranty shall warrant the installed 250 MHz horizontal copper, and both the horizontal and the backbone optical fiber portions of the cabling system. Copper links shall be warranted to the link performance minimum expected results defined in TIA-568-C. Fiber optic links shall be warranted to the link and segment performance minimum expected results defined in TIA-568-C.

13.2 Post Installation Maintenance

The Contractor shall furnish an hourly rate with the proposal submittal which shall be valid for a period of one year from the date of acceptance.

This rate will be used when cabling support is required to affect moves, additions, and changes (MACs) to the system. MACs shall not void the Contractor's nor Manufacturer's warranty.

13.3 Project Management / General

The contractor shall establish a point of contact with Appalachian State University who will be responsible for reporting progress and updating Appalachian State University's Technical Representatives, (Facilities Project Manager, ITS Application Services, ITS Network Services) with issues that Appalachian State University must address to facilitate the cabling system installation. Requests for access to limited access or restricted areas shall be made no later than *the day prior to the required access*.

The contractor shall maintain Appalachian State University's facility in a neat and orderly manner during the installation of the communications cabling system. Appalachian State University's facilities shall be maintained in broom clean condition at the completion of work each day. At the completion of work in each area, the contractor will perform a final cleaning of debris prior to moving the installation crew to the next work area.

14.0 Cabling System Acceptance

The Customer's technical representative will make periodic inspection of the project in progress. One inspection will be performed at the conclusion of cable pulling, prior to closing of the false ceiling, to inspect the method of cable routing and support, and the firestopping of penetrations. A second inspection will be performed at completion of cable termination to validate that cables were dressed and terminated in accordance with ANSI/TIA specifications for jacket removal and pair untwist, compliance with Manufacturer's minimum bend radius, and that cable ends are dressed neatly and orderly.

14.1 Final Inspection

Upon completion of the project, the Customer's technical representative will perform a final inspection of the installed cabling system with the Contractor's project foreman. The final inspection will be performed to validate that all horizontal and backbone cables were installed as defined in the drawing package, and that the installation meets the aesthetic expectations of the Customer.

14.2 Test Verification

Upon receipt of the test documentation, the Customer reserves the right to perform spot testing of a representative sample of the cabling system to validate test results provided in the test document. Customer testing will use the same method employed by the Contractor, and minor variations will be allowed to account for differences in test equipment and test variability. If

significant discrepancies are found, the Contractor will be notified for resolution.

14.3 System Performance

During the three-week period between final inspection and delivery of the test and as-built documentation, the Customer will activate the cabling system. The Customer will validate operation of the cabling system during this period.

14.4 Final Acceptance

Completion of the installation, in-progress and final inspections, receipt of the test, receipt of the as- built documentation, and successful performance of the system for a two-week period will constitute acceptance of the system.

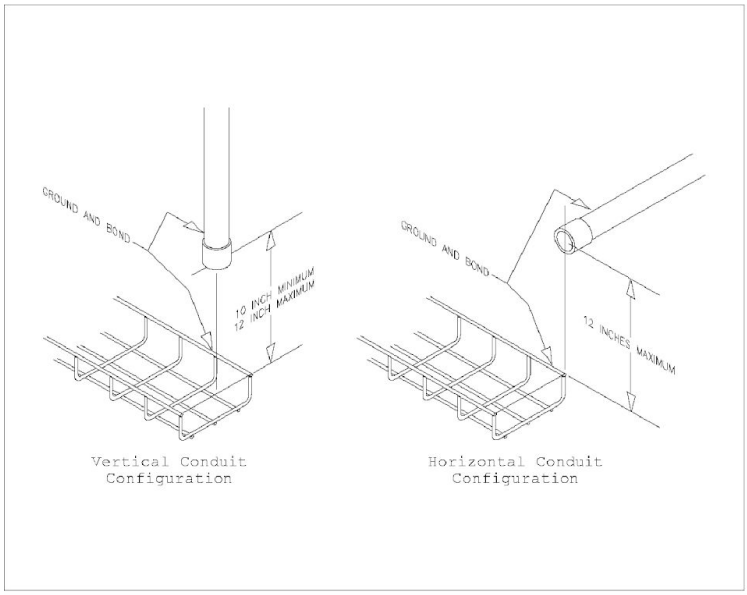

Figure A: Conduit to Cable Tray Configuration

Contacts for Questions or Information About this Standard

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