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MINIMUM REQUIREMENTS FOR STRUCTURED CABLING

WEST VIRGINIA UNIVERSITY
INFORMATION TECHNOLOGY SERVICES
Telecommunications and Network Operations

West Virginia University
Minimum Requirements for Structured Cabling
Last Revised 03-03-2015

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PURPOSE

This document has been developed to enforce standards for the design of voice, video, and data systems for West Virginia University (WVU). This document, along with industry ANSI/TIA/EIA standards, are to be followed by the Architect, Design Engineer, and installing Contractor.

Design teams and construction contractors shall meet all requirements as specified in this document. RCDD and Engineers shall refer to this document for all low voltage design. All design aspects must be approved by WVU-ITS Telecommunications and WVU-ITS Network Operations prior to installation.

SCOPE

This policy applies to all University staff, faculty, administrators, officers and students (collectively, "users"), including those on the regional campuses and Extended Learning sites.

POLICY

All new installations and upgrades of building telecommunications wiring for the transport of voice, data, video, imaging information, etc. must meet or exceed the Minimum Wiring Requirement specifications as listed below.

OBJECTIVES

1. To provide a minimum telecommunications wiring standard for new buildings and renovations with a view towards future expansion and adequate service.
2. To facilitate ease of expansion and upgrading of present services.
3. To provide for realistic cost considerations.
4. To provide a consistent wiring plan that can be implemented in such a way as to maximize telecommunications services while minimizing cost and initial design effort.

1. GENERAL

COMMON MATERIALS AND METHODS FOR TECHNOLOGY WORK

1.1 SUMMARY

A. This Section includes general administrative and procedural requirements for technology installations. Reference individual sections for further expansion of these requirements:

1.2 ABBREVIATIONS

A. General: Utilize the following abbreviations and definitions for discernment with the Specifications.

B. Abbreviations:

- ANSI American National Standards Institute
- ASA American Standards Association
- ASTM American Society of Testing Materials
- AVC Audiovisual Contractor
- EC Electrical Contractor
- EIA Electronic Industry Association
- ETL Electrical Testing Laboratories, Inc.
- GC General Contractor
- ICEA International Cable Engineers Association
- ICIA International Communication Industries Assoc.
- IDF Intermediate Distribution Frame
- IEEE Institute of Electrical and Electronics Engineers
- MDF Main Distribution Frame
- NEC National Electrical Code
- NEMA National Electrical Manufacturers Association
- NFPA National Fire Protection Association
- NIC Not in Contract
- OEM Original Equipment Manufacturers
- OSHA Occupational Safety and Health Act
- OSP Outside Service Provider
- SC Structured Cable Contractor
- T Telecommunications
- TIA Telecommunications Industry Association
- U University
- UL Underwriters' Laboratories, Inc.
- WAP Wireless Access Point

1.3 DEFINITIONS

A. PROVIDE means to furnish, install, place, erect, connect, test and turn over to University complete and ready for the regular operation, the particular work referred to.

B. INSTALL means to join, unite, fasten, link, attach, setup or otherwise connect together before testing and turning over to University, complete and ready for regular operation, the particular work referred to. It is also used to indicate the responsibility of receiving the item at the job site, providing adequate storage, unpacking or uncrating the item, physically securing the item or otherwise making ready the item for its intended use by following the instructions and approved methods of the manufacturer and those contained herein.

C. FURNISH means to indicate the responsibility to ship or deliver the item to the job site, freight prepaid, for receipt, staging and installation by others.

D. WIRING means the inclusion of all raceways, fittings, conductors, connectors, patch panels, labeling, junction and outlet boxes, connections, testing and all other items necessary and/or required in connection with such work.

E. MDF or Building Telecommunications Room means the main telecommunications room that serves the telecommunication needs of the entire building. Modular patch panels and connecting blocks are located in this room. All telecommunications services enter the building through this room. Floor telecommunications rooms are connected via risers and wire trays to the building telecommunications room. The building telecommunication room can also serve as a floor telecommunications room for its own floor.

F. IDF or Floor Telecommunications Room means the telecommunications room that serves the telecommunications needs of its floor. Modular patch panels are located in the room. Floor telecommunications rooms are connected to the building telecommunications room via risers and wire trays

G. COMMUNICATION JACK means a telecommunications connector. It may be a voice jack (such as a RJ-45), a data jack (such as a RJ-45, RS-232, or BNC connector), an integrated connector for voice and data (RJ-45), or any other appropriate connector.

H. INTEGRATED COMMUNICATIONS OUTLET (ICO) - A single outlet located in a room where a connection can be made to equipment. The ICO provides an interconnection to the building and/or university voice and data systems. This communications outlet is designed to accommodate both voice and data services.

I. CONDUIT means the inclusion of all fittings, hangers, supports, sleeves, etc.

J. AS DIRECTED means as directed by Telecommunications or its representative.

K. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within double partitions or installed within hung ceilings.

L. ACCEPTED means as accepted by Telecommunications or its representative.

M. APPROVED means as approved by Telecommunications or its representative.

N. EQUAL means equivalent as approved by Telecommunications or its representative.

O. BIDDER is used to indicate that entity generating the bid response.

P. CONTRACTOR is used to indicate the successful Bidder to whom the University has awarded the contract.

Q. PROVIDED BY OTHERS shall refer to material and work, which is related to this contract, but has been provided by parties other than the Contractor.

R. UNIVERSITY FURNISHED CONTRACTOR INSTALLED (OFCI) shall refer to equipment that will be furnished by the University for installation by the Contractor.

The Contractor shall be responsible for installing and integrating this equipment as detailed herein.

S. The term SHALL is mandatory; the term WILL is informative; and the term SHOULD is advisory.

T. AS SHOWN which means as shown on drawings, shop drawings or other graphical elements of the contract documents.

U. AS REQUIRED means as required by some other part of the contract documents which may include reference specifications or manufacturer's recommended practice.

V. UNIVERSITY or CLIENT means West Virginia University or their designated representative.

W. The SPECIFICATION is defined as the body of documentation provided to the Contractor with the Request for Quotation, Request for Proposal or Request for Bid as well as all addenda to said documentation. Throughout this document, words such as "herein" refer to the entire Specification, and not just this written document. The Specification includes, but is not limited to, this written specification document, all drawings, cable terminations and labeling schedule as listed in the Wire Pull List, additions and/or modifications as detailed in written addenda, additions and/or modifications as detailed in drawing additions or reissues.

X. TELECOMMUNICATIONS refers to the WVU Department of Telecommunications and Network Services, One Waterfront Place, Morgantown, WV 26506.

1.4 PERMITS, CODES, STANDARDS AND INSPECTIONS

A. Contractor shall obtain and pay for all permits and inspections required by laws, ordinances, rules and regulations having jurisdiction for work included under this Contract, and shall submit approval certificates to the Telecommunications.

B. The installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.

C. The installation shall be in compliance with the requirements of the latest revisions of:
- Occupational Safety and Health Act (OSHA)
- Institute of Electrical and Electronic Engineers (IEEE)
- National Electric Code (NEC)
- National Board of Fire Underwriter's (NBFU)
- National Electrical Manufacturer's Association (NEMA)
- National Electric Safety Code (NESC)
- Legislative Act 235 (1965)-Handicapped
- Legislative Act 287 (1974)-Excavation
- Building Officials and Code Administrators (BOCA)
- Americans with Disabilities Act (ADA)
- Electronic Industry Association (EIA)

- Telecommunications Industry Association (TIA)
- All local codes and ordinances in effect and having jurisdiction.
- All requirements of electric and telephone utility companies.
- The BICSI Telecommunications Distribution Methods Manual.
- All approved published instructions set forth by equipment manufacturers.

D. Submit certificates issued by approved authorized agencies to indicate conformance of all work with the above requirements, as well as any additional certificates as may be required for the performance of this contract work.

E. Should any change in drawings or Specifications be required to comply with governmental regulations, the Contractor shall notify Telecommunications prior to execution of the work. The work shall be carried out according to the requirements of such code in accordance with the instructions of Telecommunications at no additional cost to the University.

1.5 VISITING PREMISES

A. All contractors shall visit the project site before submitting his bid/quote, in order to familiarize himself with the existing conditions, which may affect his work. It is the contractor's responsibility to analyze existing conditions. Sufficient allowances shall be provided in the Contractor's bid/quote to cover work, due to existing conditions, that will be required to complete this contract work.

B. By submission of a bid/quote the Contractor is attesting that responsible personnel did, in fact, visit the site during the bidding period and verify all existing pertinent conditions.

C. Contractor shall verify all measurements and dimensions at the site prior to submitting a bid quote.

1.6 PROJECT DRAWINGS AND SPECIFICATIONS

A. When applicable, The Contractor shall carefully examine drawings and specifications of all trades and report all discrepancies to Telecommunications in writing to obtain corrective action. No departures from the Contract Documents will be made without prior written approval from the Telecommunications.

B. Questions or disputes regarding the intent or meaning of Contract Documents shall be resolved by the interpretation of Telecommunications. Telecommunications' interpretation is final and binding.

C. Drawings and Specifications are not intended to define all details, finish materials, and special construction, which may be required or necessary. The Contractor shall provide all installations complete and adequate as implied by the project documents.

D. Drawings are diagrammatic only and do not show exact routes and locations of equipment and associated wiring. When applicable, The Contractor shall verify the work of all other trades and shall arrange his work to avoid conflicts. In the event of a conflict, the Contractor shall obtain corrective action from Telecommunications.

E. If there is a conflict between contract documents, the document highest in precedence shall control. The precedence shall be: first; permits from agencies as required by law, second; special provisions, third; specifications, forth; drawings, fifth; reference specifications and sixth; vendor submittals.

1.7 COOPERATION AND COORDINATION WITH OTHER TRADES

A. When applicable, this contractor shall be responsible for all cross connecting and coordination with all vendors and other trades to provide a complete operational system.

1.8 RECORD DOCUMENTS

A. When all work has been completed and before final acceptance, the Contractor shall furnish to Telecommunications and University a complete set of documents, both electronic and paper versions that clearly represent all contract work "as-built". This shall be inclusive of all test results and drawings. The Contractor is responsible for assuring the accuracy of the As-Built documentation.

1.9 GENERAL WARRANTIES

A. Provide complete warranty information for each item to include date of beginning of warranty or bond; and names, addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

B. Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract Documents or which are damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the University.

1.10 PRODUCT REQUIRMENTS

A. Major items of equipment shall have manufacturer's name, address and catalog number on a plate securely attached. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.

B. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.

C. When two or more items of the same material or equipment are required, they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw

materials, bulk materials, conduit, fittings, sheet metal, solder, fasteners, and similar items, except as otherwise indicated.

D. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by Telecommunications and University.

E. Where the Contractor proposes substitute equipment, contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work, shall be the responsibility of this Contractor, regardless of the trade involved.

F. Deliver products to the project identified with names, model numbers, types, grades, compliance labels, and other information needed for distinct identification; adequately packaged and protected to prevent damage during shipment, storage and handling.

1.11 INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of systems, materials, and equipment. Comply with the following requirements:

B. Coordinate systems, equipment, and materials installation with other building components.

C. Verify all dimensions by field measurements.

D. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for cabling installations.

E. Sequence, coordinate, and integrate installations of cabling materials and equipment for efficient flow of the Work.

F. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

G. Coordinate the cutting and patching of building components to accommodate installation of cabling equipment and materials.

H. Coordinate the installation of all materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

I. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Plywood on MDF/IDF walls shall be void-free and treated on all sides with two coats of fire-resistant paint.

K. Ensure that the fire rating of all walls and floors is maintained.

1.12 CONDUIT AND RACEWAY

- The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete cable support systems.

- Wire basket support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.

- Ladder cable tray systems are defined to include, but are not limited to straight sections of ladder type cable trays, bends, tees, elbows, drop-outs, supports and accessories. Ladder cable tray is to be installed by the G.C. and supported independent of any cabinet or rack.

- This section also defines additional requirements for conduit installations.

A. REFERENCES

- NFPA 70 – National Electrical Code.
- ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
- NEMA VE 2-2000 – Cable Tray Installation Guidelines.
- ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes.
- NEMA VE 1-1998 - Metallic Cable Tray Systems.

B. QUALITY ASSURANCE

- Comply with NEC, as applicable to construction and installation of cable tray and cable channel systems (Article 392).

- Comply with NFPA 70B, “Recommended Practice for Electrical Equipment Maintenance” pertaining to installation of cable tray systems.

- Installer: Qualified with at least 3 years of successful installation experience on projects with technology raceway work similar to that required for this project.

C. DELIVERY, STORAGE AND HANDLING

- Deliver cable tray (ladder type and wire basket) support systems and components carefully to avoid breakage, bending and scoring finishes. Do not install damaged

equipment. Store cable tray (ladder type and wire basket) and accessories in original cartons and in clean dry space; protect from weather and construction traffic.

1.13 MDF (Main Service Entrance point)

A. The MDF shall be sized to accommodate all cable terminations and equipment, which may include wall mounted termination blocks and equipment. Adequate work space shall be provided for installers and technicians. At least 36 inches clear access is required at the front and back of each equipment rack. Three feet of space is also required on at least one side of a rack or a bay of equipment racks. Three feet of clear space is also needed to access wall mounted equipment.

B. This room shall be strategically located and contain the modular patch panels necessary to terminate the riser cable and the horizontal wiring for that floor in the case that this room also serves as the telecommunications room for that floor. This room should be located near the main service entrance point and any computer room located on its floor.

C. In addition the following items shall be carefully considered:

- Adequate work space shall be provided for installers and technicians. At least 36 inches clear access is required at the front and back of each equipment rack. Three feet of space is also required on at least one side of a rack or a bay of equipment racks. Three feet of clear space is also needed to access wall mounted equipment;

- Adequate room for conduit and wire tray entrances should be provided. The design should meet current needs and include an allowance for at least one additional wire tray and for at least one additional conduit. Additional conduit space for the addition of 30 to 50% more conduit should be provided;

- Sufficient air conditioning shall be provided for equipment cooling.

- Adequate A.C. power shall be provided with ample wall jacks. The A.C. power shall be dedicated 20 amp circuits terminated on duplex wall outlets; they must be served by the same transformer. A minimum of three dedicated circuits should be provided. Adequate work space provided for installers and technicians. **A.C. power outlets are NOT to be terminated at the top of the rack.**

    - **Power requirements may be increased for MDF or IDF with 192 or more network outlets**

1.14 NETWORK CABLE INTO THE BUILDING TELECOMMUNICATIONS ROOM

A. The cable into the building telecommunications room shall be designed in cooperation with Verizon, West Virginia, West Virginia University's Telecommunications Department and the end user building coordinator(s).

B. Trunk locations in existing, co-located building shall be studied for coordination of services. In some cases, it may be desirable to establish interconnecting services between buildings.

C. Options for fiber entrance points, backbone Local Area Networks and other common point data services shall be considered.

D. A minimum of two (2) four inch conduits shall be provided for cable entrance.

1.15 OUTSIDE PLANT CABLING

A. Copper and fiber optic outside plant cabling is often required to provide connectivity between locations on the WVU Campus. This includes installation and splicing of aerial, buried and underground cables and the associated structure.

B. Aerial cabling will require extensive design and coordination with the various other utilities, municipalities, State Government, Department of Transportation and property Universities in the area of construction. Coordination for the acquisition of rights of way and pole attachment rights must be coordinated with the appropriate entities.

C. All aerial cabling and associated structure is to be of the appropriate design for the environment in which it is placed and is to be installed in compliance with applicable local codes as well as Belcore Standards and ANSI/EIA/TIA-758-1.

D. All buried and underground cabling will require extensive design and coordination with the various other utilities, municipalities, State Government, Department of Transportation and property Universities in the area of construction. Coordination for the acquisition of rights of way and pole attachment rights must be coordinated with the appropriate entities.

E. All buried and underground cabling and associated structure is to be of the appropriate design for the environment in which it is placed and is to be installed in compliance with applicable local codes as well as Belcore Standards, ANSI/EIA/TIA-758-1 and the West Virginia University Physical Plant Construction Standards.

1.16 IDF

A. Telecommunications rooms on each floor should be strategically located and contain the rack mounted modular patch panels necessary to terminate the riser cable and the horizontal wiring for that floor.

- Siemens or Panduit angled patch panels with veritical cable management are required. Siemens part number MX-PNL-48A or Panduit model NKA5EPPG48Y.

B. The room should be located so that wire run lengths do not exceed the requirements of ANSI/TIA/EIA-568-B.2. If a floor has a main computer room, then the floor telecommunications room should be located in close proximity to the computer room.

C. In addition, the following items shall be carefully considered:

- Each floor telecommunications room of a building should be stacked directly over the lower floors telecommunications room and located near the center of the building.
- Each floor telecommunications room should be stacked over the building telecommunications room if possible.
- Adequate work space shall be provided for installers and technicians. At least 36 inches clear access is required at the front and back of each equipment rack. Three feet of space is also required on at least one side of a rack or a bay of equipment racks. Three feet of clear space is also needed to access wall mounted equipment
- Adequate room for conduit and wire tray entrances shall be provided. The design shall meet current needs and include an allowance for at least one additional wire tray and for at least one additional conduit. Additional conduit space for the addition of 30 to 50% more conduit should be provided.
- Sufficient air conditioning shall be provided for equipment cooling.
- Adequate A.C. power shall be provided with ample wall jacks. The A.C. power shall be dedicated 20 amp circuits terminated on duplex outlets at the rack. All outlets must be served by the same transformer. A minimum of three dedicated circuits should be provided. **A.C. power outlets are NOT to be terminated at the top of the rack.**
    - **Power requirements may be increased for MDF or IDF with 192 or more network outlets**

1.17 WIRELESS

- WVU Networking will review floor plans to determine WAP locations. Once plans are in the final stages, WVU will again review and sign off on the plan.
- WAPs will be installed no higher than 2' (2 feet) above a drop ceiling.
- Dual outlets will be installed at each WAP location.
- There will be a label or some other type of unique notation or marker on the ceiling where the WAP outlet is located.
- Enclosures will be specified by WVU Networking, based on each particular installation.

1.18 SPECIAL RESIDENCE HALL MINIMUM WIRING REQUIREMENTS

- For each bed in a residence hall room there shall be a telecommunications wall outlet providing two RJ-45 jacks for voice and data and a coax connection for cable TV or other video. The use of conduit and/or cable tray is optional, depending on the individual building requirements.

- For voice and data access, the Integrated Communication Outlets (ICOs) meeting the current Telecommunications Wiring Requirement shall be installed. Currently this is a modular duplex outlet with two RJ-45 jacks connected to Category 6 four pair unshielded twisted pair cable in one module and a blank module for future requirements. Either or both of the RJ-45 cables can be used for a Local Area Network (LAN) connection or for a voice telephone connection.

- For cable TV or video access, a coax outlet shall be installed. The Cable TV outlet and the voice/data outlet will be combined in a single or duplex dual gang box configuration

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with these specifications, cable tray (ladder type and wire basket) cable support systems to be installed shall be as manufactured by B-line, GS Metals Corporation or Telecommunications approved equal.

2.2 SECTIONS AND COMPONENTS

A. Provide cable tray (ladder type and wire basket) of types and sizes indicated; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

B. Material and finish specifications for each metal cable tray type are as follows:
   - Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTM B633.

C. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be coated after the wire basket runway has been fabricated in accordance with ASTM A123 (CSA Type 1). All hot-dip galvanized sections must be returned to the point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so may result in damage to cables and/or injury to installers.

D. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

E. To provide for allowable amounts of cable bend radius, provide cable fallouts or waterfalls at all points where cable transitions from horizontal to vertical.

2.3 CABLE TRAY AND SUPPORT SYSTEMS

A. All straight section longitudinal runs shall be straight (with no bends).

B. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

C. Wire basket sizes shall conform to the following nominal criteria:

- Straight sections shall be furnished in standard lengths.
- Wire basket shall have a 4 inch usable loading depth by the width identified on the drawings.
- All fittings shall be field formed as needed.
- The installation and all fittings of all raceways shall allow Category 6 cable and fiber optic cable to be pulled in and through in such a manner as to not exceed the pulling tension or minimum bending radius.
- All splicing assemblies shall be the bolted type using flange locknuts.
- Cable tray supports shall be center support hangers, trapeze hangers or wall brackets and shall be supported by 1/4 inch or 3/8 inch diameter rods.
- Special accessories shall be furnished as required to protect, support and install all cable tray support systems.
- Coordinate material and installation with the requirements of Section Technology Hangers and Supports.
- Material and finish specifications for ladder type cable tray shall be as follows: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. All fabricated parts shall be made from Aluminum Association Alloy 5052.
- Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 6 inches on center. Spacing in radiused fittings shall be 9 inches and measured at the center of the tray's width. Rungs shall have a minimum cable-bearing surface of 7/8 inch with radiused edges. No portion of the rungs shall protrude

below the bottom plane of the side rails. Each rung must be capable of supporting the maximum cable load, with a safety factor of 1.5 and a 200 pound concentrated load when tested in accordance with NEMA VE-1, section 5.4.

- Ladder type tray sizes shall have 4 inch minimum usable load depth.

- Ladder type straight tray sections shall have side rails fabricated as I-Beams. All straight sections shall be supplied in standard 10 foot lengths, except where shorter lengths are permitted to facilitate tray assembly lengths as shown on drawings.

- Ladder type tray widths shall be 12, 18, or 24 inches as shown on drawings.

2.4 INSTALLATION

A. Actual locations of all equipment, raceways, junction boxes, cable runs, conduit runs, etc., shall be determined at the site.

B. Install cable tray (ladder type and wire basket) as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), ensure that the cable tray equipment complies with requirements of the NEC, and all general installation practices.

C. Coordinate cable tray (ladder type and wire basket) with other electrical and mechanical work as necessary to properly interface installation of raceway with other work.

D. Provide sufficient space encompassing cable tray (ladder type and wire basket) to permit access for installing and maintaining cables.

E. For added support and stability, securely fasten cable tray (ladder type and wire basket) to top of racks and to walls in all MDF/IDF rooms at elevations shown on drawings.

F. Install all raceways parallel to the wall or ceiling lines unless otherwise noted. Support basket cable raceways every 4’ minimum and at 6” from ends or boxes.

G. Ground the raceway per NEC Article 250, 392 and ANSI/TIA/EIA-607.

H. Route raceways in a manner to avoid steam or water piping.

I. Fish or blow through every run of conduit before plastering to guard against obstructions or omissions and plug ends carefully with tight fitting wood plugs or bush caps to avoid filling with plaster, dust, etc. and to avoid the possibility of condensation.

J. Leave nylon or steel fish wire in all raceways where permanent wiring is not being installed under this contract.

K. Install conduit making the total cross-sectional area of each raceway of sufficient size to permit ready installation or withdrawal of the cables required therein.

L. Route cable tray (ladder type and wire basket) a minimum of 5" clearance from fluorescent light fixtures, 12" clearance from electrically operated equipment and all wiring at 120 or more volts and 4 ft. from transformers or large motors.

M. All technology conduits are to be provided with nylon bushings to allow for cable pulling without damage.

N. For cable support, provide strain relief a minimum of every 10' in vertical conduits runs. Provide the proposed method and products as a product submittal.

O. In areas without suspended ceilings, install cable tray (ladder type and wire basket) raceways 6" below the lowest obstruction unless otherwise directed.

P. Provide a pull box or pull point immediately before and after any conduit or raceway section containing three ninety-degree bends, or any single run exceeding fifty feet in length. Pull box openings must face in the direction from which personnel will approach and must have a minimum eight inches in front of and to all sides of the opening.

Q. Test cable tray (ladder type and wire basket) support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance.

R. Manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed in accordance with the latest revision of NEMA VE-1.

S. Carefully investigate the structural, electrical/electronic and finished conditions of work accordingly.

2.5 TECHNOLOGY HANGERS AND SUPPORTS

A. This Section includes secure support from the building structure for technology items by means of hangers, supports, anchors, sleeves, inserts, seals and associated fastenings.

B. All support shall utilize threaded fasteners for all Technology/attachments.

C. Exception:
- Spring steel fasteners may be used in lieu of threaded fasteners only for ¾" raceways above suspended ceilings.

D. Types of supports, anchors, sleeves and seals specified in this section include the following:
- Clevis hangers
- Riser clamps
- C-clamps
- I-beam clamps
- Conduit straps
- Round steel rods
- Lead expansion anchors
- Toggle belts
- Wall and floor seals

E. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment, are specified as part of that equipment assembly or as specified.

2.6 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of supporting devices, of types, sizes, and ratings requires, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's Qualifications: Firm with at least 3 years of successful installation experience with projects utilizing electronic/electrical supporting device work similar to that required for this project.

C. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of supporting devices.

D. MSS Compliance: Comply with applicable MSS standard requirements pertaining to fabrication and installation practices for pipe hangers and supports.

E. UL Compliance: Provide components that are UL listed and labeled.

F. FS Compliance: Comply with Federal Specification FF-S-760 pertaining to retaining straps for conduit, pipe and cable.

G. Components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

2.7 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- Slotted Metal Angle and U-Channel Systems:
- Allied Tube and Conduit

- American Electric
- B-Line Systems, Inc.
- Cinch Clamp Co., Inc.
- Elcen Metal Products Co.``
- Greenfield Mfg. Co., Inc.
- Haydon Corp.
- Kin-Line, Inc.
- Midland-Ross Corp.
- Power-Strut Div; Van Huffel Tube Corp.
- Unistrut Diversified Products

B. Anchors:
- Abbeon Cal Inc.
- Ackerman Johnson Fastening Systems Inc.
- Elcen Metal Products Co.
- Ideal Industries, Inc.
- Joslyn Mfg. and Supply Co.
- Rawl Plug Co. Inc.
- Star Expansion Co.
- U.S. Expansion Bolt Co.
- Hilti, Inc.

2.8 U-CHANNEL STRUT SYSTEMS

A. Provide U-channel strut system for supporting electronic/electrical equipment, 12-gage hot dipped galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with standard green finish, and with the following fittings which mate and match with U-channel and are of the same manufacturer:

- Fixture hangers
- Channel hangers
- End caps
- Beam clamps
- Wiring stud
- Thin wall conduit clamps
- Rigid conduit clamps
- Conduit hangers
- U-bolts

2.9 SUPPORTING DEVICES

A. Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

- Use Clevis Hangers: For supporting equipment weighing approximately 54 pounds or less.
- Use Riser Clamps: For supporting equipment weighing approximately 510 pounds or less.
- Use Reducing Couplings: For supporting equipment weighing approximately 16 pounds or less.
- Use C-Clamps: For supporting equipment weighing approximately 70 pounds or less.
- Use I-Beam Clamps: For supporting equipment weighing approximately 52 pounds or less.
- Use One-Hold Conduit Straps: For supporting equipment weighing approximately 7 pounds or less.
- Use Two-Hole Conduit Straps: For supporting ¾" rigid metal conduit, galvanized steel; ¾" strap width; and 2-1/8" between center of screw holes.
- Use Hexagon Nuts; for ½" rod size; galvanized steel; weighing approximately 4 pounds per 100 feet.
- Use Round Steel Rod: Black steel; ½" diameter; weighing approximately 67 pounds per 100 feet.
- Use Offset Conduit Clamps: For supporting 2" or less rigid metal conduit; black steel; weighing approximately 200 pounds per 100 feet.

2.10 ANCHORS

A. Provide anchors of types, sizes and materials indicated; and having the following construction features:
   - Lead Expansion Anchors: ½", approximately 38 pounds per 100 units.
   - Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 pounds per 100 units.

2.11 SLEEVES AND SEALS

A. Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:
   - Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws. For fire rated penetrations comply with all UL fire stopping system requirements.

2.12 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative

treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.13 FABRICATED SUPPORTING DEVICES

A. General: Shop-or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabrication of angles, channels and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

2.14 EXECUTION

A. Provide supporting devices that comply with manufacturer's standard materials. Install in accordance with published product information, and as required for a complete installation. Where more than one type of supporting device meets indicated requirements, selection is Contractor's option.

B. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NEC for installations of supporting devices.

C. Support all technology cables a minimum of every 4 foot with J hooks, unless other supports are available.

D. Coordinate with the building structural system and electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

E. Do not fasten supports to pipes, ducts, mechanical equipment and conduit.

F. Install surface-mounted cabinets and panels with minimum of four anchors.

2.15 MISCELLANEOUS SUPPORTS

A. Support miscellaneous technology components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panels, control enclosures, pull boxes, junction boxes and other devices.

2.16 FASTENING

A. Unless otherwise indicated, fasten technology items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, cabinets, panels, boxes and control components in accordance with the following:

B. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

C. Holes cut into reinforced concrete beams or in concrete shall not cut reinforcing bars. If the Contractor cuts into any reinforcing bars, stop work and notify the Telecommunications immediately. Fill all holes that are not used.

D. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.

2.17 TESTS

A. Test pull-out resistance of one of each type, size and anchorage material for the following fastener types:
- Expansion anchors.
- Toggle bolts.
- Powder-driven threaded studs.
- Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. When appropriate, obtain the Structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

2.18 FIRESTOPPING

General

A. Provide through penetration fire stop systems to prevent the spread of fire through openings made in fire-rated walls or floors to accommodate penetrating items such as conduit, cables and cable tray. Fire stop shall restore floor and wall to the original fire rated integrity and shall be waterproof. The fire stop systems and products shall have been tested in accordance with the procedures of U.L. and material shall be U.L. classified as Materials for use in through penetration fire stops.

B. The fire stop system shall comply with the NEC and with NFPA 101-Life Safety Code (latest edition) and shall be made available for inspection by the local inspection authorities prior to cable system acceptance. The contractor shall be responsible for verifying the fire rating of all walls and floors having cabling penetrations. When applicable, coordinate sealant installation with work of other trades and with the general contractor on site.

C. Fire stop systems shall be UL Classified to ASTM E814 (UL 1479) or shall be approved by a qualified Professional Engineer (PE), licensed in West Virginia. A drawing showing the proposed fire stop system shall be provided to the University and Telecommunications prior to installing the fire stop system(s).

2.19 TECHNOLOGY GROUNDING AND BONDING

A. Ground communications systems and equipment in accordance with the ANSI/TIA/EIA-607 Grounding Standard and NEC requirements except where the Drawings or Specifications exceed NEC requirements. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, paging equipment, CATV equipment etc. entering or residing in technology spaces shall be grounded to the respective ground system using a minimum #6 AWG solid copper bonding conductor and two hole/two barrel compression connectors. All wires used for technology grounding purposes shall be identified with green insulated wires. All cables and bus bars shall be identified and labeled in accordance with the Technology Identification requirements.
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2.20 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings of types and rating required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer: Qualified with at least 3 years of successful installation experience on projects with technology ground work similar to that required for this project.

C. Listing and labeling: Provide products specified in this Section that are listed and labeled. The terms “listed” and “labeled” shall be defined as they are in the National Electric Code, Article 100.

D. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

E. Field-testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on evaluation of organization-submitted

criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated.

F. Component Standard: Components and installation shall comply with NFPA 70, "National Electric Code" (NEC).

G. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical and electronic grounding.

H. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical and electronic grounding.

2.21 GROUNDING AND BONDING PRODUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
- B-Line Systems, Inc.
- Burndy Corp.
- Crouse-Hinds Co.
- Electrical Components Div.; Gould Inc.
- General Electric Supply Co.
- Ideal Industries, Inc.
- Thomas and Betts Corp.

B. Products: Supply types indicated and of sizes and rating to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

C. Conductor Materials: Copper with min 98% conductivity.

2.22 WIRE AND CABLE CONDUCTORS

A. Equipment Grounding Conductor: Green insulated.

B. Grounding Electrode Conductor: Stranded cable.

C. Bare Copper Conductors: Conform to the following:
- Solid Conductors: ASTM B-3.
- Assembly of Stranded Conductors: ASTM B-8.
- Tinned conductors: ASTM B-33.

2.23 MISCELLANEOUS CONDUCTORS

A. Ground Bus: Bare annealed copper bars of rectangular cross section. All bus bars shall be two-hole lug type.

B. Bonding Strap Conductor/Connectors: Soft copper, 0.05 inch thick and 2 inches wide, except as indicated.

C. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gage bare copper wire, ¾" wide, 9-1/2" long; 48.250cm. Protect braid with copper bolt hole ends with holes sized for 3/8" dia. bolts.

2.24 CONNECTOR PRODUCTS

A. Listed and labeled as grounding connectors for materials used and approved by a nationally recognized testing laboratory.

B. Pressure Connectors: High-conductivity-plated units. All lugs shall be two-hole type.

C. Bolted Clamps: Heavy-duty units listed for the application.

2.25 GROUNDING ELECTRODES

A. For technology systems, provide a #6 AWG minimum insulated stranded copper conductor from the grounding electrode system to each telecommunication room, terminal cabinet and central location.

B. Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by manufacturers for indicated applications.

C. Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials and bonding straps, as recommended accessories by manufacturers.

D. All ground cables shall be labeled in accordance with ANSI/TIA/EIA 606

2.26 EXECUTION

A. Each 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 building ground and shall be designed in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.

B. The main communications entrance facility/equipment room shall be equipped with a telecommunications main grounding bar (TMGB). Each telecommunications room shall be provided with a telecommunications ground bar (TGB) connected to the TMGB by a #6 AWG minimum insulated stranded copper conductor. The TMGB shall be connected to the building electrical entrance grounding facility (master ground bus) with a #2 AWG minimum insulated stranded copper conductor. 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.

C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, paging equipment, security equipment, CATV equipment etc. entering or residing in telecommunication spaces shall be grounded to the respective TGB or TMGB using a minimum #6 AWG insulated stranded copper conductor and compression connectors.

D. All cables and bus bars shall be identified and labeled in accordance with the Identification requirements Section 17106.

E. Except as otherwise indicated, provide grounding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, terminals (solderless lugs), bonding jumper braid, surge arresters, and additional accessories needed for complete installation. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, and established industry standards for applications indicated.

F. All bonding conductors shall not be placed in a ferrous metallic conduit. If it is necessary to place any bonding conductors in ferrous metallic conduit that exceeds 1 meter in length, the grounding conductors shall be bonded to each end of the conduit with a conductor sized as a # 6 AWG minimum.

G. All connections to building steel shall be exothermically (CAD) welded and connected to the telecommunications grounding bus bar with a minimum #2 AWG cable.

H. All cable tray and equipment racks shall be bonded together with grounding straps of a minimum of a #6 AWG cable. Bonding cables shall be equipped with a compression type ground lug on both ends. The ground lugs shall be attached to a point on the rack that is free of paint and equipped with a star washer. After connecting the ground lugs, seal the connection.

I. All ground cable connections to the telecommunications ground bar shall be with compression type lugs. No setscrew type lugs shall be used.

J. All ground conductors shall be free of splices.

K. All ground conductors shall be routed in a neat and workmanlike manner and shall be free of sharp bends and kinks.

L. All new and existing protected entrance terminals in the telecommunications room shall be grounded and connected to the telecommunications grounding bar with a # 6 AWG conductor.

M. Bond the Data/Communications cable tray located in the at the building service entrance points with a minimum of # 2 AWG cable. Note that each tray is grounded at one building service entrance panel only. Connect the bonding conductor to the tray bonding conductor with a compression type fitting. No setscrew type lugs shall be used.

2.27 INSPECTION

A. Installer must examine areas and conditions under which technology grounding connections are to be made and notify Telecommunications in writing of conditions detrimental to proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

2.28 APPLICATION

A. Provide technology grounding systems where shown, in accordance with applicable portions of NEC and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.

2.29 INSTALLATION

A. Ground communications systems and equipment in accordance with the ANSI/TIA/EIA- 607 Grounding Standard and NEC requirements except where the Drawings or Specifications exceed these requirements.

B. Coordinate with other work as necessary to interface installation of grounding system with other work.

C. Route grounding conductors along the shortest and straightest paths without obstructing access or placing conductors where they may be subjected to strain, impact, or damage, except as indicated.

D. Install bonding connections in accessible locations with approved components.

E. Each TGB shall be directly bonded to building steel and other permanent metallic systems where accessible.

F. The TGB and TMGB must be visibly labeled and physically secured.

G. Where the ground wire is exposed support at a minimum of every 24” both vertically and horizontally.

2.30 CONNECTIONS

A. General: Make connections in such a manner as to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

B. Use electroplated or hot-tin-coated materials to assure high conductivity and make contact points closer to in order of galvanic series.

C. Make connections with clean bare metal at points of contact.

D. Coat and seal connections involving dissimilar metals with inert material such as red lead paint to prevent future penetration of moisture to contact surfaces.

E. Tighten grounding and bonding connectors and terminals, including screws and bolts, using tiger washers, and in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

2.31 FIELD QUALITY CONTROL

A. Upon completion of installation of technology grounding systems, test ground resistance with ground resistance tester. Where tests show resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 2 ohms, or less.

3. TECHNOLOGY IDENTIFICATION

3.1 SUMMARY

A. This Section includes requirements for identification of components including but not limited to the following:
- Identification labeling for cables and conductors
- Operational or instructional signs
- Equipment labels and signs.

B. Comply with the EIA/TIA Standard 606, "The Administration Standard for the Telecommunications Infrastructure"

3.2 QUALITY ASSURANCE

A. Installer's qualifications: Firm with at least 3 years of successful installation experience with products utilizing technology identification equipment similar to that required for this project.

B. All work shall be in accordance with the general principles outlined in the BICSI TDMM manual latest edition and with the TIA-526, TIA-568-B.2-1 and TIA-606-A Standards.

C. UL Compliance: Comply with applicable requirements of UL Standard 969, "Marking and Labeling Systems", with regard to type and size of lettering for raceways and cable labels.

D. NEMA Compliance: Comply with applicable requirements of NEMA Standards WC-1 and WC-2 pertaining to identification of power and control conductors.

E. Major items of equipment shall have manufacturer's name, address and catalog number on the plate securely attached in a convenient place.

3.3 REQUIRED NUMBERING AND LABELING SCHEME

A. Each 48 port closet patch panel will be labeled starting with the top-most designated as "A". The next 48 port patch panel in the closet will be labeled as "B", and so forth.

B. Labeling for each room jack will follow this format:

Room - Patch Panel Letter - Patch Jack Number

All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.

C. The label shall be black letters on white background. All label printing will be machine generated by Panduit or Telecommunications approved equal hand-held printers using indelible ink ribbons or cartridges. Self-laminating labels shall 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.

D. The blank white label tags that are included in the faceplate hardware are to be installed with clear plastic shields in all positions on the faceplate.

E. There shall not be any open places on the patch panel.

F. Terminate all outlets from the same room sequentially on the same patch panel.

G. If an outlet is added it gets a new number that is next on the sequence even if it is on an existing faceplate.

H. Special considerations for Wireless Access Points

- All WAP terminations are to be placed on a separate patch panel in the closet or grouped together on one patch panel.
- There will be a label or some type of distinguishing marker on the ceiling indicating where the WAP outlet is located.
- WAP labeling will be designated by the room location or nearest room location.

I. Riser Cables

- Numbering scheme. Riser cables must be assigned specific numbers. Each shall be tagged with the room number of the MDF/IDF at both ends of the cable clearly shown.

- Labeling techniques. Each cable is to be labeled on each end within 12" of where it terminates on the cross-connect panel. Cable tags must be securely fastened to the cable sheath. Wrap around tags protected by clear polyurethane tape may be used as well. Tags must be typed and be permanent. Cable tags that appear less than permanent will not be accepted. Directly writing on the cable sheath will not suffice as proper labeling of riser cables.

J. Entrance UTP cabling cross-connect panels.

- Numbering scheme. 25 pair cables from the Utility blocks are terminated on 110 blocks. Cable pairs are numbered in 25 pair increments. The first cable is numbered 1-25, the second 26-50, etc. Pair #1 is terminated on the left position of the top block. Subsequent cable pairs are terminated from left to right and from top to bottom.

- Labeling techniques. The first label block shall read, "Cables to 110 blocks, 1-25". Subsequent label blocks shall denote the same for pairs 26 – 50, etc. The label shall be black letters on white background. Labels must be produced by label-making equipment. Handwritten labels are not allowed.

K. Fiber optic cross-connect panels.

- Numbering scheme. Fiber optic cables and terminations shall be numbered and labeled per current EIA/TIA Standards. The numbering scheme denotes the cable function (campus backbone, building entrance, or intrabuilding), sheath number, and buffer tube number.

- Labeling techniques. A label shall be installed onto the outside of the front face of the connector housing to read, "Horizontal fiber optic cables to outlets" or "Entrance/riser fiber optic cables" as appropriate. Labels must be produced by label-making equipment. Handwritten labels are not allowed. Horizontal fiber

optic cables shall be labeled on the label tags on the closet connector housing. Each cable terminated shall be labeled with the following information: type of fiber optic cable and outlet number. For example, a label block for a multi-mode horizontal fiber optic cable termination might read, "MM – 17". Terminations are numbered by the outlet number, not the housing or connector panel position number. Only adapter positions that are terminated are labeled.

L. OSP fiber optic cables.

- Numbering scheme. The numbering scheme denotes the cable function (campus backbone or building entrance). Each fiber optic cable sheath shall be tagged in each MDF and IDF with the number and type of strands in the sheath (i.e. 18SM/18MM) and the building name of the far end of the cable clearly shown. In each intermediate manhole or hand hole each cable sheath shall be tagged with the number and type of strands in the sheath and the building names of each of the cable endpoints clearly shown.

- Labeling techniques. Each cable is to be labeled within 36" of where it enters each MDF or IDF. Cable tags may be cloth or plastic tape securely fastened to the cable sheath. Wrap around tags protected by clear polyurethane tape may be used as well. Tags must be typed and permanent. Cable tags that appear less than permanent will not be accepted. Directly writing on the cable sheath will not suffice as proper labeling. In intermediate manholes and hand holes, one wrap-around cable marker shall be installed on each cable sheath. Markers shall have a clear Mylar covering reading "Fiber Optic Cable – Caution" with space for cable designation. Cable markers shall be orange in color. Other types of tags, tapes, or sheath marking are not acceptable.

M. Equipment racks.

- Numbering scheme. Each rack is numbered sequentially denoting the following information: building name, MDF/IDF room number, and rack number. There is no correspondence between the rack equipment configuration (type) and the rack number.

- Labeling techniques. Two labels shall be installed onto the front face of each equipment rack, one at the bottom of the rack, and one at the top. All labels shall be black letters on white background. Provide engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.

N. MDF/IDF room electrical receptacles.

- Each electrical receptacle in MDF/IDFs shall be labeled with the following information: room number where electrical panel is located, panel number, and circuit number. Each receptacle is to be labeled on top or front of the faceplate or outlet box. Preprinted adhesive labels or tags shall be used.

PRODUCTS

3.4 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following (for each type marker): Panduit Corp or University and Telecommunications approved equal.

3.5 TECHNOLOGY IDENTIFICATION PRODUCTS

A. Cable/Conductor Identification bands:

- Provide Manufacturer's standard wrap-around cable/conductor markers, of size required for proper application, and numbered to show circuit identification.

B. Equipment Labels

- General: Provide engraved stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening.

- Thickness: 1/16", for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Lettering and Graphics

- General: Coordinate names, abbreviations and other designations used in technology identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the technology systems and equipment.

- Fasteners for Plastic-Laminated Signs shall be self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and lock washers.

- Exception: Where specifically approved contact type permanent adhesive may be used where screws cannot or should not penetrate substrate.

3.6 EXECUTION

Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application.

A. Lettering and Graphics: Coordinate names, abbreviations, colors and other designations used in technology identification work with corresponding designations specified or

indicated. Install numbers, lettering, and colors as approved in submittals and as required by standards.

B. Install identification devices as indicated, in accordance with manufacturers written instructions.

C. Sequence of work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

3.7 CABLE/CONDUCTOR IDENTIFICATION

Apply cable/conductor identification on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used on shop drawings, contract documents, and similar previously established identification for project's technology work.

3.8 OPERATIONAL SIGNS

Provide instructional signs with approved legend where instructions or explanations are needed for system or equipment operation.

3.9 OUTLET IDENTIFICATION

Label each voice and data outlet with the proper designation and provide appropriate icon.

3.10 INSTALLATION

A. Provide equipment identification labels of engraved plastic-laminate on all equipment racks and on major units of technology equipment in buildings. Except as otherwise indicated, provide single line of text, with ½-inch high lettering on 1-½-inch high label (2-inch high where two lines are required), white lettering in black filed. Text shall match terminology and numbering of the Contract Documents and shop drawings.

B. Provide labels at locations indicated and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

3.11 TESTING

A. Contractor, at his own expense, shall make any tests directed by an inspection authority or by Telecommunications and shall provide all equipment, instruments and materials to make such tests.

B. Upon completion of work, all component parts, both singularly and as a whole, shall be set, calibrated, adjusted and left in satisfactory operation condition to suit load conditions, by means of instruments furnished by the Contractor.

C. Notify the University and Telecommunications seven (7) days prior to the testing dates. Upon completion of a test, a statement of certification shall be forwarded to Telecommunications for its approval.

4. EXECUTION

4.1 WORK

A. All work shown shall be new work provided under this Contract except that work labeled "present to remain" and that equipment labeled "to be furnished by other, but installed by the Contractor".

4.2 CUTTING, PATCHING, REPAIRING AND PAINTING

A. Perform required cutting, drilling and chasing to receive new equipment. In general, perform all patching and repairing necessary to restore to original condition, all surfaces that may become damaged during the installation. All work shall be executed by persons normally employed in the type of work to which they are assigned.

B. Paint all structural steel and all steel parts used for hangers and for supporting conduits, junction boxes and technology equipment with one (1) coat of "red" oxide primer before erection. After steel is in place, paint again with one (1) coat of "light grey" paint.

C. The contractor is responsible for all cutting, patching, plastering and painting associated with the new installation.

4.3 CLEAN UP

A. Upon completion of the contract, remove all workmen's appurtenances from the premises. Clean the premises of all debris caused by the work and leave the installation clean and in first-class operating condition.

4.4 STORAGE OF MATERIAL AND EQUIPMENT

A. Store materials and equipment in a location approved by the University.

B. Be responsible for the condition of all materials and equipment employed in the installation until final acceptance by the University.

C. Be responsible for the replacement of all damaged or defective work, materials or equipment. Do not install sensitive or delicate equipment until major construction work is completed. Ensure that equipment is protected from all construction site activities.

D. Observe and conform to all applicable safety regulations required by the University and O.S.H.A.

4.5 INTERPRETATION AND CONFLICTS

A. Bring any discrepancies determined or omissions found lacking in the Contract Documents to Telecommunications' attention before submitting the bid. After award of Contract, the University or Telecommunications will make the interpretation of any conflict.

B. The failure to question any controversial item will constitute acceptance by the Bidder who shall execute it to the satisfaction of the University after being awarded the Contract.

C. If mention has been omitted pertaining to details, items or related accessories required for the completion of any system, it is understood such item and accessories are included in the Contract. After the Contract is awarded, claims based on insufficient data or incorrectly assumed conditions, or claims based on misunderstanding the nature of the work, will not be recognized.

D. The General Conditions, Requirements, and Special Provisions, of any larger body of specifications, of which this Specification may be a part, are hereby made a part of this Specification. In the event that any clauses or provisions of the larger body of specification conflict with the letter or intent of this Specification, the Contractor shall immediately notify Telecommunications for clarification and direction.

4.6 MARKING AND IDENTIFICATION

Clearly mark all new equipment, devices and miscellaneous apparatus for easy identification and for safety.

4.7 LOCATION OF EQUIPMENT AND RACEWAY

A. The drawings are diagrammatic and indicate the general arrangement of equipment to be installed.

B. Carefully investigate the structural, electrical/electronic and finished conditions of work accordingly.

C. Actual locations of all equipment, raceways, junction boxes, cable runs, conduit runs, etc., shall be determined at the site. Install all items to meet the various conditions in the building and make deviations necessary without additional cost.

4.8 WIRING METHODS

A. All wire and cable shall be installed in finished areas in new or existing raceways as indicated.

B. New raceways shall be installed in the locations as specified.

4.9 ORDINANCES AND CODES

Nothing contained in the Specifications or shown on the drawings shall be so construed as to conflict with any local, municipal or state laws and regulations, governing the installation or other contract work, and all such ordinances and regulations, including the latest: National Electric Code, ANSI/EIA/TIA standards and the National Electric Safety Code, are hereby incorporated and made a part of these Specifications, and shall be satisfied by the contractor at no additional expense to the University. The Contractor shall secure all permits and inspection certificates for submission to the University.

4.10 SYSTEM CONTUNITY

Reconnect all existing items that remain in use. Provide all materials and labor required to retain continuity of existing circuits or systems that are disrupted by these alterations even though not indicated on the drawings.

4.11 SUBMITTALS

A. Shop drawings shall be checked, corrected and approved by the contractor before being submitted to the University/Telecommunications for approval. Before submitting shop drawings, the Contractor shall carefully examine them and shall certify by his stamp that, to the best of his knowledge, they comply with the Contract Documents. The Contractor must receive written approval from the University or an authorized representative of the Telecommunications, in writing, prior to fabricating or installing any materials. Approval will be given based upon shop drawings. The shop drawings shall indicate complete details of work to be performed. Drawings shall include a title block naming the Project, Contractor, drawing title, drawing number, revision number if applicable and date. Submit all Shop Drawings complete as a single submission. Isolated items will not be accepted, except with prior approval.

B. Where the shop drawings deviate from the requirements of the Contract documents, the Contractor shall (1) correct the shop drawings as required, or (2) where the deviations do not necessarily require correction, notify the University/Telecommunications of the deviations.

C. Submit to the University/Telecommunications two (2) sets of shop drawings or otherwise noted documents/equipment for the appropriate equipment and obtain written approval before ordering materials. Materials may include, but not be limited to, the following:

- Patch Panels (UTP and fiber including connectors)
- Cable (UTP and fiber)
- Patch Cables
- Outlets, Faceplates and Jacks
- Cable management Devices
- Inner Duct
- Punch down blocks
- Protection Devices
- Racks and cabinets
- Nameplates and Identification devices
- Basket style cable tray
- Ladder style cable tray
- Grounding equipment
- Hangers and Supports
- Strain relief products
- Security Equipment including door devices and power supplies
- All other equipment identified or inferred and as may be required by the Architect, University or Telecommunications, as per project requirements.
- Submit complete submittal list for University/Telecommunications approval prior to purchasing any equipment.

D. In some cases, manufacturer warranty may call for the review of system documentation to assure that the system design meets manufacturer warranty requirements. In such instance, with prior approval of the University, the contractor shall provide a complete set of Project Documents and product data to the system manufacturer for review. The system manufacturer shall review the complete system package and provide documentation attesting to the system compliance with manufacturer warranty requirements. This documentation shall be included with the Contractor Shop Drawings submittal. Telecommunications will not review the Contractor Shop Drawings submittal, which does not include the manufacturer warranty compliance review documentation.

E. Each shop drawing shall contain reference to the applicable drawing and specification section and verification of compatibility with the systems involved.

F. All nameplate data shall be submitted with equipment submittals – refer to other sections for complete identification requirements.

G. Shop drawings shall show conformance with specified performance characteristics, or the Contractor shall assume responsibility for all deviations including all additional costs as a result of the deviations.

4.12 STANDARDS OF MATERIAL AND WORKMANSHIP

A. All work shall be executed by persons skilled in the work to which they are assigned. This shall include all copper and fiber connections including testing, and all plastering and painting.

B. All materials and equipment in the work shall be new and of first quality, produced by manufacturers of recognized reputation for each line of material and equipment. The fact that materials or equipment offered have been recently developed or are untried may be sufficient justification for their rejection.

4.13 PROTECTION OF WORK AND EQUIPMENT

A. This Contractor shall use the required safety precautions, methods and skills to prevent possible unsafe conditions or conditions unduly susceptible to fire.

B. When this Contractor is working in areas in which the building occupants have access, contractor shall provide suitable barriers around his operation.

C. This contractor is responsible for containing the undue spread of vapors or odors from his work area.

4.14 TESTS AND INSTRUCTIONS

A. Upon completion of the work, and upon the request of the University or Telecommunications, the Contractor shall be prepared to test all systems in the presence of the University or Telecommunications. Such testing shall occur at a time that is mutually acceptable to all parties. The Contractor's representatives assisting in the performance of these tests shall be thoroughly familiar with the details of the system and shall include the field supervisor responsible for installing the system.

B. Correct all failures or improper conditions.

C. Demonstrate to the University the proper care and maintenance of all new items.

4.15 GUARANTEE

A. The contractor and his surety shall guarantee in writing for a minimum period of one (1) year from the date of final acceptance that all materials, equipment and labor furnished by contractor are free from defects. Refer to cable system warranty for additional requirements.

B. The Contractor shall further guarantee that if any piece of material or equipment is found to be defective within the guarantee period because of faulty manufacture or faulty installation, in the opinion of the University, contractor will replace and install and test such material or equipment without any further expense to the University.

5. COMMON STRUCTURED CABLING MATERIALS AND METHODS

5.1 SUMMARY

A. This Section includes general administrative and procedural requirements for the structured cabling system and campus inter building distribution systems. It includes contractor qualifications, terminations and testing parameters.

B. Codes and Regulatory References

C. Codes: The cabling system installation shall comply fully with all local, county and state laws, ordinances and regulations applicable to electronic and electrical installations.

D. The following industry standards are the basis for the structured cabling system described in this document.

- TIA/EIA
- TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
- TIA/EIA-568-B.1 General Requirements
- TIA/EIA-568-B.2 Balanced Twisted Pair Cabling Components Standard
- TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard
- TIA/EIA-569-A Commercial Building Standard for Telecom Pathways And Spaces
- TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- TIA/EIA-607 Commercial Building Grounding/Bonding Requirements
- NFPA
- NFPA 70 National Electric Code (NEC)
- ISO/IEC
- ISO 11801 Generic Cabling for Customer Premises
- If there is a conflict between applicable documents, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.
- This document does not replace any code, either partially or wholly. The contractor must be aware of local codes that may impact this project.

5.2 CONTRACTOR QUALIFICATIONS

A. All bidders shall demonstrate their qualifications by providing the following documents:

B. A list of the LAST five (5) Structured Cabling systems that were installed by the bidder:

- The listing shall include only systems that included the installation of fiber optic cable and category 5e or 6 twisted pair.
- The listings shall be for the last five projects that are completed and have been turned over to the University.
- The listing shall include a brief description of the project, size of the system, products used, University's name, phone number, address, and representative, date started, and date of completion.
- The bidder shall have a BICSI Registered Communication Distribution Designer (RCDD) or equivalent certification with five years experience, on staff. Submit the RCDD or equivalent Certificate.
- The contractor must provide a dedicated RCDD who is responsible for providing design/build services and project management as a service to WVU for the implementation of the MAC's. The RCDD must be available to WVU 24x7.
- All of the above documents shall be submitted along with the Bid Form, by the Bid due date.

C. The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data and voice network systems. The Contractor shall at a minimum possess the following qualifications:

- Those licenses/permits required to perform telecommunications installations in the specified jurisdiction.

D. Personnel trained and certified in the design of the Siemon Category 6 Cabling System.

- Personnel trained and certified to install the Siemon Category 6 Cabling System.
- The Contractor shall provide proof of current certification for the Siemon Category 6 Cabling System.
- Contractor must be a Mohawk /CDT Accredited Contractor.
- Contractor must have a minimum of 5 years experience in Inside Plant Cabling.
- Contractor must have a minimum of 5 years experience in Outside Plant Cabling.
- It is preferred that the contractor supply training certificates as proof of Wireless Training.
- Contractor must provide a dedicated account manager who is responsible for providing all services required, including resolution of services and account billing issues
- Personnel must be knowledgeable in local, state, and national codes, and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall apply.
- The Contractor shall have been in the business of installing structured cabling systems for a minimum of five (5) years.

E. The Contractor must possess and maintain current liability insurance certificates.

- The contractor should have an office located in Morgantown, WV or within a 30 Mile radius of the WVU Morgantown Campus.

F. The successful bidder shall provide the following additional documents:

- The bidder shall furnish a list of all test equipment that will be used in the installation and testing of the fiber optics, multi pair copper distribution cable and the twisted pair cable.
- The bidder shall furnish a listing of the names of full-time employees that will work on the project and list their training and certification in the installations and testing of structured cabling.

5.3 WARRANTIES

A. Warranty and Certification of the Cabling systems and connectors:

- The Contractor shall provide a 20-year performance and product warranty that all cable, connectors and connecting hardware shall be free from defects in material, workmanship and fabrication. Submit detailed warranty documentation with close out documentation.
- The system shall be certified by the cable/connector manufacturer and warranted for the specified performance for minimum of 20 years. The Contractor shall conform to the manufacturer's certification program including submittal of all required documentation to the manufacturer.
- The Contractor shall obtain, from the manufacturer, a Registration Document and Certificate for the specific installation. Upon receipt of the Registration Document and Certificate the Contractor shall forward a copy to the Telecommunications and deliver the original to the University.
- Any material, equipment or appurtenance whose operation or performance does not comply with the requirements of the Contract or any equipment which is damaged prior to acceptance will be held as defective and shall be removed and properly replaced at no additional cost to the University.

5.4 SUBMITTALS

The contractor shall provide product submittals for all system components. These components shall include all cable, termination devices; splice connectors, patch panels, associated racks and enclosures, patch cords and labeling devices. The selected contractor will allow sufficient time in project scheduling for client and review by Telecommunications.

5.5 QUALITY ASSURANCE PARAMETERS

A. All work shall be performed in accordance with these guidelines, current industry testing standards, and with the test equipment manufacturer recommendations. All work shall be in accordance with the general principles outlined in the BICSI TDMM manual, latest edition. System shall be Siemon Category 6 Cabling System Registered.

B. All equipment or apparatus of any one system must be the product of one manufacturer, or approved equivalent products of a number of manufacturer's that are suitable for use in a unified system.

C. All materials and equipment for which Underwriter's Laboratories have established standards shall bear a UL label of approval.

D. Where proprietary names are used, whether or not followed by the words "or as approved", they shall be subject to substitution only as approved by the Telecommunications.

E. Where the Contractor proposes substitute equipment, contractor shall submit acceptable evidence to indicate compliance with all requirements of the documents, including performance rating, size and resistance to wear and deterioration equivalent to the specified item. In instances where substituted equipment requires additional material or work beyond that shown or required by the specified item, said additional material or work shall be the responsibility of this Contractor, regardless of the trade involved.

5.6 UTP CABLE TESTING

A. Riser and inter building distribution cable testing: Each cable pair within all UTP riser cables shall be tested for continuity to ensure conductors are terminated in proper sequence, with correct polarity (tip and ring), and without conductor-to-conductor shorts, conductor-to-ground shorts, or opens.

B. Horizontal cable testing: All UTP station cables shall be tested to prove compliance with the current industry standard, TIA-568-B.2-1 Part 2: Balanced Twisted Pair Cabling Components, Addendum 1 – Transmission Performance Specifications for 4-pair 100 Category 6 Cabling and any subsequent addenda. Channel tests are the only acceptable test format for testing Category 6 cabling. Link tests will not be sufficient.

C. Horizontal cable testing equipment: The testing of UTP station cables shall be performed using the recommended test equipment specifically designed to test cables for all Category 6 parameters from 0 – 250 MHz. Testers shall be loaded with the most recent test values per the above referenced standard. The contractor may be required to provide documentation (or demonstration) that the testers used are properly programmed as described above.

D. The field test equipment shall meet the requirements of ANSI/TIA/EIA-568-A including applicable Technical Service Bulletins and amendments. The appropriate level III tester shall be used to verify Category 6 cabling systems.

5.7 FIBER OPTIC CABLE TESTING

A. Inter building cable testing requirements:

- One direction.
- Test multi-mode strands at 850 nm and 1300 nm.
- Test single-mode strands at 1310 nm and 1550 nm.
- Use optical time domain reflectometer (OTDR) for tests.
- Record signature trace, length, and attenuation.

5.8 TEST RESULTS

A. Submission. Prior to acceptance the contractor shall submit a copy of all applicable test results to the University/Telecommunications in both electronic (file) and paper form.

B. Category 6 UTP cables: The test results submitted for Category 6 UTP cables shall include the following:

C. Graphical/numerical data. Both graphical data plots and numerical data are required for the following test parameters:
- NEXT
- PS NEXT
- ELFEXT
- PS ELFEXT
- Attenuation
- Return loss

D. Numerical data. Numerical data only is required for the following test parameters:

- Propagation delay
- Delay skew
- Resistance

E. UTP riser cables: Continuity tests shall be performed on each pair. The contractor shall submit a document confirming that these cables were tested satisfactorily per these guidelines.

F. Fiber optic cables: Test results for fiber optic cables shall consist of the measured attenuation, the maximum attenuation allowed per these guidelines, and whether the test passed or failed for each fiber optic cable link.

5.9 TERMINATIONS

Incoming analog circuits shall be connected to an incoming riser pair, a cross connect feeds it to the T&R patch field, and a standard patch cord connects the analog circuit. (T&R pair continuity must be confirmed and documented in the identification of the T&R patch panel).

5.10 SYSTEM DOCUMENTATION

A. When all work has been completed and before final acceptance, the Contractor shall furnish to Telecommunications a complete set of documents, both electronic and paper versions, that clearly represent all contract work “as-built”. This shall be inclusive of all test results and drawings. The Contractor is responsible for assuring the accuracy of the As-Built documentation.

B. The contractor shall submit, within forty (40) working days of the completion of each phase, two (2) full sets of As-Built documentation to the Telecommunications for

approval. Prior to delivery, each document section and each drawing shall be signed and dated by the Contractor's project manager attesting to the accuracy of the as-built documents.

C. Electronic drawing files must conform to project drawing standards and be in the AutoCAD R14 format or the most current release. The As-Built drawings shall include at minimum, equipment locations, cable routes and outlet locations, and clearly show any deviations from the Contract Documents.

D. Note -The Telecommunications is under no obligation to provide the Contractor with digital drawing files. However, digital drawing files may be provided to the Contractor for use in the development of Shop Drawings or As-Built drawings under a confidentiality agreement between the Contractor and the Telecommunications.

E. Test printouts and electronic documentation (CD's) generated for each cable by the wire (or fiber) shall be submitted as part of the documentation package. The CD's shall contain the electronic equivalent of the test results and be of a format readable from Microsoft Word or Excel.

F. The As-Built drawings shall include outlet locations. Their sequential number, as defined elsewhere in this document, shall identify outlet locations. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. These documents shall be modified accordingly by the contractor to denote as-built information as defined above and returned to the Telecommunications.

G. Telecommunications may request that a 3% 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 Telecommunications, including a 100% re-test. This re-test shall be at no additional cost to the University.

H. Test Results documentation shall be clearly marked on the outside front cover with the words "Project Test Documentation", "West Virginia University", 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, and reference setup. The test equipment name, manufacturer, model number, serial number, software version and calibration date shall 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 as well as the software version being used in the field test equipment.

I. 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.

6. BACKBONE CABLING

6.1 RELATED DOCUMENTS

Refer to Specification Section 2.18: Firestopping.

6.2 SCOPE OF WORK

General

- All UTP terminations must follow 568b wiring schematic.
- All copper and fiber optic cabling shall be manufactured by Mohawk/CDT or Belden.
- The Contractor shall provide a complete structured cabling system that will accommodate voice, data and security for all rooms specified in the project.
- The Contractor will provide 12 SM fiber optics and 12 CAT6a or newer copper cable from MDF to each IDF.
- WVU does not require cabling from IDF to IDF unless there is a specific need or due to distance limitations.

6.3 PRODUCTS

A. Backbone Cabling:

Cables allowed for use in the backbone include: 100 UTP multi-pair copper cables. The cable shall support voice, data and imaging applications. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation.

B. Cable Types:

All UTP cables shall conform to ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard.

Copper [Multi-pair UTP]

Multi-pair cables shall:

- Be manufactured by: Mohawk/CDT or Belden
- Be 100 cables category 3, greater than 4 pairs.
- Be categorized using power sum testing and meet the hybrid cable requirements for use in horizontal cabling.
- Be appropriate for the environment in which it is installed.
- The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room/closet. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect. This is known as a hierarchical star topology.

- Backbone pathways shall be installed or selected such that the minimum bend radius of backbone cables is kept within manufacturer specifications both during and after installation.

Building Entrance Protection:

Each cable pair shall be protected with building entrance protectors at each end sized for the specific cable. Individual plug-in protector modules shall be provided for each pair. Products shall be Avaya/Lucent Type 489 with 110 connectors and 5 pin solid state protectors with heat coils.

C. Fiber

Cable Routing

- Fibers will be terminated in the MDF using SC connectors in rack mounted panels equipped with sufficient ports, slack storage space and splice trays if required to terminate and secure all fibers.
- Adequate riser sleeve/slot space shall be available with the ability to ingress the area at a later date in all Telecommunications rooms/closets, such that no drilling of additional sleeves/slots is necessary.

6.4 EXECUTION

A. Site Survey: Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

B. Physical Installation: Industry requirements; The following installation, documentation, component and system industry specifications shall be met or exceeded:

- ANSI/TIA/EIA-568-B.1 and addenda “Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements”.
- ANSI/TIA/EIA-568-B.2 and addenda “Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted- Pair”.
- ANSI/TIA/EIA-568-B.3 and addenda “Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling and Components Standard”.
- ANSI/TIA/EIA-569-A and addenda “Commercial Building Standard for Telecommunications Pathways and Spaces”.
- ANSI/TIA/EIA-606 and addenda ”Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.
- ANSI/TIA/EIA-607 and addenda “Commercial Building Grounding and Bonding Requirements for Telecommunications”.
- ANSI/TIA/EIA-526-7 ”Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
- ANSI/TIA/EIA-526-14A ”Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.

- IEC/TR3 61000-5-2 - Ed. 1.0 and amendments "Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling".
- ISO/IEC 11801:2000 Ed1.2 and amendments "Information technology - Generic cabling for customer premises".
- CENELEC EN 50173:2000 and amendments "Information Technology - Generic cabling systems".

C. Cable Pathways

- Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
- Grounding and bonding of pathways shall comply with applicable codes and regulations.
- Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.
- The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.

D. Cable Routing

- In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.
- Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms, shall be installed with a minimum clearance of 50 mm (2 in).
- The installation of telecommunications cabling shall maintain a minimum clearance of 3 m (10 ft) from power cables in excess of 480 Vrms.
- No telecommunications cross-connects shall be physically located within 6 m (20 ft) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.
- In the telecommunications room/closet where cable trays or cable racking are used, the Contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.
- In a false ceiling environment, a minimum of 9 inches shall be observed between the cable supports and the false ceiling.
- Continuous conduit runs installed by the Contractor should not exceed 30.5 m (100 ft) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.
- Maximum conduit pathway capacity shall not exceed a 40% fill. However, Perimeter fill is limited to 60% fill for move and changes.

E. Pulling Tension

The maximum cable pulling tensions shall not exceed manufacturer's specifications.

F. Bend Radius

- The maximum cable bend radii shall not exceed manufacturer's specifications.
- In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
- During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

G. Slack

In telecommunications room/closets a minimum of 3 m (10 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

H. Cable Wraps

Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent.
Siemon Company VCM Series.

I. Grounding

Grounding and bonding shall be done per applicable codes and standards.

J. Fire protection

- Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
- Fire stops shall be done to all applicable code.

K. Workmanship

All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

7. HORIZONTAL CABLING

7.1 SCOPE OF WORK

A. General

- The University's campus telecommunication standards use Siemon connectivity products. No substitutions will be accepted. This shall include but may not be limited to cable management, faceplates, copper and fiber modules, patch panels, racks, 110 blocks, patch cords, labels and grounding lugs.
- ALL UTP TERMINATIONS MUST FOLLOW 568B WIRING SCHEMATIC.
- All copper and fiber optic cabling shall be manufactured by Mohawk/CDT or Belden.
- The installed system shall meet all requirements necessary to achieve certification for the Siemon System-6 twenty-year warranty.
- The Contractor shall provide a complete structured cabling system that will accommodate voice, data, security and video applications for all areas.
- The Contractor shall provide upgrades and additions to the existing structured cabling system to accommodate voice, data, security and video applications.
- Contractor shall provide other outlets as listed below or indicated on drawings.
- Pathways will be a combination of surface mounted raceways where exposed or below lay-in ceilings, and j-hooks above the ceiling.

7.2 SPECIFICATIONS

A. Integrated Communications Outlet Specification

B. Each room with telecommunication needs shall have one or more Integrated Communication Outlets (ICO). There should be a minimum of two ICOs per office room for every 100 sq. ft. Placement of the ICOs must take into consideration door openings, windows and potential desk areas. In general, one ICO should be placed for every 100 square feet of floor space. Consideration shall be given to the placement of outlets with respect to terminal equipment. Consideration shall also be given to present and anticipated utilization of each room. For example, offices and laboratories generally require more ICOs than storage areas or receptions areas.

- The standard Integrated Communications Outlet provided to the user will be equipped with a minimum of two (2) Category 6, RJ45 jacks installed in a 4 port faceplate. All jacks and faceplate hardware shall be manufactured by Siemon Cabling Systems. Cables can be specified as plenum or non-plenum depending on location and applications.
- The RJ45 jacks will be placed in the first two positions in the faceplate. One of the two jacks will be designated data and the other will be designated voice. Each jack will be served with separate 4 pair, UTP Category 6 cable extending to the appropriate communications room. In the communications room each cable will be terminated on a modular patch panel dedicated to either data or voice terminations.

C. Faceplate positions 3 and 4 will be reserved for future use and may accommodate additional RJ45 jacks, or fiber optic connector

7.3 PRODUCTS

A. HORIZONTAL CABLING

- The Horizontal Subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the telecommunications room/closet. It consists of the telecommunications outlet/connector, the horizontal cables, and that portion of the cross-connect in the telecommunications room/closet serving the horizontal cable.

B. Cable Types

- All UTP cables shall conform to ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard (latest amendment and including all applicable addenda) and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addenda).

    1) Copper

        The cable manufacturer for 4-pair UTP category 6 cables shall also meet the following cable specifications:

Attenuation: Qualified Cables shall exhibit worst case attenuation less than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable attenuation performance for selected frequency points of interest is also provided.

		System 6SM
Frequency Range		1-300 MHz
Worst Case		$\leq 1.82\sqrt{f} + .017 \cdot f + \frac{0.20}{\sqrt{f}}$
Frequency Points of Interest	MHz	
	100	20.2 dB
	200	29.1 dB
	300	36.6 dB

Near End Crosstalk (NEXT) Loss: Qualified Cables shall exhibit worst case NEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable NEXT Loss performance for selected frequency points of interest is also provided.

		System 6SM
Frequency Range		1-300 MHz
Worst Case Cable NEXT Loss		$\geq 76 - 15\log(\frac{f}{0.772})$
Frequency Points of Interest	MHz	
	100	44.3 dB
	200	39.8 dB
	300	37.1 dB

Power Sum Near-End Crosstalk (PSNEXT) Loss:
Qualified Cables shall exhibit worst case PSNEXT Loss greater than the values derived using the equations shown in the chart below from 1MHz to the highest referenced frequency value. Worst-case qualified cable PSNEXT Loss performance for selected frequency points of interest is also provided.

		System 6^{SM}
Frequency Range		1-300 MHz
Worst Case PSNEXT Loss		$\geq 74 - 15\log(\frac{f}{0.772})$
Frequency Points of Interest	MHz	
	100	42.3 dB
	200	37.8 dB
	300	35.1 dB

Equal Level Far-End Crosstalk (ELFEXT):
Qualified Cables shall exhibit worst case ELFEXT greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable ELFEXT performance for selected frequency points of interest is also provided.

		System 6^{SM}
Frequency Range		1-300 MHz
Worst Case ELFEXT		$\geq 70 - 20\log(\frac{f}{0.772})$
Frequency Points of Interest	MHz	
	100	27.8 dB
	200	22.7 dB
	300	18.2 dB

Power Sum Equal Level Far-End Crosstalk (PSELFEXT):
Qualified Cables shall exhibit worst case PSELFEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable PSELFEXT performance for selected frequency points of interest is also provided.

		System 6^{SM}
Frequency Range		1-300 MHz
Worst Case PSELFEXT		$\geq 67 - 20\log(\frac{f}{0.772})$
Frequency Points of Interest	**MHz**	
	100	24.8 dB
	200	18.7 dB
	300	15.2 dB

Return Loss:
Qualified Cables shall exhibit worst case Return Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable Return Loss performance for selected frequency points of interest is also provided.

		System 6^{SM}	
Frequency Range		1-300 MHz	
Worst Case Return Loss		Frequency (MHz)	Return Loss (dB)
		$1 \leq f < 10$	$21 + 4 \cdot \log(f)$ dB
		$10 \leq f < 20$	25 dB
		$20 \leq f \leq 300$	$25 - 7 \cdot \log(f/20)$
Frequency Points of Interest	MHz		
	100	20.1 dB	
	200	18 dB	
	300	16.8 dB	

Propagation Delay (ANSI/TIA/EIA-568-A-1):
Qualified Cables shall exhibit worst case Propagation Delay less than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst-case qualified cable Propagation Delay performance for selected frequency points of interest is also provided.

		System 6^{SM}
Frequency Range		1-300 MHz
Worst Case Propagation Delay		$< 476 + \frac{36}{\sqrt{f_{MHz}}}$
Frequency Points of Interest	MHz	
	100	480 ns
	200	479 ns
	300	478 ns

Delay Skew (ANSI/TIA/EIA-568-A-1):
Qualified Cables shall exhibit worst case Delay Skew less than the values specified in the chart below per 100 m from 1 MHz to the highest referenced frequency value.

		System 6^{SM}
Frequency Range		1-300 MHz
Worst Case Delay Skew	MHz	
	100	25 ns
	200	25 ns
	300	25 ns

Longitudinal Conversion Loss (LCL):
For all categories of 100 Ω unshielded and screened cables, the worst case calculated LCL for any pair in a 100 m cable shall not be less than 35 dB, from 1 MHz to the highest referenced frequency for each performance category. LCL measurements shall be performed in accordance with ITU-T Recommendation O.9 (November, 1988) or equivalent. Calculated LCL performance shall be determined by subtracting the test balun loss correction factor (as specified by the balun manufacturer) from the measured value at all frequencies.

		System 6SM
Frequency Range		1-300 MHz
Worst Case Delay Skew	MHz	
	100	35 dB
	200	35 dB*
	300	35 dB*

** Values above 100 MHz are provided for information only, not required for conformance testing.*

Longitudinal Transfer Conversion Loss (LCTL):
For all categories of 100 Ω unshielded and screened cables, the worst case calculated LCTL for any pair in a 100 m cable shall not be less than 35 dB, from 1 MHz to the highest referenced frequency for each performance category. LCTL measurements shall be performed in accordance with ITU-T Recommendation O.9 (November, 1988) or equivalent. Calculated LCL performance shall be determined by subtracting the test balun loss correction factor (as specified by the balun manufacturer) from the measured value at all frequencies.

		System 6SM
Frequency Range		1-300 MHz
Worst Case Delay Skew	MHz	
	100	35 dB
	200	35 dB*
	300	35 dB*

** Values above 100 MHz are provided for information only, not required for conformance testing.*

Attenuation to Crosstalk Ratio (ACR):
Using "pair-to-pair NEXT Loss", all Qualified Cables shall exhibit worst case ACR performance for the specified frequency range shown in the following table.

		System 6SM
Frequency Range		1-300 MHz
Worst Case ACR	MHz	
	1-80	24.1 dB
	80-100	24.1 dB
	1-100	24.1 dB
	100-300	.5 dB

Power Sum Attenuation to Crosstalk Ratio (PSACR):
Using "Power Sum NEXT Loss", Qualified Cables shall exhibit worst case PSACR performance for the specified frequency range shown in the following table.

		System 6SM
Frequency Range		1-300 MHz
Worst Case PSACR	MHz	
	1-80	22.1 dB
	80-100	22.1 dB
	1-100	22.1 dB
	100-300	-1.5 dB

7.4 WORK AREA

This section outlines specifications for the work area equipment cords, and telecommunications outlets at the users work area. The connection between the information outlet and the device (computer/telephone) is achieved by means of this subsystem.

A. Equipment Cords shall meet or exceed the following criteria:

- Category 6, modular equipment cords shall:
- Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
- Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight through with standards compliant wiring. Plugs shall be equipped to contain internal patent pending yellow keybar that perfectly positions conductors for optimum pair balance to the point of termination.
- Be backwards compatible with lower performing categories.
- Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro inches minimum of gold plating over nickel contacts.
- Have color-coded insert molded strain relief boot with a latch guard to protect against snagging. Additional color-coding available by the use of snap in oval shaped icons.
- Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
- Utilize cable that exhibits power sum NEXT performance.
- Be available in any custom length and standard lengths of 0.9, 1.5, 2.1, 3.1, 4.6, 6.1, 7.6 meters (3, 5, 7, 10, 15, 20, and 25 feet).
- Be made by an ISO 9001 and 14001 Certified Manufacturer.
- Electrical Specifications:
- Have a DC resistance per lead: 9.38 Ω / 100 m maximum.
- Have an input impedance without averaging: 100 Ω + 15% from 1 to 100 MHz, + 22% from 100 to 200 MHz and + 32% from 200 to 250 MHz.
- Is 100% transmission tested with laboratory grade network analyzers for proper performance up to 250 MHz. Vendor shall guarantee cords are compatible with Category 6 links.
- Be UL VERIFIED (or equivalent) for TIA/EIA Category 6 electrical performance.
- Be UL LISTED 1863.
- Siemon Company MC6™ Series Modular Cords

B. The 110-to-modular patch cords shall:

- Be 100% transmission tested with laboratory grade network analyzers for proper performance (manufacturer shall guarantee cords are compatible with category 5e links).
- Be factory or field assembled using category 5e performing 110 patch plugs and stranded category 5e cable. Field assembled cords shall be made from factory made modular cords and cut in half to attach the 110 plug.
- Be available in 4-pair size with eight-position modular plug.
- Be made from factory assembled modular cords for field assembly or performance cannot be guaranteed.
- Have factory-assembled cords available with black, white, red, yellow, blue and green jacket colors.
- Have available colored boots at the base of the modular plug and snap-in colored icons on the 110 plug for administrative purposes.
- Have a DC resistance per lead: 9.38 Ω / 100 m maximum.

- Meet or exceed TIA/EIA category 5e electrical performance.
- Must be certified by Underwriters Laboratories to United States Standards and C22.2 Canadian Telecommunications Standards.
- Siemon S110® to MC5™ Patch Cords

7.5 INFORMATION OUTLETS [HIGH DENSITY]

A. Category 6: All high density information outlets for 100 Ω 22-26 AWG copper cable shall:

B.

- Be available in black, white, gray, ivory and light ivory.
- Be 8-position / 8-conductor with coherent pairing of IDC pins.
- Have available a gravity feed (45 degree angled) low profile as well as flush mount design.
- Provide universal application/multi-vendor support.
- Utilizes tri-balance technology with optimized pair balance design and linear crosstalk response to address applications up to 250 MHz.
- Have 310 style insulation displacement connectors with quadrant pair isolation and a pyramid wire entry system. Termination is accomplished with a single conductor impact tool.
- Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
- Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
- Support industry standards for T568A or T568B wiring options on each individual outlet.
- Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.
- Be side-stackable for high-density solutions.
- Have a color matching protective, hinged or flexible door to protect the outlet from dust and other airborne contaminants.
- Provide color-coded, slide-in icons available for circuit identification.
- Be constructed of high impact, flame-retardant thermoplastic.
- Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening (keystone).
- Be made by an ISO 9001 and 14001 Certified Manufacturer.

C. Electrical Specifications:

- ANSI/TIA/EIA-568-A and ISO/IEC 11801 Category 6 compliant.

The following requirements shall also be met (NEXT Loss and FEXT tested in both Differential and Common Mode):

Parameters	Margin over Category 6	Performance @ 250 MHz*
NEXT Loss	0 dB	46 dB
FEXT	2 dB	37 dB
Insertion Loss (Attenuation)	30%	0.2 dB
Return Loss	4 dB	18 dB
LCL	-	40**

***** Values above 100 MHz is provided for information only, margin applicable to swept frequency range of 1-250 MHz. Not required for conformance testing. ****** Not industry specified at this time.

- Be UL VERIFIED (or equivalent) for TIA/EIA Category 6 electrical performance.
- Be UL LISTED 1863 and cUL C22.2 approved.
- Have Austel (ACA) certification pending.
- Siemon Company MAX™ MX6 Series Jacks

7.6 FACEPLATES

All faceplates shall:

- Be applicable to both fiber and copper applications.
- Have write on designation labels for circuit identification together with a clear plastic cover.
- Be available in single-gang and double-gang configurations.
- Have as a minimum the standard stainless steel faceplate.
- Have surface mount boxes available for both single and double gang faceplates.
- Be made by an ISO 9001 and 14001 Certified Manufacturer.
- Siemon Company MAX™ Series Faceplates

7.7 OUTLET TYPES

A. Each FacePlate type FP-1 shall consist of:
   (1) faceplate Siemon # MX-WP-SK6-SS
   (1) VOICE patch cord Siemon # S110P4-A4-20 S110 TO MC cable assembly 25FT

B. Each FacePlate type FP-2 shall consist of:
   (1) faceplate Siemon # MX-FP-S-01-SS-L
   (1) Siemon # MX6-06 (blue) for data
   (2) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

C. Each FacePlate type FP-3 shall consist of:
   (1) faceplate Siemon # MX-FP-S-04-SS-L
   (1) Siemon #MX6-06 (blue) for voice
   (1) Siemon # MX6-03 (red) for data

(2) Siemon # MX-BL blank modules
(2) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

D. Each FacePlate type FP-4 shall consist of:
(1) faceplate Siemon # MX-FP-S-04-SS-L
(1) Siemon #MX6-06 (blue) for data
(1) Siemon # MX6-03 (red) for data
(2) Siemon # MX-BL blank modules
(2) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

E. Each FacePlate type FP-5 shall consist of:
(1) faceplate Siemon # MX-FP-S-04-SS-L
(1) Siemon #MX6-06 (blue) for voice
(1) Siemon # MX6-03 (red) for data
(1) Siemon # MX6-04 (gray) for data
(1) Siemon # MX6-02 (white) for data
(4) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

F. Each FacePlate type FP-6 shall consist of:
(1) faceplate Siemon # MX-FP-S-04-SS-L
(1) Siemon #MX6-06 (blue) for data
(1) Siemon # MX6-03 (red) for data
(1) Siemon # MX6-04 (gray) for data
(1) Siemon # MX6-02 (white) for data
(4) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

G. Each FacePlate type FP-7 shall consist of:
(1) device plate Wiremold # ALA-MAB
(1) module adaptor Wiremold # CM2-2UKEY
(1) Siemon #MX6-K06 (blue) for voice
(1) Siemon # MX6-K03 (red) for data
(2) Wiremold # CM3-BL blank modules
(2) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

H. Each FacePlate type FP-8 shall consist of:
(1) device plate Wiremold # ALA-MAB
(1) module adaptor Wiremold # CM2-2UKEY
(1) Siemon #MX6-K06 (blue) for data
(1) Siemon # MX6-K03 (red) for data
(2) Wiremold # CM3-BL blank modules
(2) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

I. Each FacePlate type FP-9 shall consist of:
(1) device plate Wiremold # ALA-MAB
(3) module adaptor Wiremold # CM2-2UKEY
(1) Siemon #MX6-K06 (blue) for data
(1) Siemon # MX6-K03 (red) for data
(1) Siemon # MX6-K04 (gray) for data
(1) Siemon # MX6-K02 (white) for data

(1) Siemon # MX6-K05 (yellow) for data
(1) Siemon # MX6-k09 (orange) for data
(6) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

J. Each FacePlate type FP-10 shall consist of:
(1) communications plate Wiremold # C8004P-2ACT
(4) module adaptor Wiremold # CM2-1UKEY
(1) Siemon #MX6-K06 (blue) for voice
(1) Siemon # MX6-K03 (red) for data
(1) Siemon # MX6-K04 (gray) for data
(1) Siemon # MX6-K02 (white) for data
(2) Wiremold # CM3-BL blank modules
(4) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

K. Each FacePlate type FP-11 not used.

L. Each FacePlate type FP-12 shall consist of:
(1) communications patch panel Siemon # MX-PNL-48-A
(48) Siemon #MX6-K0x (color should match other end of cable)
(48) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

M. Each FacePlate type FP-13 shall consist of:
(1) poke-thru Wiremold # RC4ATCxx
(1) Siemon #MX6-K06 (blue) for voice
(1) Siemon # MX6-K03 (red) for data
(1) Siemon # MX6-K04 (gray) for data
(1) Siemon # MX6-K02 (white) for data
(4) DATA Cat. 6 patch cord Siemon # MC6-8-T-10-07

7.8 EXECUTION

A. Site Survey. Prior to placing any cable pathways or cable, the Contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

B. Physical Installation

Industry requirements; The following installation, documentation, component and system industry specifications shall be met or exceeded:

- ANSI/TIA/EIA-568-B.1 and addenda ”Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements”.
- ANSI/TIA/EIA-568-B.2 and addenda ”Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair”.
- ANSI/TIA/EIA-568-B.3 and addenda ”Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling and Components Standard”.

- ANSI/TIA/EIA-569-A and addenda ”Commercial Building Standard for Telecommunications Pathways and Spaces”.
- ANSI/TIA/EIA-606 and addenda ”Administration Standard for the Telecommunications Infrastructure of Commercial Buildings”.
- ANSI/TIA/EIA-607 and addenda ”Commercial Building Grounding and Bonding Requirements for Telecommunications”.
- ANSI/TIA/EIA-526-7 ”Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant”.
- ANSI/TIA/EIA-526-14A ”Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant”.
- IEC/TR3 61000-5-2 - Ed. 1.0 and amendments “Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling”.
- ISO/IEC 11801:2000 Ed1.2 and amendments ” Information technology - Generic cabling for customer premises”.
- CENELEC EN 50173:2000 and amendments ” Information Technology - Generic cabling systems”.

C. Cable Pathways

- Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.
- Grounding / Earthing and bonding of pathways shall comply with applicable codes and regulations.
- Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.
- The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.

D. Cable Routing

- All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.
- The combined length of jumpers, or patch cords and equipment cables in the telecommunications room/closet and the work area should not exceed 10m (33 ft) unless used in conjunction with a multi-user telecommunications outlet.
- Two horizontal cables shall be routed to each work area. At least one horizontal cable connected to an information outlet shall be 4-pair, 100 Ω unshielded twisted-pair (UTP).
- Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.
- In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 1.5 m (5 ft) apart.
- Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms, shall be installed with a minimum clearance of 50 mm (2 in).

- The installation of telecommunications cabling shall maintain a minimum clearance of 3 m (10 ft) from power cables in excess of 480 Vrms.
- No telecommunications cross-connects shall be physically located within 6 m (20 ft) of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.
- For voice or data applications, 4-pair UTP or fiber optic cables shall be run using a star topology from the telecommunications room/closet serving that floor to every individual information outlet.
- The Contractor shall observe the bending radius and pulling strength requirements of the 4-pair UTP and fiber optic cable during handling and installation.
- Each run of UTP cable between horizontal portions of the cross-connect in the telecommunication closet and the information outlet shall not contain splices.
- In the telecommunications room/closet where cable trays or cable racking are used, the Contractor shall provide appropriate means of cable management such as reusable color-coded hook and loop cable managers (ties) to create a neat appearance and practical installation.
- In a false ceiling environment, a minimum of 3 inches (75 mm) shall be observed between the cable supports and the false ceiling.
- Continuous conduit runs installed by the Contractor should not exceed 30.5 m (100 ft) or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.
- All horizontal pathways shall be designed, installed and grounded to meet applicable local and national building and electrical codes.
- The number of horizontal cables placed in a cable support or pathway shall be limited to a number of cables that will not cause a geometric shape of the cables.
- Maximum conduit pathway capacity shall not exceed a 40% fill. However, Perimeter fill is limited to 60% fill for move and changes.
- Horizontal distribution cables shall not be exposed in the work area or other locations with public access.
- Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 75 mm (3 in) above the ceiling grid supporting the tiles.

E. Work Area Termination

- All UTP cables wired to the telecommunications outlet/connector, shall have 4-pairs terminated in eight-position modular outlets in the work area. All pairs shall be terminated.
- The telecommunications outlet/connector shall be securely mounted at planned locations.
- The height of the telecommunications faceplates shall be to applicable codes and regulations.

F. Pulling Tension

- The maximum cable pulling tensions shall not exceed manufacturer's specifications.

G. Bend Radius

- The maximum cable bend radii shall not exceed manufacturer's specifications.
- In spaces with UTP cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
- During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

H. Slack

- In the work area, a minimum of 300 mm (12 in) should be left for UTP, while 1 m (3 ft) be left for fiber cables.
- In telecommunications room/closets a minimum of 3 m (10 ft) of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

I. Cable Tie Wraps

- Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath.
- Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent. Siemon Company VCM Series.

J. Grounding

- All grounding / earthing and bonding shall be done to applicable codes and regulations.

K. Fire protection

- Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
- Fire stops shall be done to applicable code.

L. Workmanship

- All work shall be done in a workman like fashion of the highest standards in the telecommunications industry. All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed. Workers must clean any debris and trash at the close of each workday.

8. RACKS AND CABLE MANAGEMENT

8.1 SUMMARY

This Section includes the following:

- Floor-standing equipment racks.
- Provide cabinets and racks in accordance with the Contract Documents. Where conflicting data is indicated, verify mounting and equipment requirements prior to ordering.
- This section contains specific parts selected by University and Telecommunications. In the event that the parts specified are not available, University and Telecommunications shall be contacted to specify replacements.

8.2 COORDINATION

- This contractor shall be responsible for all coordination with the general and electrical contractor and data and voice vendors to provide a complete operational system.
- Coordinate layout and installation of equipment racks with adjacent construction.

8.3 SUBMITTALS

- Product Data: For cabinets and equipment racks.
- Shop Drawings: Show fabrication and installation details of components for cabinets, equipment racks, and their associated parts and pieces to make a complete system.
- Allow sufficient time in project scheduling for University and Telecommunications review.
- Submittals shall be checked by the supplier and made as complete systems including all required accessories and any special tools.
- Manufacturer's installation and maintenance instructions.

8.4 QUALITY ASSURANCE

- Source Limitations: Obtain each type of enclosure through one source from a single manufacturer.
- All work shall be in accordance with the latest edition of all applicable State, and Federal regulations and codes. Further, all work shall also be in accordance with EIA/TIA Standards, the BICSI TDMM manual, latest edition and with the manufacturer’s recommendations.

8.5 SEQUENCING AND SCHEDULING

- Sequence all work to support the installation of the structured cabling system, electrical work and all cable tray systems installation.

8.6 MANUFACTURERS

- Available Manufacturers are listed in subparagraphs for each Part 2 article below.
- Other Manufacturers' products must be submitted for University and Telecommunications review for approval.

8.7 MDF OR IDF FRAMES

- Standard Floor Distribution Frame; for rack mounted installations in MDF and IDF Rooms, the installer shall use a 7-foot high19-inch equipment rack.
- The racks shall be made by an ISO 9001 and 14001 Certified Manufacturer; Panduit Rack System, or approved equal. Use Panduit Cat Number R2P with Vertical Cable Manager Panduit Cat Number WMPV45E. Ensure product submittal includes all accessories and insures system compatibility.
- The rack shall include vertical cable managers mounted on the front of the channels with removable covers that can handle large quantities of cables and patch cords. Cable managers must retain cables even when covers are removed. Covers are modular in design, which eliminates the need to remove full-length covers for each patch cord change.
- The rack shall have channels capable of utilizing and re-locating ten high capacities, reusable hook and loop cable managers provided with rack, and have additional managers available in bags of ten.
- The rack shall have cable access holes on side rails, which allow cables to be routed between adjacent racks.
- The rack shall have standard 19-inch ANSI/EIA-310-C mounting holes having a full 45 RMS on front and back of rails.
- The rack shall utilize black grommets for unused cable openings.
- The rack shall have vertical cable management channels 11 in x 5.5 in x 7 ft which is located between racks. The channel shall include cable retainers, which can be hinged left or right and be located in any position along the channel.
- The rack shall have floor mounting holes and a ground lug for 0-6 gauge ground cable provided.
- Each rack shall have a 10 outlet (4 ft) power strip mounted onto the rack.

8.8 PREPARATION

- Coordinate requirements for riser bases, raised floor riser feet, anchors, bracing, and blocking to ensure adequate means for installation of racks/cabinets.
- Coordinate requirements for electrical cable pathways from overhead cable trays and management systems.

8.9 INSTALLATION

- Install racks in compliance with manufacturer's written instructions and shop drawings.

- Floor-standing racks/cabinets in the MDF's shall be securely attached to the concrete floor using minimum 3/8" in dia. hardware utilizing and approved length.
- Install equipment racks at locations and heights required. Rows of racks/cabinets shall be placed with a 36-inch (minimum) clearance from the walls on all sides of the rack, unless otherwise indicated on Drawings. When mounted in a row, maintain a minimum of 36 inches from the wall behind and in front of the row of racks/cabinets. Where racks/cabinets are shown side by side, securely connect together using manufacturer's ganging hardware to provide a stable system. Supply all miscellaneous parts and pieces to make a complete system.
- All racks/cabinets shall be grounded to the ground bus bar in accordance with other Sections of this document.
- Rack mount screws not used for installing patch panels, keys and other hardware shall be bagged and left with the rack upon completion of the installation.
- Vertical cable managers shall be installed on both sides (left and right) of each rack in the MDF/IDF rooms. Horizontal cable managers shall be installed per rack equipment elevation drawings.

9. ACCESS CONTROL SYSTEM

GENERAL

9.1 WORK INCLUDED

CAT 6 cabling shall be included for access to any new Telecommunications closet. The installation is to be coordinated with Telecommunications personnel. Specifications for the system will be given at the time of installation.

10. RESPONSIBILITY FOR MINIMUM WIRING STANDARDS

- The West Virginia University Minimum Wiring Standards were developed by the West Virginia University Telecommunications Department.
- The Minimum Wiring Standards are subject to change and review as telecommunications technology changes.
- This document can be only changed, modified or updated by the West Virginia University Telecommunications Department.

11. QUESTIONS OR PROBLEMS

Questions, concerns or additional information about this and any ITS policy should be directed to the CIO office at CIO@mail.wvu.edu.