



Network & Systems Services

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**University of Delaware
Information Technologies
Network & Systems Services
Enterprise Low Voltage Cabling Standards**

3 April, 2019



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To: Planning and Project Delivery
Re: Use of Network Systems & Services (NSS) Network Infrastructure Design and Construction Specification
Date: April 3, 2018

Intended Use

This is a general specification for use in developing project construction documents for Network Infrastructure at University of Delaware facilities. The specification as presented here includes all possible elements for an ITS installation. Designers and Project Managers should use this information, available on the University of Delaware Planning & Project Delivery website, as a guideline for all aspects of needs for builds of new buildings and major renovations on campus. Not all divisions and sections will be applied to every project. Not all paragraphs of any given section may apply to a given project. System variables (e.g. cable tray size, fiber backbone size) may be displayed as an example within this general specification.

Designers, Project Managers, and Architects shall not add language to this specification during the course of submittals of these specifications for projects by IT Network & Systems Services.

The Contractor shall be aware of but not focus on the "Design Requirements" section within each specifications section used. Contractors are to provide bid proposals per the "Products" sections and install per the "Execution sections.

Errors and omissions within this document shall be reported for correction in the general specification.

Installers may submit preferred products not listed in the general specification for evaluation. Installers are encouraged to submit opinions on the products listed in the general specification with respect of ease of installation, availability of products, durability, etc.

This document has been prepared for the exclusive use of University of Delaware Facilities and designers, architects, installers, manufacturers, and distributors involved in University of Delaware projects. This document is available in Microsoft Word and PDF format. The aforementioned parties are allowed to copy-and-paste from this document and may remove paragraphs and parts that do not apply to your project. The aforementioned parties are not allowed to alter the intent of the language of this document without approval of NSS.

Responsibilities – Project Architect and Engineer

- a) Site drawings showing inter-building conduit and manhole systems. Site plan must show other UD buildings that inter-building cables are routed back to.
- b) Building/Floor drawings showing Telecommunications Outlets, or WAO's (Work Area Outlets) with UD standard triangles and alphabetical configuration designations. IT-NSS will supply an AutoCAD template of these symbols. There shall also be a UD standard room circuit number on the drawings at each Telecommunications Outlet/triangle location, as per the specifications.
- c) Indicate telecommunications outlet/triangles on drawings for wireless access points, per IT-NSS submitted wireless system layout.
- d) Indicate telecommunications outlet/triangle on drawings for the door entry system, if applicable.
- e) Indicate telecommunications outlet/triangle on drawings for the building automation system, if applicable.
- f) Indicate telecommunications outlet/triangle on drawings for Video Surveillance Camera locations, if applicable.
- g) Indicate telecommunications outlet/triangle on drawings for Smart Lighting Systems (i.e. Lutron Systems), if applicable.
- h) Indicate telecommunications outlet/triangle on drawings for electrical or other discipline smart meter, if applicable.
- i) Indicate telecommunications outlet/triangle on drawings for interior and exterior Assist/Emergency Phone locations, if applicable.
- j) Indicate telecommunications outlet/triangle on drawings for the Fire Alarm Panel IP interface.
- k) Indication on drawings of 4" Riser Sleeves between each floor Telecommunications Rooms.
- l) Indication on drawings of 4" Sleeves for horizontal cable routing into each Telecommunication Room.
- m) Indication on drawings of cable tray in all hallways in the building, preferably routed along one of the walls in the ceiling.
- n) Indication on drawings of 1" metallic/bushed sleeves into all offices from the hallway of each building, for cable routing from each room, into the hallway cable tray.
- o) Indication of appropriate size metallic/bushed sleeves into each lab, classroom, conference room, or any other type of similar room from the hallway of each building, for cable routing from each room, into the hallway cable tray.

Responsibilities – UD-IT Network & Systems Services

- a) Building Entrance Telecommunications Room design criteria and design drawing to be submitted to the design team for inclusion within the construction drawings and documents.
- b) Individual Floor Telecommunications Room design criteria and design drawings to be submitted to the design team for inclusion within the construction drawings and documents.

- c) Creation of Division-27 specifications for all aspects of Inter-Building Telecommunications Conduit and Manhole system to be submitted to the design team for inclusion within the construction documents.
- d) Creation of Division-27 specifications for all aspects of Inter-Building Telecommunications Cabling system to be submitted to the design team for inclusion within the construction documents.
- e) Creation of Division-27 specifications for all aspects of Intra-Building Telecommunications Cabling system to be submitted to the design team for inclusion within the construction documents.
- f) Provide a complete plan for wireless access point deployment, for inclusion within the construction documents.
- g) Interface and coordinate with CATV company (Apogee Inc.) for design and commissioning of the campus CATV System.
- h) Interface with the UD-IT Telephone Services Department and the users/building occupants to determine the telephone, fax line, and Assist/Emergency phone needs within and around the building. All ordering of existing Telephone line moves and orders for new service are processed thru the Telephone Services Department.
- i) Submittal of NSS Microsoft Work Breakdown Structure/Schedule of all NSS work as listed below that will be entered into the Master Project Schedule.
- j) Interface with the UD-IT User Services Department for user/building occupant support and assistance with Personal Computer network configuration and general network needs.
- k) Create a Scope-of-Work for installation and commissioning of the network itself (switches, interconnects, etc.), by the UD-IT-NSS Installation Group. The NSS Installation technicians will install, interconnect, and connect all switches back to existing distribution gear for network connectivity. This work is done in coordination with the General Contractor and Telecommunications Contractor having the Telecommunications Room build-outs complete and ready for the gear to be installed.
- l) UD Technician installation of VOIP phones, along with analog conversion equipment to provide service to analog devices, including fax lines, and emergency phones.

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SECTION 27 05 00
COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Related Sections. Not limited to:
1. Section 27 05 26 - Grounding and Bonding for Communications Systems
 2. Section 27 05 28 - Pathways for Communications Systems
 3. Section 27 05 28.15 - Floorboxes and Poke-thrus
 4. Section 27 05 28.29 - Hangers and Supports for Communications Systems
 5. Section 27 05 28.33 - Conduits and Backboxes Boxes for Communications Systems
 6. Section 27 05 28.34 - Non-metallic Tubing and Fabric Innerduct
 7. Section 27 05 28.36 - Cable Trays for Communications Systems
 8. Section 27 05 48 - Vibration and Seismic Controls for Communications Systems
 9. Section 27 05 53 - Identification for Communications Systems
 10. Section 27 07 00 - Communications Testing
 11. Section 27 11 00 - Communications Room Fit-out
 12. Section 27 11 13 - Communications Entrance Protection
 13. Section 27 11 16 - Communications Cabinets, Racks, Frames and Enclosures
 14. Section 27 11 19 - Communications Termination Blocks and Patch Panels
 15. Section 27 11 23 - Communications Cable Management and Ladder Rack
 16. Section 27 11 26 - Communications Rack Mounted Power Protection and Power Strips
 17. Section 27 13 00 - Communications Backbone Cabling
 18. Section 27 13 13 - Communications Copper Backbone Cabling
 19. Section 27 13 13.13 - Communications Copper Cable Splicing and Terminations
 20. Section 27 13 23 - Communications Optical Fiber Backbone Cabling
 21. Section 27 13 23.23 - Communications Optical Fiber Splicing and Terminations
 22. Section 27 13 33 - Communications Coaxial Backbone Cabling
 23. Section 27 13 33.13 - Communications Coaxial Splicing and Terminations
 24. Section 27 13 53 - Cleaning, Lubrication and Restoration Chemicals
 25. Section 27 15 00 - Communications Horizontal Cabling
 26. Section 27 15 13 - Communications Copper Horizontal Cabling
 27. Section 27 15 23 - Communications Optical Fiber Horizontal Cabling
 28. Section 27 15 33 - Communications Coaxial Horizontal Cabling
 29. Section 27 15 43 - Communications Faceplates and Connectors
 30. Section 27 16 19 - Communications Patch Cords, Station Cords, and Cross Connect Wire
 31. Section 27 21 33 - Data Communications Wireless Access Points
 32. Section 27 32 23 - Elevator Telephones
 33. Section 27 32 26 - Ring-Down Emergency Telephones
 34. Section 27 41 33 - Master Antenna Television System
 35. Section 27 51 13 - Paging Systems
 36. Section 27 51 23 - Intercommunications and Program Systems
 37. Section 27 53 19 - Internal Cellular, Paging, and Antenna Systems
 38. Section 27 53 19.10 - Low Voltage Room/Shared Service Space
 39. Section 27 53 19.20 - Cabling - Wireless Systems
 40. Section 27 53 19.30 - Wireless Communications Testing and Identification
- B. Related Requirements: Comply with following:
1. Cutting and Patching: Section 017329 – Cutting and Patching.
 2. Firestopping: Section 078400 – Firestopping.
- C. Structured Cabling System: Provide complete Structured Cabling System (SCS) with accessories.

1. SCS: Serve as vehicle for transport of data, video, and voice telephony signals throughout network from designated demarcation points to outlets located at various desk, workstation and other locations as indicated on Drawings and Specifications.
 2. Applications and Link Standards: Include, but not be limited to:
 - a. IEEE 802.3-2015 (Ethernet) and appropriate addendums
 - b. 1000/10000 BASE-T (Gigabit Ethernet)
 - c. TP-PMD (Copper-based FDDI)
 - d. 52/155 Mbps ATM (asynchronous transfer mode)
 - e. 77 Channel Analog Broadband Video out to 550 MHz
 3. Gigabit Cable Performance:
 - a. Capable of supporting applications including AES/EBU Digital Audio
 - b. 270 Mbps Digital video
 - c. IEEE 802.5z (Gigabit Token Ring)
 - d. 622 Mbps 64-CAP ATM
 - e. 1000/10000 Base-T Gigabit Ethernet and appropriate addendums
 - f. 1.2 Gigabit ATM.
- D. Data and Voice:
1. Provide:
 - a. Free standing equipment racks, or enclosed cabinets located at Equipment Room (ER), Telecommunications Room (TR), or Telecommunications Enclosure (TE).
 - b. Wiring utilized for data and voice communications originating in equipment racks, or enclosed cabinets.
 - c. Wiring, terminations and patch bays between these designated demarcation points and outlet locations.
 - d. Work Area Outlets (WAO).
- E. Related Documents and Sections:
1. Section 002113 - Instructions to Bidders.
 2. Section 002213 – Supplementary Instructions to Bidders.
 3. Section 007200 - General Conditions.
 4. Section 007300 - Supplementary Conditions.
 5. Division 1 – General Requirements Sections.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 - References. In addition to requirements shown or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:
1. AASHTO H-20 Load Rating
 2. ANSI C80.1 - Specification for Rigid Steel Conduit, Zinc Coated
 3. ANSI C80.3 - Electrical Metallic Tubing; Zinc Coated
 4. ANSI C80.6 - Intermediate Metal Conduit; Zinc Coated
 5. ANSI/NECA/BICSI-568 - Installing Commercial Building Telecommunications Cabling
 6. ASTM A48/A48M-00 - Standard Specification for Gray Iron Castings
 7. ASTM A123 - Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
 8. ASTM A475-98 - Standard Specification for Zinc-Coated Steel Wire Strand
 9. ASTM A510 - Standard Specification for General Requirements for Wire Rods and Course Round Wire, Carbon Steel
 10. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel
 11. ASTM C33-01a - Standard Specification for Concrete Aggregates
 12. ASTM C857-95(2001) - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
 13. ASTM Test Method C136-01 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

14. ASTM Test Method D1557-00 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³(2,700 kN-m/m³)
15. AWWA E12-94 - Standard Method of Determining Corrosion of Metal in Contact with Treated Wood
16. BICSI Customer-Owned Outside Plant Design Manual, 6th edition including all subsequent addenda/errata
17. BICSI Telecommunications Distribution Methods Manual, 13th edition including all subsequent addenda/errata
18. City and State Ordinances, as applicable to location
19. Factory Mutual and/or Owner's Representative's Insurance Carrier
20. FCC Part 15 – Radiated Emission Limits
21. FCC Part 68 – Connection of Terminal Equipment to the Telephone Network
22. IEEE C2, National Electrical Safety Code[®], 2012 edition including all subsequent addenda/errata
23. ISO/IEC 11801 Ed.2:2002, Information Technology – Generic Cabling for Customer Premises
24. NEMA-250
25. NEMA TC2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
26. NEMA TC3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing
27. NEMA TC8 - PVC Plastic Utilities Duct for Underground Installations
28. NEMA TC9 - Fittings for PVC Plastic Utilities Duct for Underground
29. NEMA VE-1 – Metal Cable Tray Systems
30. NEMA VE 2-2000 - Cable Tray Installation Guidelines
31. NFPA-70, National Electrical Code[®], 2014 edition including all subsequent addenda/errata
32. NFPA-72, National Fire Alarm Code[®], 2013 including all subsequent addenda/errata
33. NFPA-101, Life Safety Code[®], 2015 edition including all subsequent addenda/errata
34. TIA-526-7 – OFSTP-7; Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
35. TIA-526-14A – OFSTP-14; Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
36. TIA-568-C.0 – Generic Telecommunications Cabling for Customer Premises
37. TIA-568-C.1 – Commercial Building Telecommunications Cabling Standard
38. TIA-568-C.2 – Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
39. TIA-568-D.3 – Optical Fiber Cabling Components Standard
40. TIA-569-C - Commercial Building Standard for Telecommunications Pathways and Spaces
41. TIA-570-C – Residential Telecommunications Infrastructure Standard
42. TIA-598-D - Optical Fiber Cable Color Coding
43. TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure
44. TIA J-STD-607-C - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
45. TIA-758-A - Customer-Owned Outside Plant Telecommunications Infrastructure Standard
46. TIA/EIA-862 – Building Automation Systems Cabling Standard for Commercial Buildings
47. TIA-TSB-155-A – Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T
48. TIA-TSB-185 – Environmental Classification (MICE) Tutorial
49. Underwriters Laboratories Standard 6 - UL Standard for Safety for Electrical Rigid Metal Conduit – Steel
50. Underwriters Laboratories Standard 797 - Electrical Metallic Tubing- Steel

51. Underwriters Laboratories Standard 1242 - Type IMC threaded and unthreaded conduit, nipples, bends, and couplings in 1 to 4-inch trade size

1.3 DEFINITIONS

- A. Definitions: See Section 014200 – References for additional definitions.
 1. Code Requirements: Minimum requirements.
 2. Final Acceptance: Owner's Representative's acceptance of project from Contractor.
 3. Furnished by Others: Receive delivery at job site or where called for and install.
 4. Labeled: Classification by standards agency.
 5. Owner's Representative.
 6. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready to use.
 7. Replace: Remove and provide new item.
 8. Rough-in: Pipe, duct, conduit, equipment layout and installation.
 9. Structured Cabling Systems (SCS): Equipment and cabling including hardware, termination blocks, cross connect wire or cordage, patch panels, patch cords, telecommunication outlets, work area cords, UTP and fiber cable installed and configured to provide computer data and voice connectivity from each data or voice device to network file server or voice network/switch designated as service point of local area network.
- B. Acronyms:
 1. ACR: Attenuation-to-Crosstalk Ratio
 2. ADA: Americans with Disabilities Act
 3. ANSI: American National Standards Institute
 4. ASTM: American Society for Testing Materials
 5. ATM: Asynchronous Transfer Mode
 6. AWG: American Wire Gauge
 7. BD: Building Distributor (replacing Intermediate Cross-Connect (IC))
 8. BDF: Building Distribution Facility
 9. BICSI®: Building Industry Consulting Services International
 10. BTU: British Thermal Unit
 11. CATV: Community Antenna Television (cable television)
 12. CCITT: The International Telegraph and Telephone Consultative Committee
 13. CCTV: Closed Circuit Television
 14. CD: Campus Distributor (replacing Main Cross-Connect [MC])
 15. dB: Decibel
 16. EF: Entrance Facility
 17. EIA: Electronics Industry Alliance
 18. ELFEXT: Equal Level Far-End Crosstalk
 19. EMC: Electromagnetic Compatibility
 20. EMI: Electromagnetic Interference
 21. ER: Equipment Room
 22. FCC: Federal Communications Commission
 23. FD: Floor Distributor (replacing Horizontal Cross-Connect [HC])
 24. FDDI: Fiber Distribution Data Interface
 25. FEXT: Far-End Crosstalk
 26. FM: Factory Mutual Insurance Company
 27. FOTP: Fiber Optic Test Procedure
 28. Freq: Frequency
 29. GE: Grounding Equalizer
 30. Gnd.: Ground
 31. HC: Horizontal Cross-Connect (replaced with Floor Distributor [FD])
 32. HH: Hand Hole
 33. HVAC: Heating, Ventilation, and Air Conditioning

34. Hz: Hertz
35. IC: Intermediate Cross-Connect (replaced with Building Distributor [BD])
36. ICEA: Insulated Cable Engineers Association
37. IDC: Insulation Displacement Contact
38. IDF: Intermediate Distribution Frame
39. IEEE: Institute of Electrical and Electronic Engineers
40. IRI: Industrial Risk Insurers
41. ISD: Information Systems Division
42. ISO: International Organization for Standardization
43. ITU: International Telecommunications Union
44. Mbps: Megabits per second
45. MC: Main Cross-Connect (replaced with Campus Distributor [CD])
46. MDF: Main Distribution Frame
47. MH: Maintenance Hole
48. MHz: Megahertz
49. MM: Multimode
50. NEC: National Electrical Code, NFPA 70
51. NEMA: National Electrical Manufacturers Association
52. NESC: National Electrical Safety Code, IEEE C2
53. NFPA: National Fire Protection Association
54. NR: Network Room
55. OSHA: Occupational Safety and Health Administration
56. OSP: Outside Cable Plant
57. OTDR: Optical Time Domain Reflectometer
58. PIC: Plastic Insulated Conductor
59. POTS: Plain Old Telephone Service
60. PR: Pair
61. PVC: Polyvinyl Chloride
62. RCDD®: Registered Communications Distribution Designer
63. RFI: Radio Frequency Interference
64. RH: Relative Humidity
65. SCS: Structured Cabling System
66. SM: Single-mode
67. SMDF: Strategic Main Distribution Frame
68. SNR: Signal-to-Noise Ratio
69. SONET: Synchronous Optical Network
70. SW: Station Wire
71. TB: Terminal Block
72. TBB: Telecommunication Bonding Backbone
73. TR: Telecommunications Room
74. TGB: Telecommunications Grounding Busbar
75. TIA: Telecommunications Industry Association
76. TMGB: Telecommunications Main Grounding Busbar
77. TO: Telecommunications Outlet
78. TR: Telecommunications Room or Technology room (replacing Telecommunications Closet (TC))
79. UL: Underwriters Laboratory
80. μ m: Micron
81. UPS: Uninterruptible Power Supply
82. WAO: Work Area Outlet

1.4 SUBMITTALS

- A. UD Requirements:

1. At the completion of the installation, the Contractor shall provide one (1) copy of each of the following:
 - a. Equipment manufacturer's operation and maintenance manuals for each piece of equipment.
 - b. "As built" drawings for all equipment installed, including patch panel assignments.
 - c. "As built" drawings on AutoCAD drawings of all wire and cable placement throughout the building and conduits.
 - d. Samples of proposed equipment may be required by the University of Delaware prior to any contracts.
 - e. The Bidder shall include a statement of warranty on the entire system and on the individual pieces of equipment. The system warranty shall be for a minimum of one (1) year from the date of system acceptance by the Owner. This warranty shall obligate the Contractor to provide all equipment, material and labor, at no charge to the Owner, during the warranty period in the event of system or equipment malfunction. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty is normally voided. In such cases, the Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.
- B. General: Comply with Section 013300 – Submittal Procedures.
 1. Submittal Schedule and Log: Comply with Section 013300.
 2. Proposed Products List: Comply with Section 013300.
 3. Product Data: Comply with Section 013300.
 4. Shop Drawings: Comply with Section 013300.
 5. Test Reports: Comply with Section 013300 and Section 270700.
 6. Operation and Maintenance Data: Comply with Section 017800 – Closeout Submittals.
 - a. Submit operation and maintenance manuals for communications systems and equipment. Use manuals during demonstrations and instruction of Owner's personnel.
 7. Warranty: Comply with Section 017800– Closeout Submittals.
- C. Project Record Documents: Comply with Section 017839 – Project Record Documents.
 1. Maintain timely and accurate records of actual device locations.
 2. Carefully documents major deviations in work as actually installed.
 3. Include notations reflecting as-built conditions of any additions to or variation from original Drawings.
 4. Include actual locations of installed conduits and cable tray.
 5. Include following intra-building wiring information for each specified media prior to final acceptance:
 - a. Location and identification of distribution cabinets and of equipment located inside cabinets and equipment rooms.
 - b. Terminal information, outlet numbering, and pair count information at each distribution frame.
 - c. Schematic drawings of backbone.
 - d. Routing of cable and termination information.
 6. Include complete listing of pair assignment records for copper wiring, optical fiber cabling and coaxial cabling.
 - a. Copper Cable Records: Include status of each copper pair.
 - b. Optical Fiber Cable Records: Include strand allocation, test results, and identification of media and protocol used.
 7. Project Record Drawings; Submit electronic drawings. Confirm format with Owner's Representative.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms regularly and currently engaged in production of equipment and accessories provided.
 - 1. Equipment: In satisfactory and efficient operation on at least three installations for not less than three years.
 - 2. Suppliers: Factory or manufacturer trained and authorized personnel for installation and service of equipment provided.
- B. Installer Qualifications:
 - 1. Certified by SCS manufacturer, adhere to engineering, installation and testing procedures and utilize authorized manufacturer components and distribution channels in provisioning this Project.
 - 2. Experienced in communications work and able to demonstrate direct experience on recent systems of similar type and size.
 - 3. Labor: Competent, skilled and certified by systems manufacturer.
 - 4. Utilize and maintain tools and equipment necessary for successful installation and testing of optical fiber and Category 6A metallic premise distribution systems and have personnel adequately trained in use of such tools and equipment.
 - 5. Employ full-time Project Manager registered by BICSI as current RCDD. Project Manager:
 - a. Installer's representative, speak and respond for Installer.
 - b. Make at least one day per week visit to construction site to determine progress of construction and be available to resolve contract issues.
 - 6. Superintendent: Contractor: Employ competent superintendent, satisfactory to Owner's Representative, on Work during progress of Work. Superintendent: Represent Contractor and communications given to superintendent shall be as binding as if given to Contractor. Contractor: Not remove approved Superintendent from Work without approval of Owner's Representative, unless that Superintendent leaves employ of Contractor.
- C. Regulatory Requirements: Comply with Section 014100 – Regulatory Requirements. Comply with following:
 - 1. Applicable rules and regulations of federal and state and local governmental agencies.
- D. Project Meetings: Comply with Section 013119 – Project Meetings.
 - 1. Pre-Construction Meeting: Attend meeting when requested by Contractor. Come prepared with questions and prepared to answer questions about communications work.
 - 2. Progress Meetings: Attend meetings. Come prepared with questions and prepared to answer questions about communications work.
- E. Intent of Documents:
 - 1. Drawings: Diagrammatic. See Section 013113 – Project Coordination.
 - a. Due to small scale of Drawings, it is not possible to indicate offsets, fittings, changes in elevation, etc. Prior to rough-in, verify exact locations for installation with field measurements and with equipment being connected.
 - b. If field conditions or equipment require significant change to original documents, contact Owner's Representative before proceeding.
 - c. Exact locations of equipment and fixtures subject to approval of Owner's Representative.
 - d. Coordination Drawings: Prepare in accordance with Section 013113.
 - 2. Omissions from Drawings or Specifications, or incorrect description of details of Work which are necessary to carry out intent of Drawings and Specifications, or which are customarily performed, shall not relieve Contractor from performing such omitted or incorrect described detail of Work. Perform such Work as if verified field measurements, field construction criteria, materials, catalog numbers and similar data, or will do so, and that he has checked and coordinated each shop drawing and sample with requirements of Work and of Contract Documents.
- F. Review of Contract Documents: Comply with Section 013113 – Project Coordination.

1. Verify dimensions locating work and its relation to existing work, existing conditions and their relation to work and man-made obstructions and conditions, etc. affecting completion and proper execution of work as indicated in Contract Documents.
- G. Coordination: Coordinate work of this section with requirements of local workstation, local area network (LAN) equipment suppliers, furniture suppliers and other sub-contractors as required.
 1. Meet with representatives of above organizations and Owner's Representative to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute record to other participants.
 3. Adjust arrangements and locations of distribution frames, patch panels, and cross connects in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
- H. Methods of construction not specifically described or indicated in Contract Documents subject to control and approval of Owner's Representative.
- I. Owner: Desires showcase cable plant following installation. Install pathways, dressing and organization of cable plant in neat and well-engineered manner.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with Section 016600.
 1. Cable Storage: Do not roll or store cable reels without appropriate underlay.
 2. Pre-installation Inspection: Visually inspect cables, cable reels, and shipping cartons to detect possible cable damage incurred during shipping and transport. Replace visibly damaged goods at no additional cost to Owner.

1.7 PROJECT CONDITIONS

- A. Use of Premises: Comply with Section 011400 – Work Restrictions.
 1. Plant Services: Schedule necessary shutdowns of plant services with Owner's Representative, and obtain written permission from Owner's Representative.
- B. Work Restrictions: Hours of Work: Limited to Monday-Friday, 7:30 AM – 5:30 PM.
- C. [Special Procedures: Apply to restricted areas such as operating rooms, labs, research areas and other public spaces (historical facilities, power facilities, prisons, etc.). Adhere to special procedures.

1.8 SEQUENCING AND SCHEDULING

- A. General: Sequence and schedule work in accordance with Section 013213 – Scheduling of Work.
- B. Progress Schedule: Prepare and submit in accordance with Section 013216 – Construction Progress Schedule.

1.9 WARRANTY

- A. Special Warranty: Prepare and submit in accordance with Section 017836 - Warranties.
 1. Cable Integrity and Associated Terminations: Warrant being free from defects, transpositions, opens-shorts, kinks, damaged jacket insulation, etc.
 2. SCS: Repair or replace elements of SCS as required to deliver specified performance of complete system.
 3. One Year Correction Period: For period of one year from Substantial Completion, replacement of defective equipment will commence within 24 hours of first notification.
 - a. Complete repairs to equipment within 72 hours. If repairs cannot be completed during this time period or if ordering of parts is required, forward to Owner's Representative every 72 hours documentation of progress of repairs.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. General: Comply with Section 016000 – Product Requirements.
- B. Materials and Equipment: New and unused, clean, free of defects, and free of damage and corrosion.
 - 1. Used equipment or damaged material not allowed.
 - 2. Standard products of manufacturer unless otherwise specified.
 - 3. Materials: Bear UL label where applicable. Application and Installation: In accordance with labeling and listing.
 - 4. Electrical Equipment and Systems: UL Standards, NEC, and CSA. This listing requirement applies to entire assembly. Perform modifications to equipment to suit intent of specifications in accordance with these requirements.
- C. Contract documents are prepared on basis of acceptable manufacturer(s).
 - 1. If Contractor elects to use products other than specified equipment, submit detailed drawings indicating proposed installation of equipment.
 - 2. If substitution submittal is rejected, revise and resubmit specified equipment that conforms to Contract Documents.
 - 3. If acceptable manufacturer is no longer available, submit equivalent manufacturer and/or product.
- D. Additional Engineering Services: If Consultant provides additional engineering services as result of substitute materials or equipment by Contractor, or changes by Contractor in dimension, weight, power requirements, etc., of equipment provided, then Contractor shall pay Owner for cost of such additional services.
- E. Installed Equipment and Materials: Compatible with other items being provided and with existing items so that complete and fully operational system results.

2.2 CABLES

- A. Cable Passing through Two or More Floors: Suitable, listed and marked for use in riser application.
 - 1. Riser Cable: CMR or OFNR rated per NEC and comply with other applicable codes.
- B. Cable in Plenums: Rated, listed and marked for use in plenum application.
 - 1. Plenum Cable: CMP rated per NEC and comply with other applicable codes.
- C. Contractor shall verify all spaces as plenum or non-plenum with the architect/mechanical engineer prior to purchasing or installing any cable. Contractor shall be aware of any owner or AHJ requirements for plenum cable or other cable types.

2.3 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
 - 1. Components of assembled unit need not be products of same manufacturer.
 - 2. Alike Constituent parts: Product of single manufacturer.
 - 3. Components: Compatible with each other and with total assembly for intended service.
- C. Components of Equipment: Bear manufacturer's name or trademark, model number and serial number on name plate securely affixed in conspicuous place, or cast integral with, stamped or otherwise permanently marked upon components of equipment.
- D. Equipment that Serves Same Function: Same make and model. Exception allowed if performance requirements cannot be met.

2.4 TOOLS AND EQUIPMENT

- A. Miscellaneous Equipment: Provide screws, anchors, clamps, tie wraps, distribution rings, wire molding, miscellaneous grounding and support hardware, etc., necessary to facilitate installation of communications system.
- B. Special Equipment and Tools: Provide special installation equipment or tools necessary to properly complete system. This may include, but is not limited to, tools for terminating cables, testing equipment for copper/fiber cables, communication devices, jack stands for cable reels, or cable winches.
- C. Lifting Attachments: Provide equipment with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting Attachments: Withstand handling conditions that might be encountered without bending or distortion of shape, such as rapid lowering and braking of load.

2.5 MISCELLANEOUS

- A. Miscellaneous Support: Metal Bars, Plates, Tubing: ASTM Standards:
 - 1. Steel Plates, Shapes, Bars, and Grating: ASTM A36.
 - 2. Cold-Formed Steel Tubing: ASTM A500.
 - 3. Hot-Rolled Steel Tubing: ASTM A501.
 - 4. Steel Pipe: ASTM A53, Schedule 40, welded.
 - 5. Provide clevis hangers, riser clamps, conduit straps, threaded c-clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps as applicable.
 - 6. Protected with zinc coating or treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic.
 - 7. Products for Outdoor Applications: Hot dipped galvanized.
- B. Metal Fasteners: Zinc-coated (type, grade and class as required).
- C. Access Doors: Provide in accordance with Section 083100 - Access Doors and Panels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The scope of work for the Telecommunications Contractor shall include all labor, materials, equipment, and services necessary for the installation of a complete inter-building fiber optic, multi-twisted pair and coaxial communications cabling system including, but not limited to, new cabling, termination hardware, lightning protection modules, and other related equipment as required. The scope of work shall also include termination, testing, and labeling of the entire systems. The contractor shall contact the University Department of Network & Systems Services prior to terminating any cabling within the Telecommunications Rooms, so that proper layout of all equipment is coordinated and verified.
- B. General: Perform in accordance with Division 02 – Existing Conditions.
- C. Examination of Premises: Visit Site to become familiar with local conditions under which work is to be performed and correlate observations with requirements of Contract Documents. No allowance made for claims for concealed conditions which Contractor, in exercise of reasonable diligence in its observations of site and local conditions should have learned of.
- D. Before ordering any materials or doing Work, verify measurements and be responsible for correctness of same.
 - 1. No extra charge or compensation allowed for duplicate work or material required because of unverified difference between actual dimension and measurement indicated on Drawings.
 - 2. Submit discrepancies found in writing to Owner's Representative for consideration before proceeding with Work.

- E. Facility Review: Conduct walk through with Owner's Representative of work areas, describing specific work methods and proposed schedules, before commencing work, enabling Owner's Representative to identify areas of concern, desired installation timetables and review important procedural and safety precautions.
- F. Prior to start of installation, meet at project site with Construction Manager and other trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with work. Plan crucial scheduled completions of equipment room, data center, workstation outlets and meeting rooms.
- G. Examine areas and conditions under which system is to be installed. Do not proceed with work until satisfactory conditions have been achieved.
 - 1. Beginning of installation means installer accepts existing conditions.

3.2 PREPARATION

- A. Protection: Protect Owner's facilities, equipment, and materials from dust, dirt, and damage during construction.
 - 1. Remove protection at completion of work.

3.3 ROUGH-IN

- A. Before construction work commences, visit site and identify exact routing for horizontal and backbone pathways. Identify required core locations.
- B. Equipment Locations: Coordinated with other trades, other renovation projects, and existing conditions to eliminate interference with required clearances for equipment maintenance and inspections.
 - 1. Provide easy, safe, and code mandated clearances at equipment racks and enclosures, and other equipment requiring maintenance and operation.
 - a. If it is determined that ample maintenance and passage space has not been provided, rearrange work and/or provide other equipment as required for maintenance space.
 - 2. Coordinate work with other trades and existing conditions to determine exact routing of cable tray, hangers, conduit, etc., before fabrication and installation.
 - a. Where more than one trade is involved in area, space or chase, cooperate to utilize space appropriately in relation to their individual requirements.
 - 3. Bring changes in size or location of material or equipment necessary to meet field conditions or in order to avoid conflicts between trades to immediate attention of Owner's Representative before such alterations are made.
 - 4. Verify with Owner's Representative exact location and mounting height of equipment in finished areas, such as equipment racks, communication and electrical devices.
 - 5. Additional Engineering Services: If Consultant provides additional engineering services for following, then Contractor shall pay Owner for cost of such additional services:
 - a. To examine and evaluate changes proposed by Contractor for convenience of Contractor.
 - b. As result of Contractor's errors, omissions or failure to conform to requirements of Contract Documents.
- C. Access Doors: Provide in accordance with Section 083100 - Access Doors and Panels when necessary to provide proper access to communication system components.

3.4 INSTALLATION

- A. General: Comply with Section 013113 – Project Coordination and Section 016000 – Product Requirements.
 - 1. Install materials and equipment in accordance with manufacturers' recommendations. Refer conflicts between manufacturer's recommendations and Contract Documents to Owner's Representative for resolution.

2. Coordinate ordering and installation of equipment with long lead times or having major impact on work by other trades so as not to delay job or impact schedule.
 3. Where mounting heights not detailed or dimensioned, install systems, materials and equipment to provide maximum headroom possible.
 4. Equipment: Not hidden or covered up prior to observation by Owner's Representative.
 5. Contractor: Responsible for damage to any surfaces or work disrupted as result of his work. Repair surfaces, including painting. Replace damaged ceiling tiles.
- B. Installation: In accordance with the above referenced standards and manufacturer's design and installation guidelines.
1. Ensure maximum pulling tensions of specified distribution cables not exceeded and cable bends maintain proper radius during placement of facilities.
 2. Provide additional material and labor in timely fashion to properly rectify failure to follow requirements.
- C. Concealment: Conceal work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment impossible or impractical, notify Owner's Representative before starting that part of work and install only after his review. In areas with no ceilings, install only after Owner's Representative's review.
- D. Cutting and Patching Comply with Section 017329 – Cutting and Patching.
- E. Waterproofing: Seal foundation penetrations by communications conduits and sleeves to eliminate intrusion of moisture and gases into building.
1. Spare Conduits: Plugged with expandable plugs.
 2. Service Entrance Conduits through Building: Sealed or resealed upon cable placement.
 3. Conduits with Cables in Them: Permanently sealed by firmly packing void around cable with oakum and capping with hydraulic cement or waterproof duct seal.
- F. Supports: Provide required supports, beams, angles, hangers, rods, bases, braces, straps, struts, and other items to properly support contract work.
1. Supports: Approved by Owner's Representative.
 2. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above.
 3. Precast Panels/Planks and Metal Decks: Support communication work as determined by manufacture and Owner's Representative.
 4. Mounting Plates: Provide heavy gauge steel mounting plates for mounting communication work.
 - a. Mounting Plates: Span two or more studs.
 - b. Size Gage and Strength: Sufficient for equipment size, weight, and desired rigidity.
- G. Cable Routing: Designed and installed so cabling and associated equipment does not interfere with operation or maintenance of other equipment.
1. Wiring: Not hung, tied to, or supported from anything other than telecommunications raceway or building structure.
 2. Accessible Spaces: Install cable for easy access.
 3. Cable Paths above Suspended Ceilings, Mechanical Rooms, Closets: Not blocked or covered in way to impede addition of cable in future.
- H. Power Separation: Do not place distribution cabling alongside power lines, or share same conduit, channel or sleeve with electrical apparatus.
- I. Painting: include following:
1. Painting for cut and patch work.
 2. Painting called for on Drawings.
 3. Painting of junction boxes, JB covers and conduits per Owner's standards.
 4. Painting for damage to existing wall and ceiling surfaces.

3.5 BONDING AND GROUNDING

- A. Provide ground at distribution frames and ensure proper bonding to existing facilities.
 - 1. Ensure ground continuity by properly bonding appropriate cabling, closures, cabinets, conduits, service boxes, and framework.
 - 2. Grounds: Supplied from approved building ground and bonded to main electrical ground.
 - 3. Grounding: In accordance with ANSI-J-STD-607-C, NEC, NESC, NFPA, and local codes and practices.

3.6 PROJECT PHOTOGRAPHS

- A. Photographs: Take prior to concealment of interior or exterior conduit pathways. UD IT-NSS Network Engineer shall be notified when work below is ready so the Network Engineer can be present to inspect work and obtain optional photos.
 - 1. Take at locations so entire length of pathway captured in photograph.
 - 2. Underground: As manholes are being installed, after they are installed, and before they are backfilled.
 - 3. Underground: Prior to concrete pour and again prior to backfill.
 - 4. Prior to concealment of other cables that will become inaccessible after concealment.
 - 5. Of interior manhole wall elevations and before final acceptance of manhole racking, plugs, racking, and final cleanout.
 - 6. Of other installation or situation as required by Owner's Representative.

3.7 PENETRATIONS

- A. Conduit and Sleeve Openings: Waterproofed and fireproofed in compliance with applicable codes and regulations.
 - 1. Seal joints on exterior of conduit penetration in accordance with Section 079200 – Joint Sealants.
- B. Firestopping: Fire-stop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 - Firestopping.
 - 1. Inside of Conduits, Fire-stop System: Dielectric, water resistant, non-hardening, permanently pliable/re-enterable putty along with appropriate damming or backer materials.
 - a. Sealant: Capable of being removed and reinstalled.
 - b. Sealant: Adhere to penetrants and common construction materials and capable of allowing normal wire/cable movement without being displaced.
 - 2. Add fire-stop pillows specs for sealing existing cable tray penetrations through firewall
 - 3. Patch openings remaining around and inside conduit, sleeves and cable penetrations to maintain integrity of fire rated assembly.

3.8 FIELD QUALITY CONTROL

- A. Site Tests & Inspections: Comply with Section 014523 – Testing and Inspection Services.
 - 1. Provide promptly, facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as required by Contract Documents.
 - 2. Inspections and Tests by Owner's Representative:
 - a. Performed in manner to not unnecessarily delay work.
 - b. Contractor: Responsible to assist with these functionality and performance tests.
 - c. Demonstration Setup: Benchmark for comparison of results.
 - d. Failure of Subsystems or Systems to Perform as Specified: Considered as failure to comply with requirements of Contract Documents.

3.9 USE OF CABLE PRIOR TO ACCEPTANCE

- A. Contractor: Permit Owner to place and install cross connects, patch cords and/or equipment onto wire or cable installed under this contract, prior to Substantial Completion.
 - 1. Such Placement or Installation: Not evidence completion of work nor signify Owner's acceptance of Work.

- B. Owner: Responsible for any damages caused by their work forces in regards to temporary connection to new cable plant before final acceptance.
- C. Wire, cabling, and equipment provided, whether work of Contractor is partially or fully completed or not, shall be property of Owner. Owner: Certain rights and privileges in connection with their use.

3.10 CLEANING

- A. General: Comply with Section 017400 – Cleaning.
 - 1. Keep site and surrounding area free from accumulation of waste materials and rubbish on daily basis.
 - 2. Owner: Right to call Contractor back to perform cleanup. If Contractor fails to perform cleanup another contractor will be engaged at Contractor's expense to perform cleanup.
 - 3. Keep communications equipment and fixtures clean for duration of project. Comply with applicable regulations regarding facilities and environmental extreme cleanliness.
- B. Dumpsters: Coordinate placement and duration with Owner's Representative.
 - 1. Costs Associated with Dumpsters: Responsibility of Contractor.

3.11 CUTOVER, GO-LIVE SUPPORT, AND SUPPORT

- A. Cutover: After UD-IT-NSS Technicians commission the Juniper network gear, install patch cables per specifications cross connects within all Telecommunications Rooms.
 - 1. Provide minimum of two technicians onsite for total of 40 hours each to assist as required with system(s) activation.
 - 2. Activities: Include, but not be limited to:
 - a. Set/Device Placement and testing for devices.
 - b. Placement of patch cables.
 - c. Troubleshooting of installed cable plant.
 - d. Installation of additional cables.
 - e. Trouble ticket resolution.
- B. Go-Live Support: Provide one person for one day beginning with first scheduled go-live date. For period of one week after this day, provide necessary support to assure two-hour response time to issues arising from Work identified by Owner's Representative.
- C. Support: Provide technician on site for problem resolution.
 - 1. Activities: Include, but not limited to:
 - a. Additional cabling.
 - b. Changes to cable plant.
 - c. Moving installed cables.
 - d. Additional or ongoing training.
 - 2. Respond with technician onsite to Owner determined emergencies within two (2) hours of request.
 - a. Response Requirement: Applies to calls received from 8 AM – 5 PM, Monday through Friday.
 - b. Calls received after 5 PM: Treated as call received at 8 AM on following business day.
 - 3. Emergency Response Requirement: In effect for duration of system warranty.

3.12 DEMONSTRATION

- A. Demonstration and Instruction of Owner's Personnel: Provide in accordance with Section 017900 – Demonstration and Training.
 - 1. Provide 40 hours of training and orientation of Owner's personnel to cable plant.
 - 2. Demonstration and Instruction: Include, but not be limited to:
 - a. Physical review of installed cable plant.
 - b. Review of cable plant documentation and test results.

- c. Instructions on industry standard termination and testing methods to enable Owner's personnel to successfully terminate and test cabling.
- d. Additional Owner requirements defined during project.

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Grounding Conductors
 - 2. Telecommunications Grounding Busbars
 - 3. Rack-mount Busbars
 - 4. Connectors
- B. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270553 – Identification for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

- A. Grounding conductor
 - 1. Stranded copper wire
 - 2. Insulated and green in color (when available)
 - 3. Sized in accordance with ANSI J-STD-607-C or as calculated from the TDMM.
- B. Grounding Strap
 - 1. Flat braided conductor, 6AWG
 - 2. UL 467 listed, CSA certified
 - 3. Seamless ferrule, two-hole
 - 4. Acceptable Manufacturers:
 - a. Erico
 - b. Harger
 - c. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

2.2 TELECOMMUNICATIONS GROUNDING BUSBARS

- A. Ground Bar Assembly: Constructed of following:
 - 1. TGB: 1/4-inch-thick by 2 inches high by 12 inches in length with TIA standard hole patterns and spacing.
 - 2. TMGB: 1/4-inch-thick by 4 inches high by 12 inches in length with TIA standard hole patterns and spacing.
 - 3. Electro tin-plated copper.
 - 4. Insulators: The busbar shall be insulated from its support.
 - 5. Wall mounting brackets shall provide a minimum 2 inches' separation from the wall to the back of the Busbar

- B. Acceptable Manufacturers:
 - 1. Cooper B-Line Systems Inc. #SBTGBK12/#SBTMGB12
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures

2.3 RACK-MOUNT BUSBARS

- A. Horizontal copper busbar for 19 inches spacing rails
- B. Vertical copper Busbar for full height cabinets
- C. 3/4-inch minimum width, 3/16-inch minimum thickness
- D. Conductor attachment:
 - 1. Pre-drilled for equipment jumpers
 - 2. Screw terminals
- E. Acceptable Manufacturers:
 - 1. Cooper B-Line Systems Inc. #SBHB119K
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures

2.4 GROUNDING WIRE

- A. Exothermic weld connections, all materials and equipment.
- B. Listed compression two-hole lug connectors with long barrels.
- C. Irreversible compression type connectors.
- D. Electro tin-plated copper.
- E. Cast metal.
- F. UL-listed and CSA certified.
- G. Acceptable Manufacturers:
 - 1. Cooper B-Line Systems Inc. #SBTGBK.
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures

2.5 BONDING JUMPERS

- A. Used to bond electronic cabinets and racks to cable tray and grounding busbar.
- B. #6 Braided Wire.
- C. Green Jacket.
- D. UL-listed and CSA certified.
- E. Terminated on cabinet and rack with Lay-in-Lug (Cooper B-Line SBLL 1)
- F. Acceptable Manufacturers:
 - 1. Cooper B-Line Systems Inc. #SBUBC6XXK. (XX can be 14,18, or 32).
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures

2.6 CONNECTORS

- A. Exothermic weld connections, all materials and equipment.
- B. Listed compression two-hole lug connectors with long barrels.
- C. Irreversible compression type connectors.
- D. Electro tin-plated copper.
- E. Cast metal.
- F. UL-listed and CSA certified.
- G. Acceptable Manufacturers:
 - 1. Cooper B-Line Systems Inc. #SBTGBK.
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures

PART 3 - EXECUTION

3.1 GENERAL INSTRUCTIONS

A. INSTALLATION OF GROUNDING AND BONDING

1. Provide and install a Telecommunications Grounding Busbar (TGB) on the 3/4" plywood within Building Entrance Telecommunications Room XXX of the building.
2. Utilize all connector fittings within the B-Line Bus bar kit as called out in this specification.
3. The contractor shall install the Telecommunications Grounding Bus Bar and grounding and bonding system in complete accordance with the recommended practices of the manufacturers and in accordance with the latest revision of the National Electrical Code.
4. The grounding and bonding system shall not rely on the plumbing systems of any type.
5. All bonding conductors shall be routed to the approved ground/bond location utilizing the shortest path possible, and shall be routed with a minimum number of bends.
6. All bonding connections shall be accomplished utilizing U.L. listed bolts, crimp pressure connectors, clamps and lugs.

B. MATERIALS AND EQUIPMENT

1. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Department of Network & Systems Services for approval four (4) weeks prior to installation. Equipment shall include, but may not necessarily be limited to, the following.
2. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.
 - a. For building entrance telecommunications rooms:
 - 1) Install one (1) B-Line Corp. Telecommunications Grounding Busbar (TGB). The TGB shall be bonded to structural steel within telecommunications room itself. The TGB shall also be bonded to a metallic branch conduit carrying electrical conductors to or thru the telecom room, which routes back to the closest electrical panel in the nearby area. The bonding wires used for this purpose shall be insulated #6 AWG braided wire, as per the NEC. Label the bonding conductor at both ends of wire as to it's from/to destination by room number, and specify that it is for the "Telecommunications Grounding and Bonding System".
 - b. For local floor telecommunications rooms:
 - 1) Provide TGB in technology rooms, computer rooms, data centers, entrance facilities, and all other technology rooms. Mount TGB in such a way as to minimize telecommunications bonding backbone (TBB) sweeps within the TR and to prevent accidental contact with the busbar. Provide multiple busbars in larger TRs as required or as shown on drawings.
 - 2) Bond metallic equipment racks, water pipes, conduits, metallic ductwork, cable runways & ladder rack to TGB. Bond all metallic elements entering the TR with the exception of explosive or flammable gas/fluid piping. Size conductors in accordance with ANSI J-STD-607-A.
 - 3) Bond any electrical service panels within room to TGB.
 - 4) Provide warning labels on or next to busbars per ANSI J-STD-607-A.

3.2 INTERIOR COMMUNICATIONS PATHWAYS

- A. Cable Tray Sections: Bonded together with grounding strap or continuous grounding conductor.
- B. Provide grounding wires from telecommunications grounding busbars (TGB) to both ends of cable support system.
- C. Provide grounding conductors from cable support system to structural steel (when present) at 15 m (50 ft) intervals along the cable support system. Bonds to structural steel shall be with exothermic welds.
- D. Bond metallic cable support system to TGB.
- E. Horizontal Pathways: Bonded and grounded per NEC Article 250.

3.3 RACK-MOUNT BUSBAR

- A. Install a grounding busbar in each rack/cabinet. Install the busbar on the back of the rack near the top of the rack/cabinet. Locate the busbar as to not interfere with access to rack-mount equipment.
- B. Prepare all painted or non-conductive surfaces as necessary to achieve a sufficient bond. Star washers shall be used on both sides of a surface to ensure an adequate bond.
- C. Self-tapping screws, or any other type of screws, shall not be used to form bonds or attach grounding hardware. Busbar kit screws may be used to attach rack-mount busbars. However, screws shall not be considered an acceptable bond, even if included by busbar manufacturer. Busbar bonds shall use bolts.

END OF SECTION

SECTION 27 05 28.15
FLOORBOXES AND POKE-THRUS

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Floor Box Assembly.
 - 2. Poke-thru Assembly.
- B. Related Requirements: Comply with following:
 - 1. Section 078400 – Firestopping.
 - 2. Section 270500 – Common Work Results for Communications.
 - 3. Section 270526 – Grounding and Bonding for Communications.
 - 4. Section 270553 – Identification for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Colors and Finishes: Submitted and approved by Architect prior to order.
- D. Product Samples: As required.
- E. If providing pre-standards manufacturer system solution, submit installer/contractor certification documentation and channel certification information and requirements from manufacturer.

PART 2 - PRODUCTS

2.1 FLOOR BOX ASSEMBLY

- A. On-grade applications: Manufactured from cast-iron.
- B. Above-grade applications: Manufactured from stamped steel.
- C. Provide two 31.75 mm (1-1/4 inch) conduit openings to feed cabling to the box. Box shall provide the means to reduce this opening to fit 25.4 mm, 19.05 mm and 12.7 mm (1 inch, 3/4 inch and 1/2 inch) conduit sizes.
- D. Covers and Flanges: Floor box options shall accept metallic [nonmetallic] cover plates and flanges.
 - 1. Flange shall provide 12.7 mm (1/2 inch) of adjustment to accommodate various floor coverings and concrete depths. Flanges shall accommodate connectivity outlets and modular inserts.
 - 2. Covers shall be available with options for tile or carpet inserts, blank covers, or covers with two 25.4 mm (1 inch) liquid tight openings for furniture feed applications.
- E. Device mounting plates shall accept both duplex power devices as well as communications connectivity outlets and modular inserts.
- F. Modular inserts shall snap directly into the faceplate through the use of a mounting bezel.
- G. Four independent wiring compartments that allow up to four duplex receptacles and/or communications services.

- H. Permit a tunneling feature that will allow internal wiring to various compartments. The box shall provide various size conduit knockout openings.
- I. Fully adjustable, providing a maximum of 47.63 mm (1-7/8 inch) pre-pour adjustment, and a maximum of 19.05 mm (3/4 inch) post-pour adjustment.
- J. Concrete Depth: The minimum concrete depth shall depend on the type of box used while accounting for the fire rating of the floor. Each box shall contain four locations to attach the box to the slab.
- K. Acceptable Manufacturers:
 - 1. Wiremold.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.2 POKE-THRU ASSEMBLY

- A. Classification and Use: Reference note: poke-thru device use is limited by the UL Fire Resistance Directory to a minimum spacing of 0.609 m (2 feet) on center and not more than one device per 65 square feet of floor area in each span. Poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to comply with UL514A and/or UL514C, as applicable and tested to Canadian Standard C22.2 and bear the cULus mark. The poke-thru shall conform to the standards set in the National Electrical Code, Section 300-21.
- B. For use in 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings, or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru device fittings.
- C. Integrated intumescent firestop material to maintain the fire rating of the floor assembly. The intumescent material shall be held securely in place in the insert body.
- D. Evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
- E. Suitable for use in air handling spaces in accordance with Section 300-22C of the National Electrical Code.
- F. Communication Modules Mounting Accessories: Facilitate mounting SCS UTP, STP, fiber optic, coaxial, and data/communications devices.
- G. Flush Poke-Thru: Assembly shall consist of an insert and an activation service head cover for flush mounted installation.
 - 1. Utilize Wiremold Evolution Series [AT-6 or AT-8 Poke-Thru Assemblies](#). Communications hardware within shall be Legrand #6ACT8A-WH devices plates, Legrand #CM2-U1KEYA-WH single-bezels or #CM2-U2KEYA-WH dual-bezels, Legrand #CM2-BL-WH blanks, Siemon Co. #MX5-K01 keystone jacks for Network/T568B terminations, and Ortronics/Legrand #OR-KSFCN-88 for CATV F-Type coax terminations.
 - 2. Insert Body:
 - a. Channels to provide complete separation of power and communication services.
 - b. Bracket that will accommodate up to four connectivity modular inserts. Bracket to also include a rubber grommet at the communication compartment opening to protect communication cables.
 - 3. Activation Cover:
 - a. Die-cast aluminum alloy powder coated or plated finish.
 - b. Slide covers: Spring loaded.
- H. Flush Furniture Feed: Assembly shall consist of an insert and an activation service head cover for flush mounted installation.
 - 1. Insert Body:
 - a. Channels to provide complete separation of power and communication services.
 - 2. One 19.05 mm (3/4 inch) conduit channel and two 12.7 mm (1/2 inch) conduit channels for power and communication cabling.
 - 3. Activation Cover:

- a. Die-cast aluminum alloy powder coated or plated finish.
 - b. Include three conduit openings to feed modular furniture applications and provide a flush appearance.
- I. Surface Mounted Furniture Feed: Assembly shall consist of an insert and an activation service head cover for surface mounted installation.
 - 1. Insert Body:
 - a. Channels to provide complete separation of power and communication services.
 - 2. One 12.7 mm (1/2 inch) conduit channel for power wiring and one 31.75 mm (1-1/4 inch) conduit channel for communication cabling.
 - 3. Activation Cover:
 - a. Die-cast alloy powder coated or plated finish, black or ivory.
 - b. Trim flange and a hexagonal service head.
- J. Acceptable Manufacturers:
 - 1. Legrand
 - 2. Wiremold.
 - 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 FLOOR BOX/POKE THRU ASSEMBLY

- A. Examine conditions under which boxes, distribution systems, accessories, and fittings are to be installed. Notify the Architect/Engineer or Construction Manager in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Strictly comply with manufacturer's installation instructions, recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
 - 1. Provide and install XXX (X) Wiremold Evolution Series RC4ATCXX, RC6ATCXX, or RC8ATCXX Poke-Thru assemblies in rooms XX.
 - 2. Provide and install XX (X) Legrand #6ACT8-WH device plate in each poke thru.
 - 3. Provide and install XX (X) Legrand #CM2-U1KEYA-WH single port bezel or #CM2-U1KEYA-WH dual port bezel in each device plate.
 - 4. Provide and install XX (X) Legrand #CM2-BL-WH blank assembly in each device plate.
 - 5. Provide and install XX (X) Siemon Co. #MX5-K02 keystone jacks in each bezel.
 - 6. Provide and install XX (X) Ortronics/Legrand #OR-FSFCN-88 Coax/F-Type keystone jack in each bezel.
- C. Mounting: Mount in either a 76.2 mm (3 inch) or 101.6 mm (4 inch) core hole as applicable.

END OF SECTION

SECTION 27 05 28.19

ZONE BOXES

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Ceiling Mounted Zone Box
- B. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 271119 – Communications Termination Blocks and Patch Panels.
 - 3. Section 271123 – Communications Cable Management and Ladder Rack.
 - 4. Section 270526 – Grounding and Bonding for Communications.
 - 5. Section 270548 – Vibration and Seismic Controls for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Colors and Finishes: Submitted and approved by Architect prior to order.
- D. Product Samples: As required.
- E. If providing pre-standards manufacturer system solution, submit installer/contractor certification documentation and channel certification information and requirements from manufacturer.

PART 2 - PRODUCTS

2.1 CEILING MOUNTED ZONE BOX

- A. Ceiling Enclosure with Fully Hinged Access Door:
 - 1. For indoor use only, in environmentally controlled areas; may be used in plenum spaces; may not be used outdoors, in industrial or harsh environments
 - 2. Removable back panels for mounting block terminating hardware or 19 inch EIA threaded equipment mounting brackets.
- B. Cable Management: Cable tie points within the enclosure
- C. Power: Includes an integrated junction box. Supports two duplex receptacles, pre-punched with 20 mm (7/8 inch) knockouts for trade size 1/2-inch conduit.
- D. Grounding: Includes two threaded studs spaced 16 mm (5/8 inch) apart for a 2-hole ground lug
- E. Material: aluminum sheet or steel sheet
- F. Construction: Riveted and bolted
- G. Finish: Mill finish on some components. Flat epoxy white powder coat paint on door/face and interior.
- H. Cable Access:
 - 1. 75 mm by 150 mm (3-inch-wide by 6 inch high) 228 mm by 150 mm (9 inch wide by 3 inch high) edge-protected cable access ports.
 - 2. Ports include intumescent foam sealing kits.

- I. Recessed panel on access door to capture ceiling tile.
- J. Certifications:
 - 1. EIA-310-D compliant
 - 2. UL File Number E185147
 - 3. UL Listed (UL 50, UL 2043, UL 1863)
- K. Carries OPA number for installation in California.
- L. Size:
 - 1. **610 mm by 1219 mm (2' X 4') Ceiling Mount Zone Box:**
 - a. Approximately 1219 mm L by 610 mm W by 305 mm H (48 inches L by 24 inches W by 12 inches H).
 - b. Sized to fit within the standard space for a 610 mm by 1219 mm (2' by 4') acoustical ceiling tile.
 - c. Usable Interior Space: 1156 mm L by 533 mm W by 267 mm H (45-1/2 inches L by 21 inches W by 10-1/2 inches H) minimum.
 - d. Removable equipment mounting brackets.
 - 1) 482 mm (19 inches) W, EIA-310-D complaint.
 - 2) Four RMU each — on the top, front and rear of each bracket.
 - 3) Threaded #12-24 equipment mounting holes
 - e. Load Capacity:
 - 1) 40 kg (85 pounds) min. of equipment total.
 - 2) (50 pounds) (23 kg) min. of equipment on the door, open or closed.
 - 2. **610 mm by 610 mm (2' X 2') Ceiling Mounted Zone Box:**
 - a. Approximately 610 mm L by 610 mm W by 305 mm H (24 inches wide by 24 inches long by 12 inches deep).
 - b. Sized to fit within the standard space for a 610 mm by 610 mm (2' by 2') acoustical ceiling tile.
 - c. Equipment Support:
 - 1) Removable door-mounted assembly for 483 mm (19 inch) rack-mount patch panels and active equipment
 - 2) 5U for patch panels/cable managers up to 64 mm (2.5 inches) minimum deep
 - 3) 2U for active components up to 381 mm (15 inches) minimum deep
 - d. Load Capacity:
 - 1) 32 kg (70 pounds) minimum of equipment total
 - 2) 9 kg (20 pounds) minimum of equipment on the door, open or closed.
- M. Acceptable Manufacturers:
 - 1. Chatsworth.
 - 2. Hoffman.
 - 3. Hubbell.
 - 4. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 CEILING MOUNTED ZONE BOX

- A. Coordinate exact placement with other trades as indicated on drawings.
- B. Install in ceiling tile as indicated on drawings.
- C. Hang using a minimum 10 mm (3/8 inch) threaded rod.
- D. Size supporting devices to withstand cable weight plus 60 percent future fill.
- E. Install per manufacturer's recommendations.
- F. Bond and ground to TGB or TBB with appropriately sized grounding wire.
- G. Maintain bend radius for fiber optic and copper cables when transitioning to/from cable support system.
- H. Secured from ceiling slab.

- I. Install cable minimum of 2 inches away from any light fixture or other source of electro-magnetic interference (EMI).
- J. Service equipment using hinged door that opens downward (toward the floor), so equipment faces the technician
- K. Cables into Zone Box: Provide neat and organized distribution of cables into zone box. Refer to Section 271123 – Communications Cable Management and Ladder Rack for cable management.
- L. Cable Horizontal Path: Ensure stress relief with cable ties and support. Support weight of cable at 90-degree bend point with this cable stress management and not by termination point at jack.
- M. Maintain adherence to BICSI cable installation guidelines.

END OF SECTION

SECTION 270528.34
NON-METALLIC TUBING AND FABRIC INNERDUCT

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Non-metallic Tubing (Inner-duct).
 - 2. Fabric Inner-duct.
- B. Related Requirements: Comply with following:
 - 1. Section 078400 – Firestopping.
 - 2. Section 270500 - Common Work Results for Communications.
 - 3. Section 270528.29 – Hangers and Supports for Communications Systems.
 - 4. Section 270553 – Identification for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 NON-METALLIC TUBING (INNERDUCT)

- A. UL listed non-metallic corrugated flexible conduit for use in plenum [riser] applications.
- B. Meet UL Standard Test Method No. 2024 of UL 910 for plenum [riser] optical fiber/communication raceways.
- C. Articles 770 and 800 for use in plenum [riser] areas.
- D. At least 1 inch in diameter, orange in color.
- E. Include 1/4-inch-wide, 900-pound tensile pre-lubricated pull tape.
- F. Acceptable Manufacturers:
 - 1. ENDOT Industries Inc.#IRI-100
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.2 FABRIC INNERDUCT

- A. Consist of flexible, textile material, sometimes referred to as “fabric duct”. Fabric duct shall meet the following:
 - 1. Available in one, two, and three cell configurations.
 - 2. Multiple cell configurations shall be attached the entire length of the product, to prevent twisting.
 - 3. Contain color coded stitching for cell identification.
 - 4. Have a maximum co-efficient of friction of 0.08.
 - 5. Riser rated; Contain a minimum 1,250 pound pull tape, UL2024A rated. Plenum rated; Contain a minimum 200 pound pull tape, UL2024A rated.
 - 6. Steel reels shall be used for total product weight exceeding 300 pounds.
- B. Acceptable Manufacturers:

1. MaxCell.
2. TVC.
3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 NON-METALLIC TUBING (INNERDUCT)

- A. For riser cable routing in continuous, long riser conduit runs (other than normal sleeves), install four (4) 1" ENDOT Industries Inc. #IRI-100 riser-rated, corrugated inner ducts with preinstalled pull tape. For areas that are plenum rated, install four (4) 1" ENDOT Industries Inc. #IPR-100 plenum-rated, corrugated inner ducts with preinstalled pull tape.
- B. Comply with manufacturer installation recommendations.
- C. Support inner-duct every 36 inches OC.

3.2 FABRIC INNERDUCT

- A. Comply with all manufacturers' installation instructions.

3.3 FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 – Common Work Results for Communications.

END OF SECTION

SECTION 27 05 28.29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Open-Top Cable Support (J-Support).
 - 2. Cable Tie.
 - 3. Supporting Device.
- B. Related Requirements: Comply with following:
 - 1. Section 078400 – Firestopping
 - 2. Section 270500 – Common Work Results for Communications.
 - 3. Section 270526 – Grounding and Bonding for Communications.
 - 4. Section 270548 - Vibration and Seismic Controls for Communications Systems.
 - 5. Section 270553 – Identification for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 OPEN-TOP CABLE SUPPORT (J-SUPPORT)

- A. Prefabricated, zinc coated, carbon steel designed specifically for telecommunication cable installations.
- B. Open top, 90 degree rolled edges and 1-5/8 to 4-inch minimum diameter loop as per load and growth requirements.
- C. UL listed and spaced at [4 to 5 foot intervals](#).
- D. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- E. Acceptable Manufacturers:
 - 1. Four-inch (4") shall be Erico Corp. #CAT64.
 - 2. Cooper B-Line
 - 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.2 CABLE TIE

- A. Plenum rated when used in plenum environment.
- B. Velcro type cable tie that easily reopens for moves, adds and changes.
- C. Acceptable Manufacturers:
 - 1. Hubbell.
 - 2. Leviton.
 - 3. Siemon.
 - 4. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.3 SUPPORTING DEVICE

- A. Miscellaneous Support: Provide in accordance with Section 270500.
- B. 14 gage U-Channel systems with 9/16 inch diameter holes at minimum of 1-7/8 inch OC in top surface.
 - 1. Provide fittings and accessories that match and mate channel.
- C. Anchors: Carbon steel, wedge or sleeve type expansion anchors, steel springhead toggle bolts and heat-treated steel power driven threaded stud fastening equipment as required by construction types.

PART 3 - EXECUTION

3.1 OPEN-TOP CABLE SUPPORT (J-SUPPORT)

- A. install the J-Hook raceways in complete accordance with the recommended practices of the J-Hook manufacturer.
- B. J-Hooks that are installed as the primary raceway in hallways shall be installed at 4 ft. intervals. For primary raceways in hallways, the contractor shall install four-inch J-Hooks, Erico Corp. #CAT64. At no time shall there be more than three-hundred (140) CAT6A cables installed in a single four-inch J-Hook pathway. For primary pathways where walls of a hallway can be used, an appropriately sized section of unistrut shall be installed as the mounting base for all four-inch J-Hooks, so as to allow a secondary pathway to be installed below the primary pathway, for future use. Attach all J-Hooks to unistrut with unistrut spring nuts and screws.
- C. J-Hooks installed as the secondary raceway, including individual outlet cable pathways to/thru various rooms within the building, the contractor shall install 4-inch J-Hooks, Erico Corp. #CAT64. At no time shall there be more than eighty (140) CAT6A cables installed in a single two-inch J-Hook pathway.
- D. Where hallway walls cannot be used for the primary pathway and for secondary pathways, utilize appropriate threaded rod assemblies and associated parts of beam clamp assemblies as the project dictates. These individual parts will be factored into the specifications during the design process.
- E. Ceiling Ties and Rods: Not allowed to hang cable or cable supports.
- F. Load supports as recommended by manufacturer.
 - 1. Provide supports side by side on common bracket where cable quantities require.
- G. Do not install cables loose above lock-in type, gypsum board, or plaster ceilings.
- H. Do not support cable from ceiling system tie wires or grid in fire rated systems.
- I. Install at a minimum of 3 inches above ceiling tiles, support channels, vertical supports and other components on the suspended ceiling, and at 6 inches where sufficient space is available.
- J. Cables shall not come in contact with the ceiling or ceiling components.
- K. Use independent telecommunication dedicated support wires and fasteners, no attachment to other systems acceptable.

3.2 CABLE TIE

- A. Install at 5 foot intervals and at corners.
- B. Installed to put snug grip on bundle of cables and not cinched down tightly.
- C. Not be used in place of J-Hooks.

3.3 SUPPORTING DEVICE

- A. Provide steel angles, channels and other materials necessary for proper support of wall-mounted cabinets, racks, panels, etc.
- B. Cabinets, large pull boxes, and cable support boxes: Secure to ceiling and floor slab and not from conduits.
- C. Small equipment boxes may be supported on walls.
- D. Racks for support of conduit and heavy equipment: Secure to building construction by substantial structural supports.

END OF SECTION

SECTION 27 05 28.33
CONDUITS AND BOXES FOR COMMUNICATION SYSTEMS

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Materials required for installation of interior pathways.
 - 2. Minimum requirements for installation of interior communication pathways.
- 1.1 B. Minimum composition requirements and installation methods for following:
 - 1. Conduit and Sleeve.
 - 2. Communications Backbox.
 - 3. Masonry Box.
- C. Related Requirements: Comply with following.
 - 1. Section 078400 – Firestopping
 - 2. Section 270500 - Common Work Results for Communications.
 - 3. Section 270526 - Grounding and Bonding for Communications.

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

SUBMITTALS

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

2.1 PART 2 - PRODUCTS

MATERIALS AND EQUIPMENT

- A. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Network & Systems Services Department for approval four (4) weeks prior to installation.
- 2.2 B. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.

CONDUIT AND SLEEVE

- A. Rigid Steel Conduit: ANSI C80.1.
- B. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Set-screw or compression type.
- C. Mechanical Sleeve:
 - 1. UL listed and approved.
- D. **SLEEVES – One-inch (1") for gypsum wallboard assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-100 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WL-3275. The cable fill capacity for these sleeves shall not exceed 48%. The Telecommunications contractor shall use the supplied fire-stop putty to satisfy this System requirement.**

- E. SLEEVES - One-inch (1") for concrete and block wall assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-100 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WJ-3141. The cable fill capacity for these sleeves shall not exceed 48%. The Telecommunications contractor shall use the supplied fire-stop putty to satisfy this System requirement.
- F. SLEEVES – Two-inch (2") for gypsum wallboard assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-200 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WL-3358. The cable fill capacity for these sleeves shall not exceed 33%. The Telecommunications contractor shall STI #FP200 firestop plugs to satisfy this System requirement.
- G. SLEEVES – Two-inch (2") for concrete and block wall assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-200 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WJ-3182. The cable fill capacity for these sleeves shall not exceed 33%. The Telecommunications contractor shall supply and install the STI #FP200 firestop plugs to satisfy this System requirement.
- H. SLEEVES – Four-inch (4") for gypsum wallboard assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-400 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WL-3358. The cable fill capacity for these sleeves shall not exceed 33%. The Telecommunications contractor shall supply and install STI #FP400 firestop plugs to satisfy this System requirement.
- I. SLEEVES – Four-inch (4") for concrete and block wall assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-400 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WJ-3182. The cable fill capacity for these sleeves shall not exceed 33%. The Telecommunications contractor shall supply and install the STI #FP400 firestop plugs to satisfy this System requirement.
- J. SLEEVES – Four-inch (4") for horizontal/gypsum wallboard assemblies where telecommunications cables will not be installed (spare sleeves) – STI Fire-Stop Corp. #FS-400 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #WL-0033. The Telecommunications contractor shall supply and install the STI #FP400 firestop plugs to satisfy this requirement.
- K. SLEEVES – Four-inch (4") for concrete floor and/or block wall assemblies where telecommunications cables will be installed – STI Fire-Stop Corp. #FS-400 sleeve assembly. The U.L. approved fire-stop System to be used for this application shall be #FA-3029. The cable fill capacity for these sleeves shall not exceed 48%. The Telecommunications contractor shall supply and install the STI #FP400 firestop plugs to satisfy this System requirement.
- L. Acceptable Manufacturers:
 - 1. STI
 - 2. Standard EMC/IMC Rated Conduit
 - 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.3

COMMUNICATIONS BACKBOX

- A. For Double Gang locations - At indicated locations provide and install one (1) Steel City #82181T-1, 5-Square Telecommunications Outlet Box with two (2) 1" conduits (standard EMT with plastic bushings) stubbed off above the ceiling. Attach one (1) Steel City double-gang Plaster Ring #82C-2G-1/2 to the front of the box for proper installation of the double-gang faceplate. This ring provides a ½" raise from face of box for ½" drywall.
- B. For Single Gang locations - At indicated locations provide and install one (1) Steel City #82C-1G-1/2 Single Gang Plaster Ring, ½" raise. This ring shall be installed on the above double-gang Outlet Box #82181T-1.
- C. For Fire Alarm Outlet- Provide and install one (1) Panduit Single Gang Junction Box, White, part #JBX3510WH-A with one (1) Siemon Single Gang CT Faceplate and one (1) Siemon CAT5E, dual RJ45 568A/B module.
- D. For Fire Alarm Panel-

1. Provide and install one (1) #ASE8X6X3 Hoffman Corp. painted pull-box enclosure with screw-cover and knockouts next to the main/primary fire alarm panel to be installed for the building. Fire Alarm outlet as defined above shall be located within this enclosure.
2. Provided and install ONE (1) 1" EMT conduit with bushings from above Hoffman pull-box to local floor telecommunications room, for routing and protection of network cabling. Install pull-boxes at each area along path of the conduit where directional changes take place (90's).
3. Provide and install one (1) ¾" conduit from the side of this enclosure, into the fire alarm panel itself, for station/patch cable routing to the IP Communications interface.

E. UL-Listed.

F. Acceptable Manufacturers:

1. Thomas & Betts/Steel City
2. Hoffman Corp.
3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

MASONRY BOX

- A. Multiple Gang, Minimal Depth: 3-1/2 inches.
- 2.4 B. Single piece construction with no interior protrusions, for purposes of accepting medical communications devices.
- C. Metallic, welded.
- D. Minimal Knock-Outs: two 0.75 inch on each side per gang size.
- E. UL-Listed.
- F. Acceptable Manufacturers:
 1. Hubbell Raco: 695, 696, 697, 698.
 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1

CONDUIT AND SLEEVE

- A. The contractor shall at all time's install the conduits and sleeves in complete accordance with the National Electrical Code and NFPA, and shall be installed true and plumb. Support hardware shall be installed at 4' intervals.
- B. For conduit installed to transport inside rated cables, the EMT rating shall be acceptable.
- C. All conduits installed for Telecommunications Cable routing, including, convenience outlet locations, riser conduits, and horizontal conduits of all sizes shall have one (1) nylon Greenlee Poly-line #502-1481.0 installed upon completion of the conduit installation.
- D. All riser and horizontal sleeves installed between floors shall be manufactured by the STI Fire Stop Corp., and be installed as per recommended practices. There shall be protective plastic bushings installed on both sides of each sleeve. The Electrical Contractor installing the sleeves shall leave the supplied fire-stop putty within the sleeves in the plastic packaging for use by the Telecommunications Contractor all cabling has been installed. The Telecommunications Contractor shall supply and install all STI firestop plugs as required.
- E. If there are areas where sleeves are required through walls or in concrete slabs, the contractor is responsible for providing those sleeves as required to accommodate his work. All holes must be core bored. After completion of the Communications Cabling System, the contractor shall fire seal all communications sleeves with a UL approved fire stop in accordance with the NFPA (National Fire Protection Agency).
- 3.2 F. Reamed and bushed prior to cable installation.'
- G. Secured with clamps or channel stock to prevent movement at wall penetration points.

GROUNDING AND BONDING

- A. Bond to ground openings in accordance with Section 270526 – Grounding and Bonding for Communications and Section 270500 – Common Work Results for Communications.

FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 – Common Work Results for Communications.

SEISMIC CONTROL

- 3.3 A. Brace and support in accordance with Section 270548 - Vibration and Seismic Controls for Communications Systems.

END OF SECTION

3.4

SECTION 27 05 28.36

CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

SUMMARY

- A. Cable Tray Systems: Provide cable tray system to route voice, data, video and other low voltage communications cable. Cable tray system shall consist of tray, bases, covers, connector assemblies, clamp assemblies, connector plates, splice plates, appropriate fittings, device mounting plates and splice bars as specified, for a complete installation.
- 1.1 B. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Wire Mesh Type
 - 2. Ladder Tray
 - 3. Cable Channel
- C. Related Requirements: Comply with following:
 - 1. Section 078400 - Firestopping.
 - 2. Section 270500 - Common Work Results for Communications.
 - 3. Section 270526 - Grounding and Bonding for Communications.
 - 4. Section 270528.29 - Hangers and Supports for Communications Systems.
 - 5. Section 270548 - Vibration and Seismic Controls for Communications Systems.
 - 6. Section 270553 - Identification for Communications Systems.

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.
 - 1. Following Articles of NFPA 70 - National Electric Code:
 - a. 376 - Metal Wireways
 - b. 378 - Nonmetallic Wireways
 - c. 392 – Cable Trays
 - d. 770 - Optical Fiber Cables and Raceways
 - e. 800 - Communications Circuits
 - 2. NEMA VE-1 – Metal Cable Tray Systems.
- 1.3 3. NEMA VE-2 – Cable Tray Installation Guidelines.

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- 2.1 C. Product Samples: As required.

PART 2 - PRODUCTS

MATERIALS AND EQUIPMENT

- A. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Network & Systems Services Department for approval four (4) weeks prior to installation.
- B. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.

- C. All cable tray shall be installed as per Cablofil recommended practices and directions, using Cablofil cutting tools, with no sharp edges left behind to compromise the cable system to be installed.
- D. All cables that exit cable tray in Telecommunications Rooms shall be supported with one (1) Cablofil Cable Drop-Down Assembly #CABLEXIT at each cable drop-down location.
- E. All corners/90's/T's shall utilize Cablofil #EZT90 corner fittings.
- F. Cable Tray materials to be used in building corridors above ceilings are as follows:
 - 1. 4" Cable Tray shall be Cablofil Inc. EZ-Tray #CF54/100-EZ
 - 2. 6" Cable Tray shall be Cablofil Inc. EZ-Tray #CF54/150-EZ
 - 3. 8" Cable Tray shall be Cablofil Inc. EZ-Tray #CF54/200-EZ
 - 4. 12" Cable Tray shall be Cablofil Inc. EZ-Tray #CF54/300-EZ
 - 5. 18" Cable Tray shall be Cablofil Inc. EZ-Tray #CF54/450-EZ
 - 6. Splicing assemblies shall be two (2) Cablofil Inc. EZ-Tray University Splice Bar #ED-275. Utilize #EZ-BN-1/4 and #SWK hardware at each splice location, per manufacturer's specifications.
 - 7. All corners/90 shall utilize Cablofil Inc. EZ-Tray #EZT90.
 - 8. 4" Wall Brackets shall be Cablofil Inc. EZ-Tray #FASL-100-PG
 - 9. 6" Wall Brackets shall be Cablofil Inc. EZ-Tray #FASL-150-PG
 - 10. 8" Wall Brackets shall be Cablofil Inc. EZ-Tray #FASL-200-PG
 - 11. 12" Wall Brackets shall be Cablofil Inc. EZ-Tray #FASL-300-PG
 - 12. 16" Wall Brackets shall be Cablofil Inc. EZ-Tray #FASL-400-PG
 - 13. 20" Wall Brackets shall be Cablofil Inc. EZ-Tray #FASL-500-PG
 - 14. 4" Wall Brackets shall be Cablofil Inc. EZ-Tray #FAS-U100-PG
 - 15. 6" Wall Brackets shall be Cablofil Inc. EZ-Tray #FAS-U150-PG
 - 16. 8" Wall Brackets shall be Cablofil Inc. EZ-Tray #FAS-U200-PG
 - 17. 12" Wall Brackets shall be Cablofil Inc. EZ-Tray #FAS-U300-PG
 - 18. 16" Wall Brackets shall be Cablofil Inc. EZ-Tray #FAS-U400-PG
 - 19. 20" Wall Brackets shall be Cablofil Inc. EZ-Tray #FAS-U500-PG
 - 20. 12" Center Hanger Assemblies shall be Cablofil Inc. EZ-Tray #FAS-P300-PG. These assemblies are to be used in ceilings where wall-mounting brackets cannot be used. As per manufacturer guidelines, utilize two (2) 3/8" threaded rods and associated mounting hardware for hanging points.
 - 21. 18" Center Hanger Assemblies shall be Cablofil Inc. EZ-Tray #FAS-P500-PG. These assemblies are to be used in ceilings where wall-mounting brackets cannot be used. As per manufacturer guidelines, utilize two (2) 3/8" threaded rods and associated mounting hardware for hanging points.
 - 22. Cable Drop-Down Assemblies shall be Cablofil Inc. EZ-Tray #CABLEXIT
- G. Cable Tray materials to be used in Telecommunications Rooms are as follows:
 - 1. Chatsworth Products Inc., Adjustable Cable runway #14300-712, 1.5" H x 119.5" L x 12" W, color black.
 - 2. Chatsworth Products Inc., Triangular wall support bracket #11746-718, for 18" W cable runway, steel 400lb cap, color black.
 - 3. Chatsworth Products Inc., cable runway wall angle support kit #11421-712 for 12" runway, color black.
 - 4. Chatsworth Products Inc., Tool-less cross member radius drop #14304-712, 12" W, color black.
 - 5. Chatsworth Products Inc., Cable runway butt splice kit #11301-701, for 1.5" stringers, color black.
 - 6. Chatsworth Products Inc., Junction splice kit for cable runway #11302-701, 1.5" x 0.375", color black.
 - 7. Chatsworth Products Inc., Cable runway corner bracket, for creating radius at corners of cable trays, #11959-715, 15", color black.
 - 8. Chatsworth Products Inc., Cable runway corner bracket, for creating radius at corners of cable trays, #11959-724, 24", color black.

WIRE MESH TYPE

- A. Constructed of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. Wire ends along cable tray sides (flanges) shall be rounded or chamfered during manufacturing for safety of cables and installers.
- B. Filled no more than 40 percent visual fill of cable tray's maximum density.
- 2.2 C. Cable tray with proper support spacing shall be capable of carrying a uniformly distributed load at 100 percent maximum fill, with a safety factor of 1.5.
- D. Constructed with rounded edges and smooth surfaces.
- E. Materials and Finishes: Material and finish specifications for each wire mesh type cable tray are as follows:
 - 1. Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.
 - 2. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. Threaded components shall be coated in accordance with ASTM B633 SC1.
- F. Fittings shall be pre-manufactured or field formed per manufacturer's instructions.
- G. Splicing assemblies shall be bolted type using serrated flange locknuts. Hardware shall be either yellow zinc dichromate in accordance with ASTM B633 SC2 or AISI Type 304 Stainless Steel.
- H. Supports shall be center support hangers, trapeze hangers, wall brackets, or a combination of, as field conditions require.
- I. Trapeze hangers or center support hangers shall be supported by 3/8 inch diameter rods, as required to support cable weight.
- J. Special accessories shall be furnished as required to protect, support and install a wire mesh type cable tray support system.
- K. Acceptable Manufacturers:
 - 1. Cablofil.
 - 2.3 Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

LADDER TRAY

- A. Consist of two longitudinal members (side rails) with transverse members (rungs) mechanically fastened to the side rails. Rungs shall be spaced 9 inches on center. Rung spacing in radiused fittings shall be industry standard 9 inch and measured at the center of the tray's width. Each rung must be capable of supporting a 200 pound concentrated load at the center of a 24 inch wide cable tray with a safety factor of 1.5. Rungs shall be capable of easy removal, reinstallation, or replacement if necessary.
- B. Filled no more than 40 percent visual fill of cable tray's maximum density.
- C. Cable tray with proper support spacing shall be capable of carrying a uniformly distributed load at 100 percent maximum fill, with a safety factor of 1.5.
- D. Supports shall be center support hangers, trapeze hangers, wall brackets, or a combination of, as field conditions require.
- 2.4 E. Trapeze hangers or center support hangers shall be supported by 3/8 inch diameter rods, as required to support cable weight.
- F. Acceptable Manufacturers:
 - 1. Chatsworth
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

CENTER SPINE

- A. Constructed of a center rail with radiused corner rungs. Rungs shall be mechanically connected to the center rail in at least two places, symmetrical about the center rail, with ends finished to protect installers and cables.
- B. Filled no more than 40 percent visual fill of cable tray's maximum density.
- C. Cable tray with proper support spacing shall be capable of carrying a uniformly distributed load at 100 percent maximum fill, with a safety factor of 1.5.
- D. Rungs shall be spaced 9 inches on center.
- E. Splice hangers must also be capable of acting as the support points for all-thread rod.
- F. Splices and connectors must protect cables from the edges of the center rail and act as a barrier to prevent the center rail from transmitting hazardous gases or smoke; hardware must be installed vertically so as not to interfere with the cables in the cable fill area.
- G. Where required, expansion splices shall allow for 1 inch of thermal expansion and contraction.
- H. Trapeze hangers or center support hangers shall be supported by 3/8 inch diameter rods, as required to support cable weight.
- I. Acceptable Manufacturers:
 - 1. Cablofil.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

CABLE TRAY

- 3.1 A. The scope of work for the **Electrical Contractor** shall include all cable pathways including cable tray in building corridors, individual outlet conduit and junction boxes, conduit and/or sleeves between all communications rooms, conduit and/or sleeves from communications rooms to hallway cable path locations, sleeves in walls from all rooms for individual station cable routing to hallway cable path locations, and all cable tray for corridors only. All conduits and sleeves within the system shall be installed with protective bushings on all exposed/cut ends.
- B. The scope of work for the **Telecommunications Contractor** shall include supplying and installing the cable tray in all telecommunications rooms in the building, along with all other aspects of the build of the telecommunications room transport infrastructure.
- C. Coordinate cable tray with other work (i.e. ductwork, electrical conduits, piping, plumbing, electrical devices, etc.) as necessary to properly integrate installation of cable tray.
- D. Install cable trays as indicated on building drawings: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment complies with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA VE-2 for general cable tray installation guidelines.
- E. Provide minimal clearances around cable tray per referenced standards to permit access for installing cables, maintaining cables, and reducing the electromagnetic interference (EMI) onto cables.
- F. There shall be no cable tray installed thru walls of any sort. The installed cable tray shall be terminated on both sides of walls. Penetrations thru said walls shall take place by way of 4" sleeves.
- G. Cable Tray Clearance Requirements for accessibility:
 - 1. Maintain a clearance of 6 inches between top of cable tray and ceiling structure or other equipment or raceway.
 - 2. Maintain a clearance of 8 inches between at least one side of cable tray and nearby objects.
 - 3. Maintain a clearance of 6 inches between bottom of cable tray and ceiling grid or other equipment or raceway.

- H. Cable Tray and J-Hook pathway clearance requirements from sources of electromagnetic interference (EMI):
 - 1. Maintain a clearance of 4 inches or more from fluorescent lighting.
 - 2. Maintain a clearance of 12 inches or more from conduit and cables used for electrical power distribution.
 - 3. Maintain a clearance of 48 inches or more from motors or transformers.
 - 4. Pathways shall cross perpendicularly to electrical power cables or conduits.
- I. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit.
- J. Cable tray fitting supports shall be located such that they meet the strength requirements of straight sections. Install fitting supports per NEMA VE-2 guidelines, or in accordance with manufacturer's instructions.
- K. Cut and install per manufacturer's recommendations. Angle cut cutters shall be used to alter wire mesh type cable tray in field.
- L. Bond and ground to TMGB/TGB with properly sized Grounding Wire. Sections: Bolted together or tied together with Grounding Wire running entire length of cable tray system.
- M. Maintain bend radius for fiber optic and copper cables when transitioning to/from cable tray system.
- N. Install cable trays as indicated: Installation shall be in accordance with equipment manufacturer's instructions, and with recognized industry practices to ensure that cable tray equipment comply with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA VE-2 for general cable tray installation guidelines.
- O. Ensure center-supported cable tray will withstand any off-balanced loading that may be created when installing cables. Follow cable tray manufacturer's recommendations on stabilizing methods.
- P. Test cable tray support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 11, for testing and test methods.
- Q. Provide manufacturer 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 or CSA C22.2 No. 126.

3.2

GROUNDING AND BONDING

- A. Sections: Bolted together or tied together with grounding jumper, or grounding wire running entire length of cable support system.
- B. Bond and ground to TMGB/TGB with electrically sized and approved grounding wire. Grounding wire shall be a minimum #6 AWG.
- C. For building entrance telecommunications rooms - A #6 AWG green-insulated ground wire shall be installed from the MTGB in building entrance telecommunications rooms, to one connection point on the cable tray within the building entrance telecommunications room itself, utilizing grounding lug (Cablofil Inc. EZ-Tray #GNDSB).
- D. For local floor telecommunications rooms - A #6 AWG green-insulated ground wire shall be installed from TGB in building entrance telecommunications rooms, to one connection point on the cable tray within the building entrance telecommunications room itself, utilizing grounding lug (Cablofil Inc. EZ-Tray #GNDSB).

- E. For cable tray in corridors of building - A #6 AWG green-insulated ground wire shall be installed from the nearest structural steel and from the nearest electrical branch conduit just outside the telecommunications room to one connection point on the cable tray in the corridor used for horizontal cable routing within 2 ft. of the end of the cable tray as it nears the telecommunications room, utilizing grounding lug (Cablofil Inc. EZ-Tray #GNDSB), as per Article I, Part 5 of this specification. For any breaks or interruptions of the cable tray as it routes thru the local floor, bond the remote section at each location in same manner as described above, bonding at structural steel and electrical branch conduits within two feet of the endpoint of the cable tray.

FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 – Common Work Results For Communications.

3.3

SEISMIC CONTROL

- A. Brace and support in accordance with Section 270548 - Vibration and Seismic Controls for Communications Systems.

3.4

END OF SECTION

SECTION 27 05 42

COMMUNICATIONS CONFINED SPACES AND SAFETY

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - Personal Protective Equipment.
 - Testers.

1.1

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.
 - 1.
 - 2.
- 1.2 B. OSHA Part 1910.146 Occupational Safety and Health Standard- Permit-required confined spaces.
- C. OSHA Part 1910.268 Occupational Safety and Health Standard- Telecommunications.
- D. ASSE/ANSI Z117.1- Safety Requirements for Confined Spaces
- E. Any applicable state and/or local OSHA program.

SUBMITTALS

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.

PART 2 - PRODUCTS

2.1 PERSONAL PROTECTIVE EQUIPMENT

- A. Equipment needed to conduct permit space rescues safely per OSHA standards.

2.2

TESTERS

- A. Calibrated direct-reading instrument, for oxygen content, for flammable gases and vapors, and for potential toxic air contaminants, tested in that order.

3.1

PART 3 - EXECUTION

MAINTENANCE HOLES

- A. All maintenance holes are classified as permit-required confined spaces. During construction of a maintenance hole, but prior to the final pathway connection(s) to other existing underground spaces or building entrance facilities, maintenance holes may not have a permit-required confined spaces classification. The Contractor shall confirm the status and requirements for maintenance holes during construction with construction management.
- B. Contractors shall comply with all federal, state, and local regulations regarding permit-required confined space entry.
- C. Contractors shall comply with all University of Delaware EHS Department Confined Space Entry Program policies and complete online permits for each manhole entry as defined at: <http://www1.udel.edu/ehs/generalhs/construction/confined-space.html>
- D. Contractors shall use appropriate personal protective equipment to work safely within maintenance holes. Contractors shall provide all appropriate safety equipment as needed to extract disabled workers or as otherwise needed to provide a safe work environment and to provide immediate support in emergency situations. Conditions may be excessively hot, cold, cramped, and/or damp.
- E. Contractors shall coordinate with construction management to gain access to maintenance holes. Contractors shall provide advanced notice for this access.

- F. Work in maintenance holes is not restricted by day or time unless otherwise indicated by construction management or owner.
- G. Handboxes and handholes are not classified as permit-required confined spaces unless otherwise determined by construction management or the owner. Contractor shall confirm the status and requirements for all handboxes and handholes. Personal protective equipment is strongly recommended and shall be the responsibility of the Contractors.
- H. Contractors shall coordinate with the construction management to gain access to handboxes and handholes. Contractors shall provide advanced notice for this access.

END OF SECTION

SECTION 27 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Trenching and Backfilling.
 - 2. Manholes, Vaults and Hand-holes.
 - 1.1 3. Duct banks.
 - 4. Fabric Inner-duct.
- B. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270542 – Communications Confined Spaces and Safety.
 - 3. Section 312333 – Trenching and Backfilling.

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:
 - 1. Following Articles of NFPA 70 - National Electric Code:
 - 344 – Rigid metal conduit: Type RMC
 - a. 352 – Rigid polyvinyl chloride conduit: Type PVC
 - b. 354 – Nonmetallic underground conduit with conductors: Type NUCC
 - c.
 - 2. Following National Electrical Manufacturers Association (NEMA) Standards:
 - a. NEMA RN1 2018 Edition, September 7, 2018 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - b. NEMA TC 3-2016 – Polyvinyl Chloride (PVC) fittings for use with Rigid PVC Conduit and Tubing.
 - c. NEMA TC 6 & 8:2013 – Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations.
 - d. NEMA TC 9:2004 (2012) - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct and Fittings for Underground Installation.
 - e. NEMA FB 2.10, 2013 Edition, January 1, 2013 - Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing).
 - a.
 - b.
 - 3. Following UL Standards:
 - 1.3 UL 6 - Rigid Metal Electrical Conduit.
 - UL 651 8th Edition, June 15, 2016 - UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

TRENCHING AND BACKFILLING

- A. Comply with Section 312333 – Trenching and Backfilling.
- B. All conduits shall terminate in the maintenance holes at locations on each side determined by UD Network & Systems Services.
- C. The center of the conduit duct-bank between maintenance holes shall be graded slightly down towards both maintenance holes with a nominal grade of 3" per 100 ft.
- 2.1 D. The top of the ductbank shall be a minimum of 24" below grade.
- E. There shall be 2" of granular select beneath the ductbanks that are non-concrete encased, and 12" above the ductbanks that are non-concrete encased.
- F. Backfill and restoration of the trench and around each maintenance hole shall be accomplished by way of tamping of the backfill in maximum 12" lifts.
- G. There shall be an orange warning tape placed approximately 12" above each ductbank, as a warning to personnel involved in future excavations, indicating that Communications cabling is buried below.
- H. CONDUIT INSTALLATION – STANDARD 1", 2", and 4"

CONDUIT DUCTBANKS

- 2.2 A. CONDUIT – 1", 2", and 4" Schedule 40 PVC shall meet NEMA TC6 and TC-8 Type EB standard for all trade sizes. Any duct bank shall utilize conduit spacers. All spare conduits not scheduled for inner duct placement shall have one (1) green #12 copper conductor.
- B. PVC CONDUIT CLEANER, PRIMER, CEMENT – Approved PVC conduit cleaning agent, priming agent, and cement agent.
- C. CONDUIT SPACERS- Carlon Snap & Stack part #SP4W20-2, for 4" ductbanks.
- D. CONDUIT BENDS-Schedule 40 PVC 90's, minimum 48" sweeps.
- E. Acceptable Manufacturers:
 - 1. Carlon Snap & Stack
 - 2. FRE Composites
 - 3. Any Suggested Substitution will be reviewed in accordance with Section 012500.
- 2.3

INNERDUCT AND ASSOCIATED CONDUIT PLUGS

- A. INNERDUCT – (1") – ENDOT Industries #ICE-105-22-21-02, Standard, corrugated, high-density polyethylene, outside/underground rated 1" inner-ducts, color orange, with individual pull-ropes installed.
- B. INNERDUCT - (1.25") – ENDOT Industries #ICE-125-22-21-02, Standard, corrugated, high-density polyethylene, outside/underground rated 1.25" innerduct, color orange, with individual pull-ropes installed.
- C. UNIVERSAL DUCT PLUG – Tyco (Jackmoon) Inc. #DPGS140-1
- D. PERMANENT EYE-NUT DUCT PLUG, 1" – Commscope Corp. #298182-000
- E. PERMANENT EYE-NUT DUCT PLUG, 1-1/4" – Commscope Corp. #187308-000
- F. PERMANENT EYE-NUT DUCT PLUG, 2" – Commscope Corp. #923104-000
- G. PERMANENT EYE-NUT DUCT PLUG, 4" – Commscope Corp. #293842-000
- H. INNERDUCT ORGANIZER PLUG for three (3) 1-1/4" Innerduct installation Condux Corp. #313092
- I. INNERDUCT ORGANIZER PLUG for four (4) 1" Innerduct installation – Condux Corp. #467948.
- J. Tyco Corp. #JM-SIM-10S035S – For use in 1" inner-ducts used for routing of cables with an O.D. of .20-.35.
- K. Tyco Corp. #JM-SIM-10S057SB – For use in 1" inner-ducts used for routing of cables with an O.D. of .35-.57.

- L. Tyco Corp. #JM-SIM-10S070SB – For use in 1” inner-ducts used for routing of cables with an O.D. of .50-.70.
- M. Include 6 mm [(1/4 inch)] wide, 400 kg [(900 pounds)] tensile pre-lubricated pull tape.
- N. Acceptable Manufacturers:
 - 1. Commscope.
 - 2. Tyco Corp.
 - 3. Endot.
 - 4. Any Suggested Substitution will be reviewed in accordance with Section 012500.

PART 3 - EXECUTION

INSTALLATION PRACTICES

- 3.1 A. Installation shall include delivery, unloading, setting in place, coring through walls or other structures where required. Installation shall be performed in accordance with applicable standards, codes, requirements and recommendations of National, State and Local authorities having jurisdiction, the N.E.C. and OSHA.
- B. A coordination meeting shall take place between The Contractor performing this scope of work, the General Contractor, a University of Delaware Planning & Project Delivery department Project Manager, and the assigned Network Engineer from The University of Delaware's Network & System Services Department before any outside plant work as specified within this document begins. No part or piece of the equipment and materials contained within these specifications shall be installed underground and covered up, backfilled, or buried until the assigned University of Delaware Network & Systems Services Network Engineer has inspected and photographed each section of installed conduit, maintenance holes and any other part of piece contained within the scope of this document. Each stage shall be inspected, photographed, and approved – installation of the conduit before concrete encasement, and then after concrete encasement and before any trenches are backfilled. The General Contractor or Construction Manager shall facilitate documentation so that official “sign-off” for all underground work is obtained on a daily basis for all sections, components and parts associated with the entire installation as specified.
- C. All equipment, etc., shall be firmly installed, plumb and square.
- D. All conduits should be left clean, dry and free of debris or other obstructions.
- E. At completion of maintenance hole and conduit installation, the maintenance hole shall be left dry and clean of dirt, mortar, concrete, and other debris.
- F. In areas where the exterior finish of walls is disturbed, the Contractor shall repair and refinish damaged areas so as to restore the area to its original condition.
- G. Upon the completion of the project, the trenched area should be properly graded and seeded, so as to restore the area to its original condition. All site restoration, as well as asphalt or concrete restoration if applicable, shall be performed as per University of Delaware Facilities Management Grounds Department, and City of Newark Specifications.
- 3.2 H. The University of Delaware shall be provided with “As-Built” drawings of the system upon completion of the project.

TRENCHING AND BACKFILLING

- A. Comply with Section 312333 – Trenching and Backfilling.
- B. All conduits shall terminate in the maintenance holes at locations on each side determined by UD Network & Systems Services.
- C. The center of the conduit duct-bank between maintenance holes shall be graded slightly down towards both maintenance holes with a nominal grade of 3” per 100 ft.
- D. The top of the ductbank shall be a minimum of 24” below grade.
- E. There shall be 2” of granular select beneath the ductbanks that are non-concrete encased, and 12” above the ductbanks that are non-concrete encased.

- F. Backfill and restoration of the trench and around each maintenance hole shall be accomplished by way of tamping of the backfill in maximum 12" lifts.
- G. There shall be an orange warning tape placed approximately 12" above each ductbank, as a warning to personnel involved in future excavations, indicating that Communications cabling is buried below.

DUCTBANKS

- 3.3 A. Install XX (X) new 4" schedule 40 conduits from manhole #X, to Telecommunications Room XXX. Install four (4) 1" corrugated outside/underground rated innerducts with pull ropes into one of the new 4" conduits between manhole #X and Telecommunications Room XXX.
- B. Install XX (X) new 4" schedule 40 conduits from manhole #X, manhole #X. Install four (4) 1" corrugated outside/underground rated innerducts with pull ropes into one of the new 4" conduits between manhole #X and manhole #X.
- C. All conduits to be concrete encased with a grout mixture of sand and cement with aggregate that is suitable for duct encasement with a compressive strength of 3000 pounds per square inch.
- D. All conduit ductbanks in general use areas, roadways, service areas, and entering buildings or manholes shall include ½" rebar.
- E. The ductbank configuration, routing, and rebar installation within the concrete encasement shall be installed per specifications. At ductbank drop-off points for future extensions, the installed rebar shall protrude/extend from the concrete pour at a minimum of 24", for the purpose of fastening and securing the future ductbank pour to the original pour. The final process is to be discussed and verified in field with UD/NSS project engineer.
- F. The conduit ductbanks shall be installed with plastic spacer clamps installed every 8'. The plastic spacer clamps shall create a horizontal and vertical separation of 2" between each duct.
- G. The conduit ductbank shall be staked on both sides of conduit every 8 ft. and wired in place, so as to prevent the ductbank from "floating" upon pour of the concrete encasement.
- H. Where duct banks enter manholes, center as nearly as possible to center between roof and floor and end walls.
- I. All conduit splicing/interconnects for STANDARD Schedule-40 conduit shall first be cleaned with an approved PVC conduit cleaner around the entire circumference of the straight and bell sides of the conduit. All cleaned surfaces shall be completely "primed" with an approved PVC Purple Primer, then properly bonded together using approved PVC Cement, which shall also be applied around the entire circumference of the straight and bell sides of the conduit.
- J. Where transitional changes are required for horizontal and vertical directions, use long field sweeping bends only. The bend radius for all 1", 2", and 4" conduits shall be 48" minimum. See product section.
- K. There shall be no conduit installed between any two points, including maintenance hole to maintenance hole, maintenance hole to buildings, maintenance hole to utility poles, or any other structure, that exceeds a total of 180 degrees of bends.
- L. Any and all changes or adjustments to conduit pathways and installation that are a variance to project drawings shall be reviewed and approved by the UD Network Services Department assigned Network Engineer before such changes are made in the field. Changes shall include adjustments that are caused by conflicts with other utilities, route changes, and repair of conduits that are damaged during the installation process.
- M. All conduit ductbanks indicated to be concrete encased as they enter into manholes shall be accomplished by way of saw cutting thru the concrete walls of the manholes to enable a tight and proper seal around concrete encased conduits.
- N. All conduits shall be centered in the saw cuts, and properly encased with the concrete as a monolithic pour upon installation on both sides of the manhole walls, so as to provide a complete fill of the surrounding cavity around each conduit.

- O. For installations of four (4) 4" conduits (2x2 stacked), a 14.5" x 14.5" symmetric opening shall be saw-cut into the appropriate entry window of the manhole.
- P. For installations of two (2) 4" conduits, a 10" x 14.5" opening shall be saw-cut into the appropriate entry window of the manhole with gasket detail.
- Q. Any conduits indicated to be installed as non-concrete encased shall be routed into the manholes via cored holes, which shall be 1" larger than the outside diameter of the conduit itself. Upon completion of the conduit installation into the cores, the conduit shall be centered, and the surrounding core shall be sealed with hydraulic cement, then cut off flush with the inside wall of the maintenance hole.
- R. Upon completion of proper installation of the concrete encased 4" conduits to the manholes, the conduits shall be flush and even with the inside wall of the maintenance hole. There shall be no protrusion of any conduit beyond the inside face of the maintenance holes.
- S. Upon completion of the concrete duct-bank installation into manholes, all concrete around conduits on the inside of manholes shall have a smooth layer of hydraulic cement applied to all entry points to further seal the concrete, and provide a consistent and clean appearance.
- T. All conduits entering buildings shall be flush and even with the inside wall of the Telecommunications Room. There shall be no protrusion of any conduit beyond the inside face of the wall of the Telecommunications Room.
- U. After all STANDARD Schedule-40 conduits are installed in maintenance holes, each shall have an appropriately sized mechanical plug installed. Temporary "Universal" plugs shall be installed into conduits at all times during construction. Permanent "Eye Nut" plugs shall be installed in all conduits at completion of the installation.
- V. All spare conduits not scheduled for inner duct placement shall have one (1) green #12 copper conductor installed for marking the conduits as part of the Miss Utility program. Route each copper conductor from each duct-bank to ground rod, and bond to rod by way of properly sized ground lugs. After the conductors routing from the conduits are bonded to the ground lug, install a #12 copper conductor from the ground lug to the manhole cover opening. Secure the #12 to manhole wall and ceiling with anchors and tie-backs to keep the conductor from draping across the workable area of the manhole itself.
- W. During installation, all core bored holes not occupied by conduits shall be plugged utilizing mechanical plugs, so as not to allow dirt or debris to enter the maintenance hole during off-hours as a result of rain or any other means.
- X. After all conduits are installed in manholes, each shall have an appropriately sized mechanical plug installed. Temporary "Universal" plugs shall be installed into conduits at all times during construction. Permanent "Eye Nut" plugs shall be installed in all conduits at completion of the installation.
- 3.4 Y. All conduits scheduled for placement of four (4) 1" inner-ducts shall have inner-duct organizer plugs installed, at each end of conduit. All inner-ducts installed shall have individual 1" solid "Eye-Nut" inner-duct plugs installed.

3.5 INNERDUCT

- A. Comply with manufacturer installation recommendations.
- B. Support inner duct every (36 inches) OC.

FABRIC INNERDUCT

- A. Comply with all manufacturers installation instructions.

END OF SECTION

SECTION 27 05 44
UNDERGROUND MAINTENANCE HOLES AND HAND HOLES
FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

SUMMARY

- 1.1
- A. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this section.
 - B. The Contractor shall be responsible for the complete installation of all necessary equipment, including all conduit and maintenance holes.
 - C. The Contractor shall have all equipment substitutions approved by the University's agent.
 - D. All work specified within this section falls under the responsibility of the Electrical Contractor.
 - E. A coordination meeting shall take place between The Contractor performing this scope of work, the General Contractor, a University of Delaware Planning & Project Delivery department Project Manager, and the assigned Network Engineer from The University of Delaware's Network & System Services Department before any outside plant work as specified within this document begins. No part or piece of the equipment and materials contained within these specifications shall be installed underground and covered up, backfilled, or buried until the assigned University of Delaware Network & Systems Services Network Engineer has inspected and photographed each section of installed conduit, maintenance holes and any other part of piece contained within the scope of this document. Each stage shall be inspected, photographed, and approved – installation of the conduit before concrete encasement, and then after concrete encasement and before any trenches are backfilled. The General Contractor or Construction Manager shall facilitate documentation so that official "sign-off" for all underground work is obtained on a daily basis for all sections, components and parts associated with the entire installation as specified.
 - F. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Maintenance holes.
 - 2. Hand holes.
 - G. The general provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this section.
 - H. The Contractor shall be responsible for the complete installation of all necessary equipment, including all conduit and maintenance holes.
 - I. The Contractor shall have all equipment substitutions approved by the University's agent.
 - J. All work specified within this section falls under the responsibility of the Electrical Contractor.
 - K. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 1.2 2. Section 270542 – Communications Confined Spaces and Safety.
 - 3. Section 270526 – Grounding and Bonding for Communications.
 - 4. Section 270548 – Vibration and Seismic Controls for Communications Systems.
 - 5. Section 312333 – Trenching and Backfilling.

^aREFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:
 - 1. Following Articles of NFPA 70 - National Electric Code:
 - 344 – Rigid metal conduit: Type RMC

- 352 – Rigid polyvinyl chloride conduit: Type PVC
- 354 – Nonmetallic underground conduit with conductors: Type NUCC
- 2. Following National Electrical Manufacturers Association (NEMA) Standards:
 - NEMA RN1 2018 Edition, September 7, 2018 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - NEMA TC 3-2016 – Polyvinyl Chloride (PVC) fittings for use with Rigid PVC Conduit and Tubing.
 - b. NEMA TC 6 & 8:2013 – Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations.
 - a. NEMA TC 9:2004 (2012) - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct and Fittings for Underground Installation.
 - b. NEMA FB 2.10, 2013 Edition, January 1, 2013 - Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing).
 - c.
- d. 3. Following UL Standards:
 - e. UL 6 - Rigid Metal Electrical Conduit.
 - UL 651 8th Edition, June 15, 2016 - UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

a.
b. **SUBMITTALS**

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 **MATERIALS AND EQUIPMENT**

- A. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL approved. The contractor shall supply the latest model available at the time of bidding each piece of equipment.

2.2

MAINTENANCE HOLE

- A. MANHOLE– Oldcastle Precast #MH4X6-7/PCS-687 standard maintenance hole (two-piece design) with knockout windows, sump, ground rod hole, pulling irons, and cable racks. Install standard 6" H collar for manhole frame and solid lid placement. Install one (1) US Foundry 479 Heavy Duty Ring and Cover Assembly, which shall be physically labeled and designated as a "Communications" maintenance hole. Part number for Ring is #8022875, part number for cover is #8019091. Assembly part number is #8023990.
- B. MANHOLE– Oldcastle Precast #MH6X8-7/PCS-687 standard maintenance hole (two-piece design) with knockout windows, sump, ground rod hole, pulling irons, and cable racks. Install standard 6" H collar for manhole frame and solid lid placement. Install one (1) US Foundry 479 Heavy Duty Ring and Cover Assembly, which shall be physically labeled and designated as a "Communications" maintenance hole. Part number for Ring is #8022875, part number for cover is #8019091. Assembly part number is #8023990.
- C. MANHOLE RACKS – Inwesco Inc. #10A14, 47-3/4" Racks.
- D. MANHOLE RACK HOOKS – Inwesco Inc. #10A36 Rack Hooks.
- E. MANHOLE RACK MOUNTING GALVANIZED HARDWARE – ½" X 2" Hex-Head Cap-screws (#13 UNC Threads), ½" washers supplied on ALL Hex-Head Cap-screws, ½" Nuts, ½" Heavy Duty Concrete Expansion Anchor (#13 UNC Threads).
- F. Provide pre-cast or cast-in-place reinforced concrete designed for AASHTO H-20 loading.

1. Angled corners, cut on 45 degrees for optimum cable racking.
 2. Pre-cast, Type A, off-center wall penetrations/windows (Type J, L, or T with prior approval)
- G. Manufacturer
1. Oldcastle Precast Inc. #MH6X8-7 maintenance hole.
 2. No Substitution
 3. Embedded by maintenance hole manufacturer.

HANDHOLES

- 2.3
- A. HANDHOLES – Strongwell Corp., Quazite Products #PG3660BA24, 36"W x 60"L x 24"D, composite, stackable handholes. Utilize Strongwell Corp. Quazite #PG3660HA12 Heavy Duty Lid/Covers. Install in pairs/stacked for a total of 48" total depth.
 - B. HANDHOLE RACK SUPPORTS - Quazite 12" cable racks. 7-1/2" cable rack hooks #80905.
 - C. HANDHOLE CONDUIT END-BELL - Carlon 4" conduit end-bell #E997N and #E948N 4" slip coupling.
 - D. HANHOLE CONDUIT END-BELL – Carlon 2" conduit end-bell #E997J and #E948J slip coupling.
 - E. Tier 15 or greater per ANSI/SCTE 77 2002 - Specification for Underground Enclosure Integrity.
 - F. AASHTO H-20 rated for areas of deliberate vehicular traffic.
 - G. Cover:
 1. Labeled "Communications"[, locking cover].
 2. Gray hand box and lid, green acceptable in grass.
 - H. Large Hand boxes:
 1. Pulling eyes (hand box sides (3 feet) or larger).
 2. Racking (hand box sides (2 feet) or larger).
 - I. Manufacturers:
 1. Hubbell Strongwell (Quazite).
 2. Oldcastle Precast
 3. Jensen Precast.
 4. Any Suggested Substitution will be reviewed in accordance with Section 012500.

3.1 PART 3 - EXECUTION

INSTALLATION PRACTICES

- A. Installation shall include delivery, unloading, setting in place, coring through walls or other structures where required. Installation shall be performed in accordance with applicable standards, codes, requirements and recommendations of National, State and Local authorities having jurisdiction, the N.E.C. and OSHA.
 - B. All equipment, etc., shall be firmly installed, plumb and square.
 - C. All conduits should be left clean, dry and free of debris or other obstructions.
 - D. At completion of maintenance hole and conduit installation, the maintenance hole shall be left dry and clean of dirt, mortar, concrete, and other debris.
 - E. In areas where the exterior finish of walls is disturbed, the Contractor shall repair and refinish damaged areas so as to restore the area to its original condition.
- 3.2
- F. Upon the completion of the project, the trenched area should be properly graded and seeded, so as to restore the area to its original condition. All site restoration, as well as asphalt or concrete restoration if applicable, shall be performed as per University of Delaware Facilities Management Grounds Department, and City of Newark Specifications.
 - G. The University of Delaware shall be provided with "As-Built" drawings of the system upon completion of the project.

MAINTENANCE HOLE

- A. MANHOLE - Provide and install xxx (x) Oldcastle Precast Inc. #MH6X8-7 maintenance holes.
- B. Manholes shall be installed level on all sides to ensure proper drainage to the sump.
- C. All manholes shall be installed in the ground first, before any conduit is installed along any routes, so conduit take-offs are straight and enter all other manholes with little or no bends or adjustments.
- D. MANHOLES INSTALLED IN GRASS LANDSCAPE AREAS - The top of the frame and cover/lid assemblies of the installed maintenance holes shall be 2" above existing grade in the area. A minimum installation of a 3" grade ring is required. Provide grade ring riser castings as required to elevate cover flush with finished grade. Grading from the top of the lid shall be accomplished by fanning topsoil away from the collar and lid at a 10" drop in grade over a 20 ft. radius of the lid itself.
- E. MANHOLES INSTALLED IN PAVED/ROADWAY AREAS -The top of installed manholes shall be flush with the existing grade in the area. A minimum installation of a 3" grade ring is required. A traffic rated collar with lid is required. Provide grade ring riser castings as required to elevate cover flush with finished grade.
- F. All maintenance holes shall be completely assembled and installed at the time of the initial installation. As the maintenance hole is set, all materials shall be immediately installed within the maintenance hole including all racking equipment and materials, the ground rod, grade-rings, along with the frame and cover/lid assembly. All standard schedule-40 conduits installed shall be immediately sealed on both sides of the cores with hydraulic cement on both sides of the cores, and then sealed with the specified conduit plugs for non-concrete encased installations. All inner-ducts when installed shall be immediately cut off to proper length and secured with the specified organizer plugs. The immediate commencement of this work will ensure that when cable installation occurs, proper and safe entry into the maintenance holes is provided, and all routing, splicing, and protection of the cables is not compromised. All specifics of the equipment and materials to be installed are defined within the following sections of this specification.
- G. All manholes shall have standard manhole cable racks installed. There shall be four (4) racks installed on each of the 8 ft. walls. Each rack shall have two (2) cable rack hooks installed for cable routing and installation. All of the above hardware shall be secured by way of ½" galvanized hardware, using the manufacturer's provided pre-drilled anchor holes on all walls.
- H. Before the top half of the manhole is set in place, a 5/8" x 10 ft. Copperweld Ground Rod shall be driven thru the provided ¾" hole in the bottom of the structures, until a minimum of 4"/maximum 6" of the rod is protruding into the manholes. Upon completion of the installation of the ground rod in the supplied hole in the bottom of the manhole, the opening shall be properly sealed with hydraulic cement.
- I. Provisions shall be made to install the manholes on a base of 6" of washed gravel.
- J. A standard/supplied gasket shall be installed around the entire perimeter of the manhole walls, between the top and bottom halves of the manhole.
- K. The grade rings of installed manholes shall be centered on the manhole opening, and mortared to the roof of the manhole around the entire perimeter and up to manhole frame and cover/lid assembly. Internal diameter of grade rings to be not less than internal diameter of manhole cover ring. Mortar between each collar if additional collars are required.
- L. The manhole frame and cover/lid assembly shall be bolted/anchored to the top of the installed grade ring with ½" galvanized hardware & gasket.
- 3.3 M. The manhole cover/lid shall be physically designated as a "Communications" manhole, and be traffic rated.
- N. Seal conduits watertight after conduits or duct banks are complete.
- O. Make no permanent attachments to pulling irons or loops. Cables shall not be permanently supported by pulling irons or loops.

HANDHOLES

- A. Handholes shall be installed with covers flush with the final grade. Hand boxes shall match any slope in the final grade. Hand boxes may be installed with a partially exposed side on steep grades.
- B. HANDHOLE #1 - Provide and Install XX (X) pair/pairs of Strongwell Corp. Quazite 36"W x 60"L x 48"D #PG3660BA24 handholes (stacked). Install one (1) Quazite #PG3660HA12 Heavy Duty Lid/Cover on top handhole.
- C. Handholes shall be installed level on all sides to ensure proper drainage to the sump.
- D. Provisions shall be made to install the handholes on a base of 6" of washed gravel.
- E. HANDHOLES INSTALLED IN GRASS LANDSCAPE AREAS- The top of installed handholes (concrete envelope) shall be flush with the existing grade in the area. The grading from the edge of the concrete envelope shall be accomplished by fanning topsoil away from the concrete envelope at a 2" drop in grade over a 10 ft. radius of the lid itself.
- F. HANDHOLES INSTALLED IN PAVED/ROADWAY AREAS- The top of installed handholes (concrete envelope) shall be flush with the existing grade in the area.
- G. All handholes shall have standard cable racks installed. There shall be two (2) racks installed on each of the 60" walls. The cable racks shall be installed in 12" lengths, starting at the top of the hand-holes. Each rack shall have xxx (x) cable rack hooks installed for cable routing and installation. All of the above hardware shall be secured by way of ½" galvanized hardware. The handhole racks shall be thru-bolted thru the walls of the hand-holes by way of two (2) bolts per rack, mounted to the top and bottom of each rack.
- H. All Quazite handholes to be installed shall be installed as per Quazite "Concrete Collar Applications" Instruction Sheet provided in drawing set, which defines an approximate 10" wide x 12" deep angled and sloped concrete ring to be installed around the entire perimeter of the hand-hole itself, for additional support in the event of heavy loading from motor vehicles, tractors, mowers, and other similar equipment.
- I. All handholes shall be installed as per all standard Strongwell Corp. Quazite Product Field Applications sheets, including #101, #102, and Standard Box Installation Sheet #104.
- J. All conduit entry into hand-holes for 4" conduit shall be accomplished utilizing 5" carbide hole saws only. All conduits shall be terminated at handhole with Carlon 4" schedule 40 end-bell part #E997N on the interior, with a Carlon #E948N slip coupling glued on the exterior up against the hand-hole itself.
- K. All conduit entry into hand-holes for 2" conduit shall be accomplished utilizing 2-3/4" carbide hole saws only. All conduits shall be terminated at hand-hole with Carlon 2" schedule 40 end-bell part #E997J on the interior, with a Carlon #E948J slip coupling glued against the exterior of the hand-hole itself.
- L. All conduit entry into hand-holes for 1" conduit shall be accomplished utilizing 1-3/4" carbide hole saws only. All conduit shall be terminated at hand-hole with Carlon 4" 1" schedule 40 end bell part #E997F on the interior, with a Carlon 1" (no part number listed) standard slip coupling glued on the exterior up against the hand-hole itself.
- M. The handhole cover/lid shall be physically designate the maintenance hole as a "Communications" handhole, and be traffic rated.

END OF SECTION

SECTION 27 05 46.13
AERIAL CABLE INSTALLATION HARDWARE

PART 1 - GENERAL

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Messenger Strand System.
- B. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270526 - Grounding and Bonding for Communications.
 - 3. Section 270548 - Vibration and Seismic Controls for Communications Systems.

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:
 - 1. Follow industry best practices:
BICSI Outside Plant Design Reference Manual, 5th edition.

SUBMITTALS

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1

MESSENGER STRAND SYSTEM

- A. Messenger Strand: ASTM A475 and accepted by both REA and RBOC standards.
 - 1. (3/16 inch) diameter 7-wire galvanized 6M steel messenger strand.
 - 2. Strand: At least utilities grade, minimum breaking strength of (5500 pounds), left lay, and at least A rated galvanized coating weight.
- B. Strand Attachments: Provide S guy bolts, B beam clamps, wall straps, brackets, etc., as necessary to adequately support strand.
 - 1. S guy bolts (anchor rods or thimble-eye bolts): Minimum (5/8 inch) diameter with straight shank and designed for attaching messenger strand dead-ends. Bolt Length: At least (4 inches) longer than width of structural steel flange it will be attached to.
 - 2. B beam Clamps: Designed to be used for dead-ending strand on flange of structural steel members (columns and beams) and for use with (5/8 inch) S guy bolt.
- C. Strand Connectors: Provide B strand connectors, suspension/cable clamps, grounding tap clamps, hangers, 1-bolt and 3-bolt clamps to adequately support strand.
- D. Strand Cable Rings: Ring Size for Each Strand Run: Identified on Drawings.
- E. Acceptable Manufacturers:
 - 1. Change.
 - 2. Clifford.
 - 3. Diamond.
 - 4. Joslyn.
 - 5. Preformed.
 - 6. Reliable.
 - 7. Any Suggested Substitution will be reviewed in accordance with Section 012500.

PART 3 - EXECUTION

AERIAL INSTALLATION

- 3.1** A. Fasten cable messenger strand to buildings and poles using galvanized steel wall straps, suspension clamps, etc.
 - 1. Strand Connectors: For strand runs in excess of (15 feet) between structural columns, provide additional (1/2 inch) rod supports and appropriate strand clamps (3-hole clamps or kindorf C-708 supports) on minimum (25 feet) centers.
 - 2. Strand Cable Rings: Space rings on maximum (16 inch) centers with latch able ring oriented in same direction.
 - 3. Use approved cable guide and lashing device to secure cable to messenger strand.
- B. Clamp cable to exterior of building with approved galvanized steel cable clamps.

END OF SECTION

SECTION 27 05 48

VIBRATION AND SEISMIC CONTROLS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Anchorage and Structural Attachment Components.
 - 2. Vibration Isolators.
 - 3. Seismic Bracing Components.
- 1.1 B. Related Requirements: Comply with following.
 - 1. Section 078400 – Firestopping.
 - 2. Section 270500 – Common Work Results for Communications.

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.
- 1.2

SUBMITTALS

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Colors and Finishes: Submitted and approved by Architect prior to order.
- D. Product Samples: As required.
- E. Product Data: Illustrate and indicate types, styles, materials, strength, fastening provisions, and finish for each type and size of seismic restraint component used.
 - 1. Anchor Bolts and Studs: Tabulate types and sizes, complete with report numbers and rated strength in tension and shear as evaluated by ICBO Evaluation Service agency approved by authorities having jurisdiction.
- F. Shop Drawings: For anchorage and bracing not defined by details and charts on Drawings. Indicate materials, and show designs and calculations signed and sealed by professional engineer.
 - 1. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - 2. Details: Detail fabrication and arrangement. Detail attachment of restraints to both structural and restrained items. Show attachment locations, methods, and spacing, identifying components and listing their strengths. Indicate direction and value of forces transmitted to structure during seismic events.
 - 3. Preapproval and Evaluation Documentation: By ICBO Evaluation Service agency approved by authorities having jurisdiction, showing maximum ratings of restraints and basis for approval (tests or calculations).
- G. Informational Submittals: Submit following:
 - 1. Coordination Drawings: Plans and sections drawn to scale and coordinating seismic bracing for electrical components with other systems and equipment, including other seismic restraints, in vicinity.
 - 2. Product Certificates: Signed by manufacturers of seismic restraints certifying that products furnished comply with requirements.
 - 3. Qualification Data: For firms and persons specified in Quality Assurance Article.
- H. Material Test Reports: From qualified testing agency indicating and interpreting test results of seismic control devices for compliance with requirements indicated.

DEFINITIONS

- A. BOCA: BOCA National Building Code.
- B. SBC: Standard Building Code.
- C. UBC: Uniform Building Code.
- D. Seismic Restraint: Fixed device (seismic brace, anchor bolt or stud, or fastening assembly) used to prevent vertical or horizontal movement, or both vertical and horizontal movement, of electrical system component during earthquake.
- E. Mobile Structural Element: Part of building structure such as slab, floor structure, roof structure, or wall that may move independent of other mobile structural elements during earthquake.

QUALITY ASSURANCE

- A. Comply with seismic restraint requirements in BOCA California Building Code/Code of Regulations of OSHPD SBC UBC, unless requirements in this Section are more stringent.
- B. Professional Engineer Qualifications: Professional engineer legally qualified to practice in jurisdiction where Project is located and experienced in providing seismic engineering services, including design of seismic restraints that are similar to those indicated for this Project.
- C. Testing Agency Qualifications: Independent testing agency, acceptable to authorities having jurisdiction, with experience and capability to conduct testing indicated.

[PROJECT CONDITIONS

- A. Project Seismic Zone and Zone Factor as Defined in UBC: [Zone 1, Zone Factor 0.075.
- B. Occupancy Category as Defined in UBC: [I].
- C. Acceleration Factor:0.2G.

COORDINATION

- A. Coordinate layout and installation of seismic bracing with building structural system and architectural features, and with mechanical, fire-protection, electrical, and other building features in vicinity.
- B. Coordinate concrete bases with building structural system.

2.1 PART 2 - PRODUCTS

ANCHORAGE AND STRUCTURAL ATTACHMENT COMPONENTS

- A. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times maximum seismic forces to which they will be subjected.
- B. Concrete and Masonry Anchor Bolts and Studs: Steel-expansion wedge type.
- C. Concrete Inserts: Steel-channel type.
- D. Through Bolts: Structural type, hex head, high strength, ASTM A325.
- E. Welding Lugs: MSS SP-69, Type 57.
- F. Beam Clamps for Steel Beams and Joists: Double sided. Single-sided type not allowed.
- G. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to type and size of anchor bolts and studs used.
- H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to type and size of attachment devices used.
- I. Materials for restraints:
 - 1. Indoor Dry Locations: Steel, zinc plated.
 - 2. Outdoors and Damp Locations: Galvanized steel.

- J. Acceptable Manufacturers:
1. Mason Industries, Inc.
 2. Powerstrut.
 3. Thomas & Betts Corp.
 4. Unistrut Corporation.
 5. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

VIBRATION ISOLATORS

- 2.2 A. Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil and water-resistant.
- B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to 6 mm [(1/4 inch)] thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 3447 kPa [(500 psig)].
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- C. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4 inch thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- D. Materials for Restraints:
1. Indoor Dry Locations: Steel, zinc plated.
 2. Outdoors and Damp Locations: Galvanized steel.
- E. Acceptable Manufacturers:
1. Amber/Booth Company.
 2. Kinetics Noise Control.
 3. Vibration Mountings & Controls, Inc.
 4. Mason Industries.
 5. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.
- 2.3

SEISMIC BRACING COMPONENTS

- A. Slotted Steel Channel: 41 by 41 mm [(1-5/8 by 1-5/8 inch)] cross section, formed from 2.7 mm [(0.1046 inch)] thick steel, with 14 by 22 mm [(9/16 by 7/8 inch)] slots at maximum of 50 mm [(2 inches)] o.c. in webs, and flange edges turned toward web.
1. Materials for Channel: ASTM A570, GR 33.
 2. Materials for Fittings and Accessories: ASTM A575, ASTM A576, or ASTM A36.

3. Fittings and Accessories: Products of same manufacturer as channels and designed for use with that product.
4. Finish: Baked, rust-inhibiting, acrylic-enamel paint applied after cleaning and phosphate treatment, unless otherwise indicated.
- B. Channel-Type Bracing Assemblies: Slotted steel channel, adjustable hinged steel brackets, and bolts.
- C. Cable-Type Bracing Assemblies: Zinc-coated, high-strength steel wire rope cable attached to steel thimbles, brackets, and bolts designed for cable service.
 1. Arrange units for attachment to braced component at one end and to structure at other end.
 2. Wire Rope Cable: ASTM 603. Use 49- or 133-strand cable with minimum strength of 2 times calculated maximum seismic force to be resisted.
- D. Hanger Rod Stiffeners: Slotted steel channels with internally bolted connections to hanger rod.
- E. Materials for Restraints:
 1. Indoor Dry Locations: Steel, zinc plated.
 2. Outdoors and Damp Locations: Galvanized steel.
- F. Acceptable Manufacturers:
 1. Mason Industries, Inc.
 2. Powerstrut.
 3. Thomas & Betts Corp.
 4. Unistrut Corporation.
 5. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Generator Sets: Comply with Section 260548 Vibration and Seismic Controls for Electrical Systems.

3.2 INSTALLATION

- A. Install seismic restraints according to applicable codes and regulations and as approved by authorities having jurisdiction, unless more stringent requirements are indicated.

3.3

STRUCTURAL ATTACHMENTS

- A. Use bolted connections with steel brackets, slotted channel, and slotted-channel fittings to spread structural loads and reduce stresses.
- B. Attachments to New Concrete: Bolt to channel-type concrete inserts or use expansion anchors.
- C. Attachments to Existing Concrete: Use expansion anchors.
- D. Holes for Expansion Anchors in Concrete: Drill at locations and to depths that avoid reinforcing bars.
- E. Attachments to Solid Concrete Masonry Unit Walls: Use expansion anchors.
- F. Attachments to Hollow Walls: Bolt to slotted steel channels fastened to wall with expansion anchors.
- G. Attachments to Wood Structural Members: Install bolts through members.
- H. Attachments to Steel: Bolt to clamps on flanges of beams or on upper truss chords of bar joists.

3.4

SEISMIC RESTRAINT ANCHORAGE

- A. Anchor rigidly to single mobile structural element or to concrete base structurally tied to single mobile structural element.
- B. Anchor raceways or cables, panelboards, switchboards, transformers, busways, battery racks, static uninterruptible power units, power conditioners, capacitor units, communication system components, and electronic signal processing, control, and distribution units as follows:

1. Size concrete bases so expansion anchors minimum of 10 bolt diameters from edge of concrete base.
2. Concrete Bases for Floor-Mounted Equipment: Use female expansion anchors and install studs and nuts after equipment is positioned.
3. Bushings for Floor-Mounted Equipment Anchors: Install to allow for resilient media between anchor bolt or stud and mounting hole in concrete.
4. Anchor Bolt Bushing Assemblies for Wall-Mounted Equipment: Install to allow for resilient media where equipment or equipment-mounting channels are attached to wall.
5. Torque bolts and nuts on studs to values recommended by equipment manufacturer.

SEISMIC BRACING INSTALLATION

- A. Install bracing according to spacing and strengths indicated by approved analysis.
- B. Expansion and Contraction: Install to allow for thermal movement of braced components.
- 3.5 C. Cable Braces: Install with maximum cable slack recommended by manufacturer.
- D. Attachment to Structure: If specific attachment not indicated, anchor bracing to structure at flanges of beams, upper truss chords of bar joists, or at concrete members.

ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- 3.6 A. Make flexible connections in raceways, cables, wire-ways, cable trays, and busways where they cross expansion and seismic control joints, where adjacent sections or branches are supported by different structural elements, and where they terminate at electrical equipment anchored to different mobile structural element from one supporting them.

FIELD QUALITY CONTROL

- 3.7 A. Testing Agency: Engage qualified testing agency to perform following field quality-control testing:
- B. Testing: Test pull-out resistance of seismic anchorage devices.
 1. Provide necessary test equipment required for reliable testing.
 2. Provide evidence of recent calibration of test equipment by testing agency acceptable to authorities having jurisdiction.
 3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
 4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 5. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 6. Test to 90 percent of rated proof load of device.
 7. If device fails test, modify all installations of same type and retest until satisfactory results are achieved.
 8. Record test results.

END OF SECTION

SECTION 27 05 53

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Identification Products.
- B. Related Requirements: Comply with following:
 - 1.1
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270526 – Grounding and Bonding for Communications Systems.
 - 3. Section 271116 – Communications Cabinets, Racks, Frames, and Enclosures
 - 4. Section 271119 – Communications Termination Blocks and Patch Panels
 - 5. Section 211123 – Communications Cable Management
 - 6. Section 271323 – Optical Fiber Backbone Cabling
 - 7. Section 271323.13 – Optical Fiber Splicing and Terminations
 - 8. Section 271333 – Coaxial Backbone Cabling
 - 9. Section 271513 – Copper Horizontal Cabling
 - 10. Section 271523 – Optical Fiber Horizontal Cabling
 - 11. Section 271533 – Coaxial Horizontal Cabling

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
 - 1. Product Data: Include data on features, ratings, and performance for each component specified.
 - 2. a. Shop Drawings: Include dimensioned plan and elevation views of components. Show access and workspace requirements.
 - System labeling schedules, including electronic copy of labeling schedules, as specified in Part 3, in software and format selected by Owner.
 - 3. Samples: For workstation outlet connectors, jacks, jack assemblies, and faceplates for color selection and evaluation of technical features.
- B. Informational Submittals: Submit following packaged separately from other submittals:
 - 1. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
 - 2. Product Certificates: Signed by manufacturers of cables, connectors, and terminal equipment certifying that products furnished comply with requirements.
 - 3. Qualification Data: For firms and persons specified in Quality Assurance Article. Provide evidence of applicable registration or certification.
- 2.1 C. Closeout Submittals: Submit following in accordance with Section 017800.
 - 1. Operation and Maintenance Data: For products.

PART 2 - PRODUCTS

IDENTIFICATION PRODUCTS

- A. Cable Marking:
 - 1. Vinyl substrate with white printing area and clear tail that self laminates printed area when wrapped around cable.

2. If cable jacket white, provide cable label with printing area colored other than white, preferably orange or yellow – so that labels easily distinguishable.
3. Acceptable Label Manufacturers:
 - Thomas & Betts E-Z-CODE WSL I.
 - Panduit.
 - WH Brady.
 - Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

B. Labels: Preprinted or laser printed type.

1. ^{a.} Legibility, Defacement, Exposure and Adhesion: UL 969.
2. ^{b.} The labeling scheme should be ANSI/TIA-606-B compliant.
3. ^{c.} Labeling shall meet the visibility and durability requirements of ANSI/TIA-606-B.
4. ^{d.} Where insert type labels used provide clear plastic cover over label.
5. Confirm color of labels, font, and size with owner prior to labeling. Confirm placement of label on faceplates without windows with owner prior to labeling.
6. Acceptable Label Manufacturers:
 - Brother P-Touch.
 - Thomas & Betts E-Z-CODE WSL I.
 - Panduit.
 - WH Brady.
 - Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

C. ^{e.} Plastic Warning Tape:

1. 152 mm (6 inches) wide
2. Continuously printed.
3. Bright colored, Orange, labelled as “Communications”.
4. Metallic detection element.
5. Highly elastic.
6. Acceptable Label Manufacturers:
 - a. Brother P-Touch.
 - b. Deal.
 - c. Panduit.
 - d. WH Brady.
 - e. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

D. Surface Markers:

1. ^{a.} Posts.
2. ^{b.} Soil Markers.
3. ^{c.} Acceptable Label Manufacturers:
4. ^{d.} Almetek Industries.
5. ^{e.} APC International.
- Tech Products Inc.
- William Frick & Company.

3.1 Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

IDENTIFICATION

- A. Confirm specific labeling requirements with Network Systems & Services' Representative prior to cable installation or termination.
- B. Outside Cable Plant:

1. All exposed cable shall be prominently labeled with a securely fastened warning tag, supplied by the UD IT-NSS Network Engineer, stating that the equipment contains fiber optic cable and is transmitting potentially hazardous wavelengths of light if broken or exposed. A stenciled or anodized label shall be applied to the fiber termination equipment denoting a like message.
 2. All fiber optic cable shall be prominently and permanently labeled at building entrance/exit and cable termination points with to and from destinations. The fiber count of each cable is to be included on the labels.
 3. Label the bonding conductor at both ends of wire as to it's from/to destination by room number, and specify that it is for the "Telecommunications Grounding and Bonding System".
 4. Plastic Warning Tape: Provide at 450 mm (18 inches) above direct buried services, underground conduits and duct-banks. Plastic warning tape shall be color orange, and labelled as "Communications".
 5. Surface markers: Provide at changes in pathway direction. Confirm style and placement with owner.
- C. Distribution Racks and Frames: Label each unit and field within that unit.
- D. Within Connector Fields, in Wiring Closets and Equipment Rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware.
- E. Patch Cables and Panels:
1. All patch cables shall be labelled at each end of the cables (Patch Panel and Switch), with a UD designated Patch Panel and Switch Port number. For example, "A0, A1, A2...thru A47. Switch ports on Juniper 3300 series are labelled 0-47. Patch Panels are labelled 1-48. "A" indicates patch panel assignments "A, B, C, D, E, F" for a total of six (6) maximum switches and panels. UD will provide detailed labelling list upon build.
- F. Workstation:
1. Label cables within outlet boxes.
 2. Each outlet faceplate shall have one (1) identification label for each module (with cable) installed. The label shall contain the room number and outlet number within the room, followed by a "1a" designating the first cable within the outlet, or a "2a" for the second cable in the outlet. The information on the label shall be typed, not handwritten. For example, the first outlet shall have labels reading 100-1-1a and 100-1-2a. If there are multiple quad outlets, the next would be 100-2-1a and 100-2-2a, following an ascending numerical sequence for the outlet numbers. The "a" after each cable number is necessary for insertion into NSS connectivity database. In a single-gang faceplate, the cable assignment shall be first cable in upper left module position, second cable in lower left position, third cable in upper right position, and fourth cable in lower right position. This will follow suit for a quad faceplate, with cables five thru eight terminating to the right of the faceplate in an upper/lower assignment. All labels shall be placed on the provided white tags within the label holders above and below each outlet module location. All labels shall be of "Brother P-Touch" system quality or equivalent.
 3. Each twisted pair module shall have one (1) Siemon Co. Computer Icon tags installed, which shall identify the jacks as "data". The Icons are included within the module packaging.
 4. The first four-pair cable shall be terminated and installed in the upper left position in the faceplate. The second cable shall be installed in the lower left position. All other cables shall be installed in same order in next position, upper and lower.
 - 5.

6. All UTP cables must be permanently marked with a wrap-around vinyl self-laminating printable marker label (Thomas & Betts E-Z-CODE WSL or accepted equivalent) at both ends, no more than 1" from the de-sheath point of the cable at blocks, and no more than 3" from the de-sheath point at work area outlet module termination. All Existing and new RG-6 coax cables shall be labeled using Panduit Corp., PAN-TY "Flag Type" Nylon Marker Ties at splitter locations. There shall be no unmarked cables at any place in the system. Labels shall contain the room number, drop number, and cable number within the room. All labeling shall be typed onto the label, not handwritten.
 7. Cables shall not be run in close proximity to, in the same bundle as, or parallel with power cables or fluorescent lighting, in order to reduce signal contamination. A minimum separation of 2 feet from these sources of EMI is required.
 8. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.
- G. Cables, General: Label each cable within 100 mm (4 inches) of each termination and tap, where it is accessible in cabinet or junction or outlet box, and elsewhere as indicated.
- H. Exposed Backbone Cables and Backbone Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 m (50 feet).
- I. Cable Schedule: Post in prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Provide electronic copy of final comprehensive schedules for Project, in software and format selected by Owner.

END OF SECTION

SECTION 27 07 00
COMMUNICATIONS TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing methods for copper cable, optical fiber cable, coaxial cable and grounding and bonding.
 - 2. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - a. Fiber Optic Cable Tester.
 - b. Category 6A 100 Ohm UTP Tester.
 - c. Grounding and Bonding Tester
 - d. Spectrum Analyzer with Power Meter.
 - e. Signal Generator.
- B. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:
 - 1. ANSI/EIA/TIA 455-78-B, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Test Procedures - Attenuation.
 - 2. TIA 526-7-A (2015) - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
 - 3. ANSI/TIA-1152-A, Requirements for Field Test Instruments and Measurements for Balance Twisted-Pair Cabling, 2017.
 - 4. ANSI/NECA/BICSI-568-2006 - Installing Commercial Building Telecommunications Cabling.
 - 5. BICSI Telecommunications Distribution Methods Manual, 13th edition.
 - 6. BICSI ITS Installation Methods Manual, 6th edition.
 - 7. BICSI Wireless Design Reference Manual, 3rd edition.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit following:
 - 1. Test equipment.
- C. Test Reports: Submit electronic copies.
 - 1. Electronic Reports: Submit on CD-ROM. If proprietary software used, include necessary software required to view test results (not required for standard formats like Excel, Access, CSV and PDF files). Accompany electronic reports by Certificate signed by authorized representative of Contractor warranting truth and accuracy of electronic report. Certificate: Reference traceable circuit numbers that match electronic record.
 - 2. Hardcopy Summary Reports: Submit in labeled 3 ring binders with attached affidavit verifying passing execution of tests. Hardcopy Summary Reports: Contain following information on each row of report: Circuit ID, test specification used, length, date of test, and pass/fail result. Hand-written test reports not allowed.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. The equipment and components included in this specification are manufactured and/or distributed by the Corning Cable Systems, Reliance Comm/Tec, and the AT&T Corporations.
- B. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.
- C. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Department of Network & Systems Services for approval four (4) weeks prior to installation. Equipment shall include, but may not necessarily be limited to, the following:

2.2 FIBER OPTIC CABLE TESTER

- A. Light Source – Multimode:
 - 1. Provide 850 nm (plus or minus 30 nm) and 1300 nm (plus or minus 20 nm) wavelength LED light sources.
 - 2. Spectral Width of Sources: 30 – 60 nm for 850 nm wave length and 100 – 140 nm for 1300 nm wavelength.
 - 3. Output of Light Source: ≥ -14 dbm for 62.5um core optical fiber.
 - 4. Output of Light Source: 8 mW for 62.5um core optical fiber.
 - 5. Output Stability: Plus or 0.40 dB from 0 to 50 degrees C.
 - 6. Long Term Output Stability: Plus or minus 0.10dB at 25 degrees C.
- B. Light Source: Single-Mode:
 - 1. Provide 1310nm and 1550nm (plus or minus 20 nm) wavelength laser light sources.
 - 2. Output Stability: Plus or 0.40 dB from 0 to 50 degrees C.
 - 3. Long Term Output Stability: Plus or 0.10dB at 25 degrees C.
- C. Power Meter
 - 1. Provide 850 nm, 1300 nm, 1310nm and 1550nm plus or minus 20 nm wavelength test capability.
 - 2. Measurement Range: From 10 to -60 dBm.
 - 3. Accuracy: Plus or minus 5 percent at 0 to -50dBm and plus or minus 10 percent 10 to 0dBm and -50 to -60 dBm.
 - 4. Resolution: 0.1 dB.
 - 5. Connector Types: Include SMA, FC, MT-RJ, ST and SC.
 - 6. Power: From rechargeable Ni-Cad batteries.
- D. Optical Time Domain Reflectometer (OTDR): Front CRT display.
 - 1. Connector Types: Include SC SMA FC MT-RJ ST.
- E. Acceptable Manufacturers:
 - 1. Corning.
 - 2. Fluke.
 - 3. Ideal.
 - 4. JDSU.
 - 5. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

2.3 CATEGORY 6A 100 OHM UTP TESTER

- A. User Interface: 128 by 64 backlit LCD display.
 - 1. Date stamp of tests.
 - 2. Tone generation audio warning.
- B. Physical Interface: Modular RJ-45 connector and serial port with DB-9 connector.
- C. Injector for complete wire mapping and TDR for determining cable length.
- D. Measure NEXT for six pair combinations and Attenuation on four pairs from 1.0 to 100 MHz 500 MHz.

- E. Additional Measurement Capabilities: Include impedance, loop resistance, capacitance, impulse noise and peak to peak noise.
- F. Acceptable Manufacturers:
 - 1. Fluke.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.4 GROUNDING AND BONDING TESTER

- A. Clamp-On:
 - 1. Amprobe.
 - 2. Fluke.
 - 3. Extech Instruments.
- B. 2/3 Point:
 - 1. Fluke.
 - 2. LEM.
 - 3. Megger.

PART 3 - EXECUTION

3.1 FIBER OPTIC CABLE TESTER

- A. Fiber Optic Testing:
 - 1. The Contractor shall perform continuity tests on every fiber in each fiber optic cable both before and after installation of the cable. If any fibers are found to be non-continuous BEFORE installation, the Contractor shall inform the University of such a condition immediately. It will then be the University's responsibility to determine the method of repair and or replacement.
 - 2. If non-continuous fibers are found AFTER installation, the Contractor shall inform the University of such a condition immediately. The University will then decide the method of repair or replacement, but the Contractor shall be responsible for repairing or replacing the damaged fiber optic cable unless given other written instruction from the University.
 - 3. It may be possible that improper installation, i.e. non-compliant bend radius or other form of stressing of the fiber cable may not be determined by this testing. The University's acceptance of the initial testing from end to end does not release the Contractor from their obligation in the proper installation of the fiber as outlined in these specifications.
 - 4. Upon completion of the construction, splicing, and/or terminations, the Contractor shall perform Tier 1 and Tier 2 testing per TIA-568-C.O. All fiber testing shall adhere to all aspects of the ANSI/TIA/EIA.
 - 5. Upon completion of the construction and terminations, the Contractor shall perform an end-to-end loss test on every fiber that has been connectorized and/or spliced on both ends. The tests shall be taken from fiber distribution panel to fiber distribution panel, or other appropriate fiber terminal equipment, using calibrated light sources and optical power meters.
 - 6. The one-jumper reference method shall be used before any tests are complete. Reference-grade jumpers shall be used for testing the installed fiber.
 - 7. The contractor shall perform OTDR tests on every fiber and shall supply to the University the original trace taken from the OTDR. Detail of the loss, distance, date and time, OTDR operators name, type and length of reference jumpers, test procedure and reference method used, UD cable I.D. #, buffer tube color and fiber color shall be made a part of the record. Pulse shall be set to its lowest value and no more than 50ns. Cursors for the OTDR traces are required to be in the correct position to measure end-to-end loss, and should include the second connector pair. For multimode fiber, each fiber shall be tested at 850nm and 1300nm. For single mode fiber, each fiber shall be tested at 1310nm and 1550nm.

8. Testing shall be conducted in both directions (forward and rearward) and with the light sources operating at 850 and 1300 nanometers for multimode and 1310 and 1550 for single mode. The Contractor shall provide the University with certified verification of the light sources and optical power meters' calibration dates, which must be within the manufacturer's calibration interval.
 9. The maximum attenuation of any connector pair in the installed system shall not exceed .50 dB. The maximum attenuation of any fusion splice in the system shall not exceed .10 dB.
 10. All fiber optic testing shall take place *before* any active service is placed upon the fibers and placed into production.
 11. All OTDR test results shall be submitted to the University of Delaware's Network & Systems Services department in electronic format, and be in .trc (Exfo Format) or .sor (Bellcore Universal) file extension format. There will be no exceptions to this requirement. Attenuation results shall be in. flw (Fluke Linkware) format.
 12. The Contractor shall give the University of Delaware's Network & Systems Services personnel five (5) working days' notice of all fiber optic cable testing dates so that representatives may be present if so elected.
- B. Pre-installation Cable Testing: Test fiber optic cable prior to installation of cable.
1. Contractor: Responsible for replacement of cable if found defective at later date.
- C. Loss Budget - Fiber Links:
1. Maximum loss of:
 - a. $(\text{Allowable cable loss per km})(\text{km of fiber in link}) + (0.75 \text{ dB}) (\text{number of mated pairs of connectors}) = \text{maximum allowable loss.}$
 - b. Bring links not meeting requirements of standard into compliance, at no charge to Owner.

3.2 CATEGORY 6A 100 OHM UTP TESTER

1. Before Acceptance Tests are scheduled, the Contractor shall perform his own system checkout. The Contractor shall furnish all required test equipment and shall perform all work necessary to determine and/or modify performance of the system to meet the requirements of this specification. This work shall include the following:
 - a. End-to-End tests of the wiring of each communications outlet shall include length, delay skew, propagation delay, wire-map, return loss (RL), insertion loss (IL), near end cross talk (NEXT), power sum near end cross talk (PS NEXT), attenuation to cross talk ratio - Near End (ACR-N), power sum attenuation to cross talk ratio – Near End (PS-ACR-N), far end cross talk (FEXT), attenuation to crosstalk ratio – Far End (ACR-F), and power sum attenuation to crosstalk ratio – Far End (PS ACR-F) . Complete tests are required for all cables as specified in the ANSI/TIA-568-C.2 and ISO/IEC 11801:2011 Edition 2.2 standards for Category 6A/Class E-a links. The Fluke Corp. DSX-5000 twisted pair test sets are the required test devices capable of providing these tests, as the Network and Systems Services Department utilizes a database that will accept these results. Test results shall be verified by letter and by supplying the University Department of Network and Systems Services with documentation of the test results upon completion by way of submittal of two (2) electronic data files. The first file should be readable by the Fluke Linkware program provided by Fluke and have an. FLW extension. The second file is exported from the Linkware program and will be a test result summary report in the form of a Microsoft Excel, comma-delimited file. Printed tests results are not required.
 - b. Maintain documentation of all performance tests for reference by the Owner during the System Acceptance Tests.

- c. FINAL TESTING UPON CROSS-CONNECT OF DATA/NETWORK SERVICE. All network connections shall be tested upon completion of link tests of the horizontal cable plant as defined above, and after the final cross-connects have been installed to provide network connectivity from the install network switches. For this final “ping” testing, the Telecommunications Contract shall utilize a Fluke AT2000 Linkrunner. The purpose of this “ping” test is to show the following:
 - 1) Verification that the horizontal cable is properly cross-connected to the correct switch and switch port per the network activation spreadsheets.
 - 2) Verification that a remote host can be reached. For this project there are TWO (2) types of remote hosts.
 - 3) The majority of the connections for this project will reside on the building subnet/vlan. For these types of connections, the Telecommunication Contractor shall use the host address 128.175.13.92
 - 4) For special circuits such as Fire Alarm Building Automation, Electric Metering, Surveillance Cameras, etc., special host addresses shall be provided by UD/Network Services to the UD Facilities Project Manager and General Contractor TWO (2) weeks prior to final testing.
 - 5) Since the Fluke AT2000 can only store FIFTY (50) test results, it is recommended that the Telecommunications contractor has an onsite laptop for transfer of these electronic files or uploads to a “cloud” account. A summary/report of all test results shall be submitted to UD Network & Systems Services for review thru the General Contractor by way of Microsoft Excel format. These tests shall be performed after the UD NSS commissioning of the network within the building.
- B. If post-manufacture performance data supplied by manufacturer of cables or connecting hardware, keep copies of such data for inclusion in documentation and make available to Owner upon request.
- C. Testing Parameters Called for in this Section: Apply for up to 90 m (295 ft.) of horizontal cable, 8P8C outlet and one consolidation point or transition point.
- D. Test Process:
 - 1. Owner reserves right to be present during testing.
 - 2. Testing of Permanent Link: Retest cabling not tested in accordance with these procedures at no additional cost to Owner.
 - 3. Test 100 Percent of Installed Cabling: Tests shall pass acceptance criteria defined below.
- E. Test cable with test set to match NVP for cable as stated by cable manufacturer.
- F. Test Parameters: Include Wire Map, Length, Attenuation, NEXT, ACR, PS-NEXT, PS-ACR, Return Loss, ELFEXT and PS-ELFEXT.
- G. Wire Map:
 - 1. Wire Map Test: Verify pair to pin termination at each end and check for connectivity errors. Wire map shall indicate following for each of eight conductors:
 - a. Continuity to remote end.
 - b. Shorts between any two or more conductors.
 - c. Crossed pairs.
 - d. Reversed Pairs.
 - e. Split Pairs.
 - f. Other miss-wiring.
- H. Cable Length:
 - 1. Maximum Length of Test Link Excluding Test Equipment Cords: 90 m (295 ft).
 - 2. Test permanent link attenuation and NEXT of cables. Permanent Link: Sum of attenuation of connecting hardware and 90 m (295 ft) of cable.
- I. Data Reporting and Accuracy:

1. General: Determine **PASS** or **FAIL** result for each parameter by allowable limits for each parameter. If test result of parameter closer to test limit than accuracy of tester, mark with asterisk. Test results marked with asterisk count as **FAIL**. Upload data at measured points to PC and printed on laser printer.
2. Wire Map: Mark wire map tests **PASS** if wiring determined correct.
3. Length: Provide test results in meters and marked **PASS** or **FAIL** based on length versus allowable length.
4. Attenuation: Report attenuation value and frequency at point of failure or highest frequency passed. Measured attenuation values lower than 3dB used for **PASS** / **FAIL** determination.
 - a. Report attenuation per unit length for links longer than 5 meters (16.4 feet).
 - b. Measure attenuation from 1 MHz to 500 MHz (Category 6A) in 1 MHz increments.
5. NEXT: Report NEXT value and **PASS** or **FAIL**.
6. Documentation: Test Reports: Include following information for each cabling element tested.
 - a. Wiremap results that indicate cabling has no shorts, opens, miswires, split, reversed, or crossed pairs, and end to end connectivity achieved.
 - b. Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT, and PSELFEXT data that indicate worst case result, frequency at which it occurs, limit at that point, and margin.
 - 1) Tests: Perform in swept frequency manner from 1 MHz to highest relevant frequency, using intervals consistent with TIA and ISO requirements.
 - 2) Provide information for pairs or pair combinations and in both directions when required by appropriate standards.
 - 3) Mark individual test that fails relevant performance specification as **FAIL**.
 - c. Length (in meters), propagation delay, and delay skew relative to relevant limit. Mark individual test that fails relevant performance specification as **FAIL**.
 - d. Cable manufacturer, cable model number/type, and NVP.
 - e. Tester manufacturer, model, serial number, hardware version, and software version.
 - f. Circuit ID number and project name.
 - g. Autotest specification used.
 - h. Overall pass/fail indication.
 - i. Date of test.
 - j. Submit test reports within seven business days of completion of testing.

3.3 GROUNDING AND BONDING TESTER

- A. All bonds installed by the contractor shall be tested for impedance with an earth ground resistance test in its two-point setup, such as a LEM Handy GEO tester.
- B. The Contractor shall test the impedance of all bonds of the grounding system, including cable armor bonding to ground. The impedance of a two-point bonding test across any bond shall not exceed 0.1 ohm. The Contractor shall remediate any bond(s) over this limit or which contribute to a total impedance exceeding 0.1 ohm from any point in the network.
- C. Test all grounding conductors, once installed, for current. Measure AC and bi-directional DC current. Report any AC current over 1 Amp. Report any DC current, in either direction, over 500 milliamps.

3.4 TEST RESULTS

- A. Fiber Optic Cables:
 1. Test fiber optic cables and submit fiber test result data in electronic format, to include showing graphically, entire length of fiber.
 2. Reports: Show circuit ID, cursor marks, total attenuation, date of installation and test used.
 3. Submit one copy of software capable of viewing electronic test result files.
- B. Cables: Submit test results in electronic format.

1. Horizontal Station Cables: Test individual copper cables.
 2. High Pair Count Copper Cables: Test high count copper cables.
 3. Acceptable Formats: Manufacturers format (include one copy of software capable of viewing test result files) and in PDF format.
- C. Grounding and Bonding:
1. Place a QA label (with date and inspector) in proximity to each bond tested.

3.5 ACCEPTANCE

- A. The Bidder shall include a statement of warranty on the entire system and on the individual pieces of equipment. The system warranty shall be for a minimum of one (1) year from the date of system acceptance by the Owner. This warranty shall obligate the Contractor to provide all equipment, material and labor, at no charge to the Owner, during the warranty period in the event of system or equipment malfunction. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor modified equipment, the manufacturer's warranty is normally voided. In such cases, the Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.
- B. Once work has been completed, 100 percent **PASS** rating test documentation has been received, and Owner's Representative satisfied that work in accordance with Contract Documents, Owner's Representative shall notify Contractor in writing of formal acceptance of system.
- C. Acceptance Requirements:
1. Contractor: Warrant in writing that 100 percent of installation meets requirements specified under Standards Compliance and Test Requirements above.
 2. Owner reserves right to conduct, using Contractor equipment and labor, random re-test of up to five percent of cable plant to confirm documented results.
 - a. Random Re-testing, if performed: At expense of Owner, using standard labor rates.
 - b. Failing Cabling: Re-tested and restored to passing condition. In event more than two percent of cable plant fails during re-test, re-test and restore entire cable plant to passing condition at no additional cost to Owner.
 3. Owner's Representative may agree to allow certain cabling runs to exceed standardized performance criteria (e.g. length). In this Event, such Runs: Explicitly identified by contractor and excluded from requirements to pass standardized tests.

END OF SECTION

SECTION 27 11 00
COMMUNICATIONS ROOM FIT-OUT

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Backboard
- B. Build Requirements:
 - 1. All levels within the building shall have one (1) TR each, as minimum, for termination of cables and placement of equipment related to the entire Telecommunications System.
 - 2. All TR's with the building shall be stacked upon one another, to satisfy minimum riser cable routing and lengths.
 - 3. The TR's are dedicated for network related equipment only. No other mechanical or electronic systems and related equipment or junction/control panels of any other discipline shall be co-located within the rooms.
 - 4. There shall be no routing of domestic water supply, sanitary, or any type of plumbing piping into, passing thru, or entering the TR's, with the exception of the supply for the local room AC units being fed by campus chilled water loop.
 - 5. There shall be no routing of ductwork into, passing thru, or entering the TR's.
 - 6. The room size shall be determined by the amount of circuits to be installed within the building, as well as communications equipment that will operate the system, and shall be determined by the UD IT-NSS Department. Rooms shall be a minimum of 100 sq. ft. and be configured as 10ft. x 10ft, or similar.
 - 7. The rooms are furnished with plywood wall fields.
 - 8. It is required that all branch circuits for equipment within this space shall be provided utilizing generator back up circuits.
 - 9. There shall be a dedicated 20 amp 125V ac circuit installed on each wall of each TR in the building, with 5-20R receptacles.
 - 10. There shall be two (2) receptacles above each relay rack in each TR in the building. One (1) receptacle shall be a 30 amp 125V circuit with L5-30 receptacle, and one (1) shall be a 20 amp 125V circuit with 5-20R receptacle.
 - 11. The TR floor is tiled and not carpeted to avoid dust and static electricity.
 - 12. No raised access flooring has been installed within this space.
 - 13. The ceiling height within this space has not been detailed to confirm the height of the ACT.
 - 14. The recommended height from the finished floor to the finished ceiling in the MTR/CMR should be at least 8'-6" (no false ceilings).
 - 15. Ceiling protrusions must be placed to assure a minimum clear height of 8' to provide space over the equipment frames for cables and suspended cable trays.
 - 16. HVAC shall be provided on a 24-hour a day, 7-day a week basis for this space and is not on emergency power. Provisions shall be made so systems cooling the TR's are tied into the campus chilled water loop. UD IT-NSS will provide the BTU requirements during the design process. Communications equipment being installed may generate up to 20,000 BTU's.
 - 17. The recommended environmental limit is 64-81degrees Fahrenheit dry-bulb, 60 percent maximum relative humidity, 59 degrees Fahrenheit maximum dew point, 42 degrees Fahrenheit minimum dew point, and a maximum rate of temperature change of 9 degrees per hour.
 - 18. Where sprinklers are required within the MTR, wire cages or other protection shall be installed to prevent them from being accidentally set off. Use drainage troughs under the sprinkler pipes to prevent them from leaking onto the telecommunications equipment.
 - 19. All penetrations into the MTR shall be fire stopped to a minimum of 1-hour of protection, or to local code specifications to meet the original rating of the wall systems.

20. Verify that Lighting requirements meet a minimum of 50 foot-candles maintained at 36-inches AFF. Lighting fixtures, motors, air conditioning, etc., shall not be powered from the same electrical distribution panel as the telecommunications equipment in the room.
- C. Related Requirements: Comply with following:
 1. Section 270500 - Common Work Results for Communications.
 2. Section 27 11 13 - Communications Entrance Protection
 3. Section 27 11 16 - Communications Cabinets, Racks, Frames, and Enclosure
 4. Section 27 11 19 - Communications Termination Blocks and Patch Panels
 5. Section 27 11 26 - Communications Rack Mount Power Protection and Power Strips
 6. Section 07 84 00 - Firestopping
 7. Section 08 74 11 - Electronic Locking Hardware
 8. Section 09 67 17 - Floor Coatings
 9. Section 09 69 00 - Access Flooring

1.2 REFERENCES

- A. Reference Standards: See Section 270500 - Common Work Results for Communications.

1.3 DEFINITIONS

- A. Telecommunications Room (TR): A TR is an enclosed architectural space for housing telecommunications equipment, cable terminations, and cross-connect cabling.
- B. Telecommunications Enclosure (TE): A TE is a case or housing for telecommunications equipment, cable terminations, and cross-connect cabling.
- C. Building: All structures that include an OSP element that are not defined as spaces. These may include structures not normally occupied, such as storage sheds and athletic field grandstands
- D. Entrance Facility (EF): A room into which inter-building backbone cables enter. Cables may or may not terminate in this room. Most often the EF is the Main Telecommunications Room.
- E. Equipment Room (ER): A room containing voice and data electronics. Reserved for rooms with enough electronics to impact space and cooling requirements (rooms with PBX hardware or core network electronics).

1.4 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.

PART 2 - PRODUCTS

2.1 BACKBOARD

- A. 1.2 m (4 feet) wide by 2.4 m (8 feet) high by 18 mm (3/4 inch) thick AC-grade, void-free plywood.
 1. Plywood to be painted with two (2) coats of fire retardant paint, all sides, all edges.
 2. Plywood shall not be fire rated, as UD IT-NSS has had issues in the past with true fire-rated plywood flaking and warping on walls.

2.2 PAINT

- A. Intumescent:
 1. ASTM E84 (UL 723) "Surface burning characteristics of building materials" Class "A" rating
 2. ASTM E119 (UL 263) "Fire tests of building construction and materials" certified.
 3. Manufacturers:
 - a. Hy-Tech Flame Guard Additive for interior flat latex paint.
 - b. PPG Pittsburgh Paint Firetex.
 - c. Benjamin Moore 220 Latex Fire Retardant Coating.
 - d. Sherwin Williams Flame Control.

- e. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

2.3 CONDUIT

- A. Galvanized rigid steel conduit and fittings,
 - 1. 4" trade size, manufactured to:
 - a. ANSI C80.1 (Specification for Rigid Steel Conduit, Zinc Coated)
 - b. Underwriters Laboratories Standard 6 (Electrical Rigid Metal Conduit - Steel)
- B. Galvanized intermediate metal conduit and fittings,
 - 1. 4" trade size, manufactured to:
 - a. ANSI C80.6 (Intermediate Metal Conduit (IMC) Zinc Coated)
 - b. Underwriters Laboratories Standard 1242 (Type IMC threaded and unthreaded conduit, nipples, bends, and couplings in 1 to 4 inch trade size)
 - c. Underwriters Laboratories Standard 797 (Electrical Metallic Tubing - Steel)

PART 3 - EXECUTION

3.1 BACKBOARD

- A. Standard AC-grade plywood shall be painted on both sides and all edges, twice, with intumescent paint. Plywood shall be painted prior to installation. Confirm procedure with local AHJ to achieve approval before using standard plywood and intumescent paint.
- B. Provide and install 3/4" AC grade plywood on ALL walls of Telecommunications Rooms XXX. Substitution of fire-rated plywood of any sort is deemed unacceptable. All plywood shall extend from 6" above the floor to ceiling in each room, and shall be painted with two (2) coats of fire-retardant paint on ALL sides and ALL edges to match the interior color of the room BEFORE any and all equipment is installed within the rooms. Fire Retardant paint shall be Benjamin Moore #INSL-X-LFR-110, color white, or equivalent.
- C. Each 4 ft. x 8 ft. sheet of plywood shall secure to the wall at ten (1) locations.
- D. For block/masonry walls, securing hardware at each location shall consist of one (1) 1/4" x 1-1/4" zinc fender washer and one (1) 1/4" x 2-1/4" hex tapcon.
- E. For drywall installation, securing hardware at each location shall consist of one (1) 1/4" x 1-1/4" zinc fender washer and one (1) 1/4"-20 x 4" toggle bolt.
- F. For partial sheets of plywood that are 36" or less in horizontal length, midpoint fastening is not required.
- G. Non-rectangular pieces of plywood shall be secured on an individual basis.
- H. All AC power outlets shall be installed in telecommunications rooms as flush mount outlets, with junction boxes and conduits shall be roughed into the wall, junction boxes shall be installed and sized to accommodate the 3/4" plywood on the walls. No surfaced mounted outlets or conduit shall be mounted to the plywood.

3.2 INSTALLATION IN EQUIPMENT ROOMS AND TELECOMMUNICATIONS ROOMS

- A. Mount patch panels brackets, terminal strips, and other connecting hardware on backboards, unless otherwise indicated.
- B. Group connecting hardware for cables into separate logical fields.
- C. Use patch panels to terminate horizontal cables entering space, unless otherwise indicated.

3.3 GROUNDING AND BONDING

- A. Bond to ground in accordance with Section 270526 – Grounding and Bonding for Communications and Section 270500

3.4 IDENTIFICATION

- A. Identify system components complying with applicable requirements in Section 270553 - Identification for Communications Systems.

3.5 CLEANING

- A. Cleaning: Comply with Section 017400. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

SECTION 27 11 13
COMMUNICATIONS ENTRANCE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Category 6A Surge Protection Block.
 - 2. Coax/UTP Surge Protection Device.
- B. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270526 – Grounding and Bonding for Communications.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 CATEGORY 6A SURGE PROTECTION BLOCK

- A. Wall-mountable.
- B. ITW-Linx Surgegate #CAT6A-75,
- C. Solid-state protection to divert surges to ground within 2-5 nanoseconds.
- D. Automatically resets without user intervention.
- E. Integral shield grounding clip for cable shield attachment.
- F. Clamping voltage: 16 volts.
- G. UL listed for primary (497) and isolated loop (497B) applications.
- H. Acceptable Manufacturers:
 - 1. ITW Linx.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.2 COAXIAL PROTECTION TERMINAL

- A. Wall-mountable.
- B. Correct terminal for application (i.e. CATV, Satellite, two-way radio, cellular, etc.) as identified.
- C. Input and output connections shall be coordinated with cable connectors.
- D. Max. continuous operating voltage (d.c.) (UC) 135 V
- E. Nominal current (IL) 6 A
- F. Max. transmission capacity 60 W
- G. D1 Lightning impulse current (10/350 μ s) (Iimp) 1 kA
- H. C2 Nominal discharge current (8/20 μ s) (In) 5 kA
- I. Voltage protection level for In C2 (UP) \leq 650 V
- J. Frequency range 0-5.8 GHz

- K. Acceptable Manufacturers:
 - 1. DEHN #929044.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 SURGE PROTECTION

- A. Provide labels for each cable in accordance with Section 270553 – Identification for Communications Systems.
- B. Fully protect pairs entering building either with active pair surge protection modules or surge protection modules specified of inactive pairs.

3.2 50 OHM COAXIAL CABLE SURGE PROTECTION MODULE

- A. Connect directly to coaxial cable. Do not use jumpers.
- B. Ground to TGB with appropriately sized conductor as per TIA J-STD-607-A and NFPA 70.

3.3 GROUNDING AND BONDING

- A. Bond to ground in accordance with Section 270526 – Grounding and Bonding for Communications and Section 270500 – Common Work Results for Communications.
- B. Conductive elements of OSP optical fiber shall be bonded to ground upon entering a building.
- C. Ground Conductor: Install as straight as possible from terminal to grounding busbar.

END OF SECTION

SECTION 27 11 16

COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provides specifications for network cabinets, racks, and telecommunications enclosure components utilized to house various telecommunications infrastructure components within technology distribution spaces.
- B. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Two Post Floor-Mount Rack.
 - 2. Four Post Floor-Mount Rack.
 - 3. Wall-Mount Relay Rack.
 - 4. Accessories.
- C. The indicated manufacturers shall be the basis of the design and each infrastructure component selected shall address the particular requirements.
- D. Select relay racks and components capable of supporting the telecommunications cable and equipment quantities required for each location.
- E. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270526 -Grounding and Bonding for Communications.
 - 3. Section 270553 – Identification for Communications Systems
 - 4. Section 271119 – Communications Termination Blocks and Patch Panels

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References 014219 – Reference Standards] and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 TWO POST FLOOR-MOUNT RACK

- A. Standard (7 foot) high by (19 inch) wide aluminum/metallic self-supporting rack system to house Owner-provided equipment and Contractor provided termination bays for multiple cable types.
- B. Support and organize electronic equipment, cross-connection and termination hardware for fiber optic cabling, station cabling, riser cabling, or building entrance cabling as required by design.

- C. Designed for cable and jumper management and have hardware to organize and support cabling and patch cords in vertical and horizontal planes.
- D. Accessory mounting brackets to accept mounting of two (2) vertical plug strips.
- E. Provide with necessary hardware to assemble frame included.
- F. Conventional equipment mounting width of (19 inches).
- G. Equipped for electrical grounding to meet ANSI-J-STD-607-C standards.
- H. Fastening System for Equipment: Facilitate easy installation.
- I. Finish: Not scratched, chipped or marred.
- J. Rack Components: Charcoal black in color clear chem finish.
- K. (3 inch) wide channels at each side and with extruded aluminum top angles and base angles providing support.
- L. Able to be mounted side by side and be secured to adjacent racks in line-up.
- M. Base Angles: (0.3125 inch) thick.
- N. Top Angles: (0.1875 inch) thick.
- O. Frames: Capable of supporting (700 pounds), with uniform distribution of weight.
- P. (0.19 inch) thick channel flange and (0.13 inch) web thickness.
- Q. Acceptable Manufacturers:
 - 1. Chatsworth Products Inc. #55053-703- 2-Post Relay Racks, color black.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.2 FOUR POST FLOOR-MOUNT RACK

- A. (7 foot) high by (19 inch) wide aluminum/metallic self-supporting rack system to house Owner-provided equipment and Contractor provided termination bays for multiple cable types.
- B. Support and organize electronic equipment, cross-connection and termination hardware for fiber optic cabling, station cabling, riser cabling, or building entrance cabling as required by design.
- C. Designed for cable and jumper management and have hardware to organize and support cabling and patch cords in vertical and horizontal planes.
- D. Provide with necessary hardware to assemble frame included.
- E. Conventional equipment mounting width of (19 inches).
- F. Equipped for electrical grounding to meet ANSI-J-STD-607-C standards.
- G. Fastening System for Equipment: Facilitate easy installation.
- H. Independent adjustable front and rear mounting rails. Adjustable while rack secured to floor.
- I. Rear rail construction with a clear ventilation path.
- J. Finish: Not scratched, chipped or marred.
- K. Rack Components: Charcoal black in color [clear chem finish].
- L. (3 inch) wide channels at each side and with extruded aluminum top angles and base angles providing support.
- M. Able to be mounted side by side and be secured to adjacent racks in line-up.
- N. Base Angles: (0.3125 inch) thick.
- O. Frames: Capable of supporting (2000 pounds), with uniform distribution of weight.
- P. (0.19 inch) thick channel flange and (0.13 inch) web thickness.
- Q. Comply with following:

Dimensions	(7 feet high by 23.3 inches wide) by (35.64 inches deep) with (19 inch) center mounting.
	(6 feet – 7 inches) usable vertical space.
Hole Pattern	Adjustable (square-punched mounting holes.
RMU's	45 Rack Mounting Units.
Mounting Screws	No. 12-24 thread combination Phillips/straight heads and pilot points.
Flanges	Flange edge to edge internal measurement of (17.5 inches)

- R. Acceptable Manufacturers:
1. Chatsworth Products Inc. #15217-703 4-Post Adjustable Relay Racks, color black.
 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.3 ACCEPTED SUBSTITUTE IN ACCORDANCE WITH SECTION 012500 – SUBSTITUTION PROCEDURES.

2.4 SINGLE-SIDED SHELF

- A. (5.19 inches) high by (19 inches) wide by (15 inches) deep.
- B. Wall-mountable shelf.
- C. Metallic construction.
- D. Frames: Capable of supporting (30 pounds).
- E. Include TIA-310 universal mounting holes.
- F. Acceptable Manufacturers:
 1. Chatsworth # 40074-500.
 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Check actual site conditions prior to start of any work. Ensure all preceding trade work associated with the telecommunications system is accurate and complete before proceeding with installation or use of products specified in this section. Examples of work which must be checked include, but are not limited to:
 1. Electrical requirements (conduit installation and capacity)
 2. Adequate clearances of doors, riser spaces and ceilings for all component of the telecommunications system.
 3. Examine and compare the telecommunications drawings and specifications with the drawings and specifications of other trades. Report any discrepancies between them to the A/E and obtain written instructions for changes or revisions.

3.2 FLOOR-MOUNT RACK

- A. Anchored to floor. To anchor four post rack into floors, use Chatsworth anchor kit #40604-003. Use 3/8" kit for wood floors, and 1/2" kit for concrete floors.
- B. Provide vertical and horizontal cable management sized for no more than 40 percent fill.
- C. Mount with minimum of (36 inches) clear access behind and in front of rack/cabinet.

- D. Ground rack/cabinet to TMGB/TGB with Grounding Wire.
- E. Additional information: Swing-out rack:
 - 1. Orient swing to match drawings.
 - 2. Attached cable management to face of rack. Attach on hinged side of the rack. Do not obscure equipment mounting holes or interfere with the ability to mount hardware in rack.
 - 3. Provide 9" minimum distance from rear foot of rack to wall behind rack.
 - 4. Racks shall be "ganged" to increase stability.

3.3 WALL-MOUNT CABINET/WALL MOUNTED SHELF

- A. Secure to plywood backboard with appropriate type screws or fasteners.

3.4 GROUNDING AND BONDING

- A. Bond to ground in accordance with Section 270526 – Grounding and Bonding for Communications and Section 270000 – Communications.

3.5 CLOSEOUT ACTIVITIES

- A. Contractor shall provide documentation of all telecommunications system components under this section utilized throughout the site for review and reference by the Owner and A/E team.
- B. Contractor to submit all as-built drawings and any test documentation required prior to acceptance by the owner.

END OF SECTION

SECTION 27 11 19

COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
- B. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Category 6A Horizontal Patch Panel.
- C. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270526 – Grounding and Bonding for Communications.
 - 3. Section 270553 – Identification for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.
- D. If providing pre-standards manufacturer system solution, submit installer/contractor certification documentation and channel certification information and requirements from manufacturer.

PART 2 - PRODUCTS

2.1 CATEGORY 6A HORIZONTAL PATCH PANEL

- A. Meet or exceed latest Category 6 [6A] standards.
- B. Contain designation label strips for port identification.
- C. UL listed.
- D. Termination Block: Support appropriate Category 6A applications, including 100 Mbps TP-PMD, 155 Mbps ATM, 10000BASE-T, IEEE 802.3af (PoE), IEEE 802at (PoE), and 1.2 Gps ATM.
 - 1. 110-IDC style termination.
 - 2. Able to accommodate up to 23 AWG cable conductors.
- E. Provide port-sized patch panels as indicated on Drawings.
- F. Acceptable Manufacturers:
 - 1. Siemon Co. ZMAX 48 Port Patch Panel Kit, Category 6A, Black, with Jacks.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 UTP PATCH PANEL

- A. Patch Panels - TR-XXX, provide and install XX (XX) Siemon Co. Z6A-PNLA-U48K. ZMAX 48 Port Patch Panel Kits, Category 6A, 1 RMS, Angled, Black, with Jacks. All patch panels shall be installed at rack positions as defined on telecommunications room drawings.

- B. Include rear cable management bar to support cables.
- C. Terminate cables to T-568B standard.
- D. All horizontal cables installed to patch panels shall be routed to patch panels in bundles as determined by contractor pulling strategy, and assigned to patch panel port assignments accordingly. The assigned IT-NSS Network Engineer will provide the contractor with Microsoft Excel Spreadsheets for each telecommunications room, with columns populated with all assigned circuit numbers for horizontal cables on each floor. The contractor shall populate these spreadsheets with patch panel numbers and associated port numbers for each horizontal cable in the appropriate columns. These spreadsheets shall be returned back to the assigned IT-NSS Network Engineer upon completion of each TR, so the tracked information can be uploaded into IT-NSS connectivity database.
- E. All equipment shall be secured plumb and square with consideration being given not only to operational efficiencies, but also to overall aesthetic factors.
- F. Upon installation of fiber cables, telecommunications room relay racks, and their associated vertical and horizontal management assemblies, and at defined dates for installation of network service to the building, the University of Delaware Network Services Department will dispatch technician's to commission and install network switches in each telecommunications room. Network switches will be installed in each relay rack, and fiber channels will be built and connected to each stack of switches. At the completion of the commissioning and installation of switches, the contractor can now install patch cords from horizontal patch panel terminations, to the front of each switch.
- G. All patch cables shall be labelled at each end of the cables (Patch Panel and Switch), with a UD designated Patch Panel and Switch Port number. For example, "A0, A1, A2...thru A47. Switch ports on Juniper Series Switches are labelled 0-47. Patch Panels are labelled 1-48. "A" indicates patch panel assignments "A, B, C, D, E, F" for a total of six (6) maximum switches and panels. UD will provide detailed labelling list upon build.
- H. There will be no more than six (6) Patch Panels in a Rack. The Patch Panels will be installed using the following configuration:
 - 1. TR-XXX – Patch Panel #1 – provide and install forty eight (48) Patch Cables – 5 ft. length - Belden #CA21106005, 10GX Modular cord, color blue:
 - a. PP Ports 1-12, to network switch 20 (top switch in rack) ports 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, respectively. Route thru horizontal manager at top of switch, and thru vertical manager on left side of rack.
 - b. PP Ports 13-24, to network switch 20 (top switch in rack) ports 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, respectively. Route thru horizontal manager at top of switch, and thru vertical manager on right side of rack.
 - c. PP Ports 25-36, to network switch 20 (top switch in rack) ports 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, respectively. Route thru horizontal manager at bottom of switch, and thru vertical manager on left side of rack.
 - d. PP Ports 37-48, to network switch 20 (top switch in rack) ports 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, respectively. Route thru horizontal manager at bottom of switch, and thru vertical manager on right side of rack.
 - 2. TR-XXX – Patch Panel #2 – Provide and install forty-eight (48) Patch Cables – 5 ft. length, Belden #CA21106005, 10GX Modular cord, color blue. These patch cables will route to network switch 21, which is the second switch in the rack under network switch 20. Patch cables shall be routed in numerical order from PP #2 to network switch 21 as per above layout and routing.
 - 3. TR-XXX – Patch Panel #3 – Provide and install forty-eight (48) Patch Cables – 6 ft. length, Belden #CA21106006, 10GX Modular cord, color blue. These patch cables will route to network switch 22, which is the third switch in the rack under network switch 22. Patch cables shall be routed in numerical order from PP #3 to network switch 23 as per above layout and routing.

4. TR-XXX – Patch Panel #4 – Provide and install forty-eight (48) Patch Cables – 6 ft. length, Belden #CA21106006, 10GX Modular cord, color blue. These patch cables will route to network switch 23, which is the fourth switch in the rack under network switch 22. Patch cables shall be routed in numerical order from PP #4 to network switch 23 as per above layout and routing.
5. TR-XXX – Patch Panel #5 – Provide and install forty-eight (48) Patch Cables – 6 ft. length, Belden #CA21106006, 10GX Modular cord, color blue. These patch cables will route to network switch 24, which is the fifth switch in the rack under network switch 23. Patch cables shall be routed in numerical order from PP #5 to network switch 24 as per above layout and routing.
6. TR-XXX – Patch Panel #6 – Provide and install forty-eight (48) Patch Cables – 7 ft. length, Belden #CA21106007, 10GX Modular cord, color blue. These patch cables will route to network switch 25, which is the fifth switch in the rack under network switch 24. Patch cables shall be routed in numerical order from PP #6 to network switch 25 as per above layout and routing.
7. Contract drawings shall indicate relay rack layout and network switch installation position to further define this section.
- I. Test all cables in accordance with Section 270700 – Communications Testing.
- J. Shielded patch panel: Ground per manufacturers' recommendations and accordance with Section 270526 – Grounding and Bonding for Communications.

END OF SECTION

SECTION 27 11 23
COMMUNICATIONS CABLE MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Rack/Cabinet/Zone Box Management: Vertical and Horizontal.
 - 2. Horizontal Lacing Bar.
 - 3. D-Ring.
- B. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270528.29 – Hangers and Supports for Communications Systems.
 - 3. Section 270528.36 – Cable Trays for Communications Systems.
 - 4. Section 270553 – Identification for Communications Systems.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 RACK/CABINET/ZONE BOX MANAGEMENT: VERTICAL AND HORIZONTAL

- A. Horizontal Cable Manager: Locate in every cable rack/cabinet/zone box above and below every patch panel.
 - 1. No more than (3.5 inches) high.
 - 2. Management Panels: Metallic with at least four integral plastic or metal wire retaining fingers.
- B. Vertical Cable Manager: Locate on each side of rack.
 - 1. Minimum of (6 inches) wide and (12.75 inches) deep.
 - 2. Management Panels: Front and rear channels and removable front and rear covers.
 - 3. Same height as rack/cabinet.
- C. Acceptable Manufacturers:
 - 1. [Chatsworth, Evolution G3 series #35571-703, 7ft. x 6" vertical cable management assemblies.](#)
 - 2. [Chatsworth, Evolution G3 series #35572-703, 7 ft. x 8" vertical cable management assemblies.](#)
 - 3. [Chatsworth, Evolution G3 series #35441-701, 1U, horizontal cable management assemblies.](#)
 - 4. [Chatsworth, Standard series #13070-719, 1U, horizontal cable management assemblies.](#)
 - 5. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.2 HORIZONTAL LACING BAR

- A. Provides convenient cable tie points within rear of rack/cabinet.
- B. Constructed of (1/4 inch) diameter flattened rod (3/16 inch) thick aluminum/steel.

- C. Acceptable Manufacturers:
 - 1. Chatsworth
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

2.3 WALL MOUNT DISTRIBUTING "D" RING

- A. Composite or zinc plated steel to resist corrosion.
- B. Ring edges: Rolled to prevent nicks and scratches in the cable and wire insulation.
- C. Acceptable Manufacturers:
 - 1. Chatsworth.
 - 2. Panduit.
 - 3. Siemon.
 - 4. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

3.1 RACK MANAGEMENT: VERTICAL AND HORIZONTAL

- A. Provide and install two (2) Chatsworth Products Inc., Evolution G3 series #35571-703, 7 ft. vertical cable management assemblies, 84x6x20.2, color black, onto each of the installed relay racks in Telecommunications Room XXX.
- B. Provide and install two (2) Chatsworth Products Inc., Evolution G3 series #35572-703, 7 ft. vertical cable management assemblies, 84x8x20.2, color black, onto each of the installed relay racks in Telecommunications Room XXX.
- C. Provide and install XX (XX) Chatsworth Products Inc., Evolution G3 series #13070-719 horizontal cable management assemblies, 1U, color black, onto the relay rack in Telecommunications Room XXX.
- D. These horizontal management assemblies are to be installed for placement and storage of Juniper Switch DAC cables, and not for patch cable routing. Horizontal Management assemblies shall be installed at relay rack positions as defined in each Telecommunications Room Rack Drawing.
- E. Cables into Racks: Provide neat and organized distribution of cables into rack/cabinet.
- F. Cable Transitions from Vertical to Horizontal Path: Ensure stress relief with cable ties and support. Support weight of cable at 90-degree bend point with this cable stress management and not by termination point at jack.

3.2 HORIZONTAL LACING BAR

- A. Install within rear of rack/cabinet behind each patch panel to facilitate proper cable support and management.

3.3 WALL MOUNT DISTRIBUTING "D" RING

- A. Rings: Install open end distribution rings for wall mounted cross-connect fields above wall mounted blocks. Minimum two rings per vertical row.
- B. Acceptable Option: Score standard distribution ring with copper tubing cutters to eliminate 3/4 of one of mounting legs, snap off and debur. Mount rings with two hex head screws per ring.

END OF SECTION

SECTION 27 16 19

COMMUNICATIONS PATCH CORDS, STATION CORDS, AND CROSS CONNECT WIRE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Qualitative requirements for Patch Cords, Station Cords and Cross Connect Wire.
 - 2. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - a. Category 6A UTP Patch Cord/Station Cord.
 - b. RG-6 Coaxial Patch Cord/Station Cord.
 - c. Fiber Optic Patch Cord/Station Cord.
- B. Modular Cords: A modular cord is a length of cable with connectors on both ends used to join telecommunications circuits/links. A Patch Cord is a modular cord located at the cross-connect. A Station Cord is a modular cord located at the work area outlet.
- C. Cross Connect Wire: One or two pairs of insulated conductors used to connect circuits/links between multi-pair backbone cables at the cross-connect.
- D. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 271513 – Communications Copper Horizontal Cabling.
 - 3. Section 271523 – Communications Optical Fiber Horizontal Cabling.
 - 4. Section 271533 – Communications Coaxial Horizontal Cabling.
 - 5. Section 271543 – Communications Faceplates and Connectors.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit product data for each type of Patch Cord, Station Cord and Cross Connect Wire to be installed including but not limited to physical dimensions, configurations, construction and performance specifications
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 CATEGORY 6A UTP PATCH CORD/STATION CORD

- A. Physical Characteristics:
 - 1. Conductors: Stranded.
 - 2. Lengths: Coordinate with Owner prior to ordering.
 - 3. Color: Coordinate with Owner prior to ordering.
- B. Transmission Characteristics:
 - 1. Performance Requirements: Meet Category 6A performance criteria.
 - 2. Manufacturer: Approved partner with horizontal cable, jacks & patch panels.
- C. Provide one patch cord for every voice jack and two patch cords for every data jack.
- D. Acceptable Manufacturers:
 - 1. Patch Cables – 5 ft. length - Belden #CA21106005, 10GX Modular cord, color blue.
 - 2. Patch Cables – 6 ft. length – Belden #CA21106006, 10GX Modular cord, color blue.
 - 3. Patch Cables – 7 ft. length – Belden #CA21106007, 10GX Modular cord, color blue.

4. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

2.2 SERIES 6 COAXIAL PATCH CORD/STATION CORD

- A. Physical Characteristics:
 1. Lengths: Manufactured in field to Owner's required lengths.
 2. Connector Type: Terminated with F-type connector at both ends.
- B. Transmission Characteristics:
 1. Performance Requirements: Meet same characteristics as horizontal RG-6 cable.
 2. Manufacturer: Approved partner with horizontal cable, jacks & patch panels.
- C. Provide two patch cables for every coaxial pass-through adapter.
- D. Acceptable Manufacturers:
 1. Belden.
 2. Commscope.
 3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

2.3 FIBER OPTIC PATCH CORD/STATION CORD

- A. Physical Characteristics:
 1. Cable: Shall contain the same number of fibers as the connector used (e.g., duplex connectors using duplex patch cord cable) and be of an indoor construction.
 2. Connectors: Duplex 568SC, in accordance with Section 271543 – Communications Faceplates and Connectors.
 3. Lengths: Coordinate with Owner prior to ordering.
 4. Color: Multimode – Orange; Laser Optimized – Aqua; Single-mode – Yellow.
- B. Transmission Characteristics:
 1. Performance Requirements: Meet transmission characteristics of optical horizontal cable.
 2. Manufacturer: Approved partner with horizontal cable and connectors.
- C. Provide two patch cords for every port.
- D. Acceptable Manufacturers:
 1. Fiberdyne Labs.
 2. Belden.
 3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

3.1 CAT6A PATCH CORD INSTALLATION

- A. There will be no more than six (6) Patch Panels in a Rack. The Patch Panels will be installed and the Patch Cords installed using the following configuration:
- B. TR-XXX – Patch Panel #1 – provide and install forty-eight (48) Patch Cables – 5 ft. length - Belden #CA21106005, 10GX Modular cord, color blue:
 1. PP Ports 1-12, to network switch 20 (top switch in rack) ports 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, respectively. Route thru horizontal manager at top of switch, and thru vertical manager on left side of rack.
 2. PP Ports 13-24, to network switch 20 (top switch in rack) ports 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, respectively. Route thru horizontal manager at top of switch, and thru vertical manager on right side of rack.
 3. PP Ports 25-36, to network switch 20 (top switch in rack) ports 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, respectively. Route thru horizontal manager at bottom of switch, and thru vertical manager on left side of rack.
 4. PP Ports 37-48, to network switch 20 (top switch in rack) ports 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, respectively. Route thru horizontal manager at bottom of switch, and thru vertical manager on right side of rack.

- C. TR-XXX – Patch Panel #2 – Provide and install forty-eight (48) Patch Cables – 5 ft. length, Belden #CA21106005, 10GX Modular cord, color blue. These patch cables will route to network switch 21, which is the second switch in the rack under network switch 20. Patch cables shall be routed in numerical order from PP #2 to network switch 21 as per above layout and routing.
- D. TR-XXX – Patch Panel #3 – Provide and install forty-eight (48) Patch Cables – 6 ft. length, Belden #CA21106006, 10GX Modular cord, color blue. These patch cables will route to network switch 22, which is the third switch in the rack under network switch 22. Patch cables shall be routed in numerical order from PP #3 to network switch 23 as per above layout and routing.
- E. TR-XXX – Patch Panel #4 – Provide and install forty-eight (48) Patch Cables – 6 ft. length, Belden #CA21106006, 10GX Modular cord, color blue. These patch cables will route to network switch 23, which is the fourth switch in the rack under network switch 22. Patch cables shall be routed in numerical order from PP #4 to network switch 23 as per above layout and routing.
- F. TR-XXX – Patch Panel #5 – Provide and install forty-eight (48) Patch Cables – 6 ft. length, Belden #CA21106006, 10GX Modular cord, color blue. These patch cables will route to network switch 24, which is the fifth switch in the rack under network switch 23. Patch cables shall be routed in numerical order from PP #5 to network switch 24 as per above layout and routing.
- G. TR-XXX – Patch Panel #6 – Provide and install forty-eight (48) Patch Cables – 7 ft. length, Belden #CA21106007, 10GX Modular cord, color blue. These patch cables will route to network switch 25, which is the fifth switch in the rack under network switch 24. Patch cables shall be routed in numerical order from PP #6 to network switch 25 as per above layout and routing.
- H. Contract drawings shall indicate relay rack layout and network switch installation position to further define this section.
- I. Deliver patch cords to site or location designated by Owner's Representative.

END OF SECTION

SECTION 27 05 45

VAULTS, PEDESTALS AND ENCLOSURES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Controlled Environment Vault.
 - 2. Pedestals.
 - 3. Enclosures.
- 1.1 B. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270542 – Communications Confined Spaces and Safety.
 - 3. Section 270526 – Grounding and Bonding for Communications.
 - 4. Section 270548 – Vibration and Seismic Controls for Communications Systems.
 - 5. Section 312333 – Trenching and Backfilling.

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.
- 1.2 B. Following Articles of NFPA 70 - National Electric Code:
 - 1. 344 – Rigid metal conduit: Type RMC
 - 2. 352 – Rigid polyvinyl chloride conduit: Type PVC
 - 3. 354 – Nonmetallic underground conduit with conductors: Type NUCC
- C. Following National Electrical Manufacturers Association (NEMA) Standards:
 - 1. NEMA RN1 2018 Edition, September 7, 2018 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - 2. NEMA TC 3-2016 – Polyvinyl Chloride (PVC) fittings for use with Rigid PVC Conduit and Tubing.
 - 3. NEMA TC 6 & 8:2013 – Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations.
 - 4. NEMA TC 9:2004 (2012) - Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct and Fittings for Underground Installation.
 - 5. NEMA FB 2.10, 2013 Edition, January 1, 2013 - Selection and Installation Guidelines for Fittings for Use with Non-Flexible Metallic Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit, and Electrical Metallic Tubing).
- D. Following UL Standards:
 - 1. UL 6 - Rigid Metal Electrical Conduit.
 - 2. UL 651 8th Edition, June 15, 2016 - UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- 1.3

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- 2.1 B. Product Data and Installation Instructions: Submit for products included within this specification section.

PART 2 - PRODUCTS

CONTROLLED ENVIRONMENT VAULT (CEV)

- A. Certified to Telcordia GR-487 for electronics, certified to Telcordia GR-3115-CORE for passive equipment only.
- B. Expandable or gangable.
- C. Manufacturers:
 - 1. Emerson Network Products (formerly Marconi), Energy Systems.
 - 2. Purcell Systems.
 - 3. Any Suggested Substitution will be reviewed in accordance with Section 012500.

PEDESTALS

- A. Manufacturers:
 - 1. Emerson Network Products (formerly Marconi), Energy Systems:
ACCESS 360 Metallic Pedestal.
 - 2. Any Suggested Substitution will be reviewed in accordance with Section 012500.
- 2.2 B. Other acceptable manufacturers offering equivalent products.

^aENCLOSURES

- A. Buried closures shall use re-enterable encapsulate-material specified by the closure manufacturer.
- 2.3 B. Manufacturers:
 - 1. 3M.
 - 2. Preformed Line Products.
 - 3. Tyco Electronics.
 - 4. Any Suggested Substitution will be reviewed in accordance with Section 012500.

PART 3 - EXECUTION

3.1 CEV AND PEDESTALS

- A. Install in accordance with manufacturer's instructions.

3.2 ENCLOSURES, DIRECT-BURIED

- A. Direct-buried spaces shall be at a minimal depth of (30 inches) to the device in the space, where possible.
- B. Excavate in and around the final space location such that (6 inches) of gravel or crushed rock can be placed below and around any direct buried device in the space. Cover any direct buried devices in the space with (6 inches) of gravel or crushed rock.
- C. Direct-buried locations shall not necessitate the installation of a ground rod. Electrical ground continuity through the enclosure shall be maintained.

END OF SECTION

SECTION 27 11 26

COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

PART 1 - GENERAL

SUMMARY

- A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Horizontal Rack-mounted Power Protection
 - 2. Vertical Rack-mounted Power Protection
- 1.1 B. The University of Delaware utilized two types of Racks: 4-Post Distribution Racks located in MDFs and strategic locations and 2-Post Distribution and Access Racks.
- C. Related Requirements: Comply with following:
 - 1. Section 270500 – Common Work Results for Communications.
 - 2. Section 270526 – Grounding and Bonding for Communications.

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.
- 1.2

SUBMITTALS

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

PART 2 - PRODUCTS

2.1 RACK-MOUNTED POWER PROTECTION-20 AMP

- A. Receptacles:
 - 1. Rated: 20 amp
 - 2. Output: 120 VAC.
 - 3. Non-locking
- B. Input: 120 VAC.
- C. Rack-mountable without protruding into equipment space.
- D. UL1499 let through rating 330V - UL Verified
- E. AC suppression surge current rating 96,000 amps min.
- F. AC suppression joule rating 3840 joules AC suppression.
- G. Conforms to IEE 587 / ANSI C62.41
- 2.2 H. Include at least (15 foot) power cord with twist-lock plug
- I. Acceptable Manufacturers:
 - 1. Tripp-Lite-ISO BAR
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

RATED RACK-MOUNTED POWER PROTECTION-30 AMP

- A. Receptacles:
 - 1. Rated: 30 amp
 - 2. Output: 120 VAC.
 - 3. Non-locking
- B. Input: 120 VAC.

- C. 70 Inch-Rack-mountable without protruding into equipment space.
- D. UL1499 let through rating 330V - UL Verified
- E. AC suppression surge current rating 96,000 amps min.
- F. AC suppression joule rating 3840 joules AC suppression.
- G. Conforms to IEE 587 / ANSI C62.41
- H. Include at least (15 foot) power cord with twist-lock plug
- I. Acceptable Manufacturers:
 - 1. Chatsworth Basic eConnect® PDU
 - 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

HORIZONTAL RACK-MOUNTED POWER PROTECTION

- 3.1 A. For 2-Post Distribution Rack;
 - 1. Provide and install two (2) Isobar #IBAR-12 rack mounted PDUs in the newly installed relay rack in Telecommunications Room XXX. Connect one PDU to Street Power receptacle and the other to the UPS receptacle as shown on drawings. All PDUs shall be installed at relay rack positions as defined in each telecommunications room relay rack drawing.
- B. For 2-Post Access Rack
 - 1. Provide and install one (1) Isobar #IBAR-12 rack mounted PDU in the newly installed relay rack in Telecommunications Room XXX. Connect the PDU to Street Power receptacle as shown on drawings. The PDU shall be installed at relay rack position as defined in each telecommunications room relay rack drawing.
- C. Mount so as to minimize obstruction of patch panels, housings, and rack-mount equipment.
- D. Coordinate final receptacle type and configuration with owner, architect, designer prior to purchase and installation.

3.2 VERTICAL RACK-MOUNTED POWER PROTECTION

- A. For 4-Post Distribution Rack;
 - 1. Provide and install two (2) Chatsworth eConnect® PDUs in the newly installed relay rack in Telecommunications Room XXX. Connect one PDU to Street Power receptacle and the other to the UPS receptacle as shown on drawings. All PDUs shall be installed at relay rack positions as defined in each telecommunications room relay rack drawing.
- B. Mount so as to minimize obstruction of patch panels, housings, and rack-mount equipment.
- C. Coordinate final receptacle type and configuration with owner, architect, designer prior to purchase and installation.

END OF SECTION

SECTION 271313
COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
1. Qualitative requirements for multi-pair backbone cables consisting of 22 AWG to 24 AWG thermoplastic insulated solid conductors that are formed into one or more units of balanced twisted pairs. For cables larger than 25 pairs, the units are assembled into binder groups of 25 pairs or part thereof following the industry color code. The groups are identified by distinctly colored binders and assembled to form the core. The core shall be covered by a protective sheath. The sheath consists of an overall thermoplastic jacket and may contain an underlying metallic shield and one or more layers of dielectric material applied over the core.
 2. Minimum requirements for cable installations for connecting communications rooms (TR, MTR, ER, EF). Includes backbone transmission media between these locations. Installed in star topology with first-level backbone cables beginning at main cross-connect (MC).
- B. Backbone:
1. Intra-building copper cables (indoor) between various communications rooms (TR, MTR, ER, EF).
 2. Inter-building copper cable (outdoor) between various EF or between an EF and an OSP device or termination point.
 3. Routes: Approved by Owner's Representative prior to installation.
- C. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
1. Category 6 Cable.
 2. Category 6A Cable.
- D. Related Requirements:
1. Section 270500 – Common Work Results for Communications.
 2. Section 270526 – Grounding and Bonding for Communications.
 3. Section 270553 – Identification for Communications Systems.
 4. Section 270700 – Communications Testing
 5. Section 271113 – Communications Entrance Protection
 6. Section 271119 – Communications Termination Blocks and Patch Panels

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of the following for the design, materials, fabrication, and installation of component parts:
1. ANSI/ICEA S-80-576.
 2. ANSI/ICEA S-84-608.
 3. ISO/IEC 11801.

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data: Submit product data for each type of cable to be installed including but not limited to physical dimensions, configurations, construction and performance specifications
- C. Product Samples: As required.

PART 2 - PRODUCTS

CATEGORY 6 CABLE

A. General: General requirements for category 6 cable.

1. Only four-pair horizontal cable is recognized for use in Category 6 backbone cabling.
2. Plenum [Non-plenum], indoor [outdoor], non-armored [armored] Category 6 copper cable recommended for use by the manufacturer for the specific application (i.e. aerial, direct burial, underground, etc.) and as required by the NEC Article 800.
3. Conductor size: 22 AWG to 24 AWG.
4. Conductor insulation color coded in accordance with ANSI/ICEA S-80-576.
5. Jacket: The core shall be enclosed by a uniform, continuous thermoplastic jacket.
6. Jacket type: FEP [PVC].

2.1

B. Transmission Characteristics (Channel):

1. Resistance of any Conductor, ASTM D4566: Shall not exceed 9.38 ohms per 100 m [(328 ft.)] at 20°C.
2. DC Resistance Unbalance between Two Conductors of any Pair, ASTM D4566: Shall not exceed 5 percent at 20°C.
3. Mutual Capacitance of any Backbone Cable Pair at 1 kHz, ASTM D4566: Shall not exceed 5.6 nF per 100 m [(328 ft.)] at 20°C.
4. Maximum Capacitance Unbalance of any Backbone Cable Pair at 1 kHz, ASTM D4566: Shall not exceed 330 pF per 100 m [(328 ft.)] at 20°C.
5. [Minimum channel Return Loss at 20°C ± 3°C: Meet or exceed following, worst pair:

Frequency (MHz)	Return Loss (dB/100m)
1.00	19.0
4.00	19.0
8.00	19.0
10.00	19.0
16.00	18.0
20.00	17.5
25.00	17.0
31.25	16.5
62.50	14.0
100.00	12.0
200.00	9.0
250.00	8.0

6. Maximum Insertion Loss (Attenuation): Meet or exceed following, worst pair:

Frequency (MHz)	Insertion Loss (dB/100m)
1.00	2.1
4.00	4.0
8.00	5.7
10.00	6.3
16.00	8.0
20.00	9.0
25.00	10.1

31.25	11.4
62.50	16.5
100.00	21.3
200.00	31.5
250.00	35.9

7. Minimum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	65.0
4.00	63.0
8.00	58.2
10.00	56.6
16.00	53.2
20.00	51.6
25.00	50.0
31.25	48.4
62.50	43.4
100.00	39.9
200.00	34.8
250.00	33.1

8. Minimum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	74.3
4.00	65.3
8.00	60.8
10.00	59.3
16.00	56.2
20.00	54.8
25.00	53.3
31.25	51.9
62.50	47.4
100.00	44.3
200.00	39.8
250.00	38.3

9. Minimum Power Sum Near End Crosstalk (PSNEXT) Loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSNEXT (dB/100m)
1.00	62.0
4.00	60.5
8.00	55.6
10.00	54.0
16.00	50.6
20.00	49.0
25.00	47.3
31.25	45.7
62.50	40.6
100.00	37.1
200.00	31.9
250.00	30.2

10. Minimum Power Sum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	72.3
4.00	63.3
8.00	58.8
10.00	57.3
16.00	54.2
20.00	52.8
25.00	51.3
31.25	49.9
62.50	45.4
100.00	42.3
200.00	37.8
250.00	36.3

11. Minimum ACRF at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	ACRF (dB/100m)
1.00	63.3
4.00	51.2
8.00	45.2
10.00	43.3
16.00	39.2
20.00	37.2
25.00	35.3
31.25	33.4

62.50	27.3
100.00	23.3
200.00	17.2
250.00	15.3

12. Minimum ACRF at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	ACRF (dB/100m)
1.00	67.8
4.00	55.8
8.00	49.7
10.00	47.8
16.00	43.7
20.00	41.8
25.00	39.8
31.25	37.9
62.50	31.9
100.00	27.8
200.00	21.8
250.00	19.8

13. Minimum PSACRF at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSACRF (dB/100m)
1.00	60.3
4.00	48.2
8.00	42.2
10.00	40.3
16.00	36.2
20.00	34.2
25.00	32.3
31.25	30.4
62.50	24.3
100.00	20.3
200.00	14.2
250.00	12.3

14. Minimum PSACRF at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	PSACRF (dB/100m)
1.00	64.8

4.00	52.8
8.00	46.7
10.00	44.8
16.00	40.7
20.00	38.8
25.00	36.8
31.25	34.9
62.50	28.9
100.00	24.8
200.00	18.8
250.00	16.8

15. Minimum TCL at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	TCL (dB/100m)
1.00	40.0
4.00	40.0
8.00	36.5
10.00	35.0
16.00	31.9
20.00	30.5
25.00	29.0
31.25	27.6
62.50	23.1
100.00	20.0
200.00	15.5
250.00	14.0

16. Minimum ELTCTL at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	ELTCTL (dB/100m)
1.00	30.0
4.00	18.0
8.00	11.9
10.00	10.0
16.00	5.9
20.00	5.0
25.00	2.0
31.25	n/s
62.50	n/s
100.00	n/s

200.00	n/s
250.00	n/s

17. Maximum Propagation Delay at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	Propagation Delay (ns)
1.00	580
4.00	562
8.00	557
10.00	555
16.00	553
20.00	552
25.00	551
31.25	550
62.50	549
100.00	548
200.00	547
250.00	546

18. Maximum Propagation Delay at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	Propagation Delay (ns)
1.00	570
4.00	552
8.00	547
10.00	545
16.00	543
20.00	542
25.00	541
31.25	540
62.50	539
100.00	538
200.00	537
250.00	536

2.2

C. Acceptable Manufacturers:

1. Belden.
2. Siemon.
3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

CATEGORY 6A CABLE

A. General: General requirements for category 6A cable.

1. Only four-pair horizontal cable is recognized for use in Category 6A backbone cabling.

2. Plenum [Non-plenum], indoor [outdoor], non-armored [armored] Category 6A copper cable recommended for use by the manufacturer for the specific application (i.e. aerial, direct burial, underground, etc.) and as required by the NEC Article 800.
 3. Conductor size: 22 AWG to 24 AWG.
 4. Conductor insulation color coded in accordance with ANSI/ICEA S-80-576.
 5. Jacket: The core shall be enclosed by a uniform, continuous thermoplastic jacket.
 6. Jacket type: FEP [PVC].
- B. Transmission Characteristics (Channel):
1. Resistance of any Conductor, ASTM D4566: Shall not exceed 9.38 ohms per 100 m [(328 ft.)] at 20°C.
 2. DC Resistance Unbalance between Two Conductors of any Pair, ASTM D4566: Shall not exceed 4 percent at 20°C.
 3. Mutual Capacitance of any Backbone Cable Pair at 1 kHz, ASTM D4566: Shall not exceed 5.6 nF per 100 m [(328 ft.)] at 20°C.
 4. Maximum Capacitance Unbalance of any Backbone Cable Pair at 1 kHz, ASTM D4566: Shall not exceed 330 pF per 100 m [(328 ft.)] at 20°C.
 5. [Minimum channel Return Loss at 20°C ± 3°C: Meet or exceed following, worst pair:

Frequency (MHz)	Return Loss (dB/100m)
1.00	19.0
4.00	19.0
8.00	19.0
10.00	19.0
16.00	18.0
20.00	17.5
25.00	17.0
31.25	16.5
62.50	14.0
100.00	12.0
200.00	9.0
250.00	8.0
300.00	7.2
400.00	6.0
500.00	6.0

6. Maximum Insertion Loss (Attenuation): Meet or exceed following, worst pair:

Frequency (MHz)	Insertion Loss (dB/100m)
1.00	2.3
4.00	4.2
8.00	5.8
10.00	6.5
16.00	8.2
20.00	9.2
25.00	10.2

31.25	11.5
62.50	16.4
100.00	20.9
200.00	30.1
250.00	33.9
300.00	37.4
400.00	43.7
500.00	49.3

7. Minimum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	65.0
4.00	63.0
8.00	58.2
10.00	56.6
16.00	53.2
20.00	51.6
25.00	50.0
31.25	48.4
62.50	43.4
100.00	39.9
200.00	34.8
250.00	33.1
300.00	31.7
400.00	28.7
500.00	26.1

8. Minimum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	74.3
4.00	65.3
8.00	60.8
10.00	59.3
16.00	56.2
20.00	54.8
25.00	53.3
31.25	51.9
62.50	47.4
100.00	44.3

200.00	39.8
250.00	38.3
300.00	37.1
400.00	35.3
500.00	33.8

9. Minimum Power Sum Near End Crosstalk (PSNEXT) Loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSNEXT (dB/100m)
1.00	62.0
4.00	60.5
8.00	55.6
10.00	54.0
16.00	50.6
20.00	49.0
25.00	47.3
31.25	45.7
62.50	40.6
100.00	37.1
200.00	31.9
250.00	30.2
300.00	28.8
400.00	25.8
500.00	23.2

10. Minimum Power Sum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	72.3
4.00	63.3
8.00	58.8
10.00	57.3
16.00	54.2
20.00	52.8
25.00	51.3
31.25	49.9
62.50	45.4
100.00	42.3
200.00	37.8
250.00	36.3

300.00	35.1
400.00	33.3
500.00	31.8

11. Minimum ACRF at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	ACRF (dB/100m)
1.00	63.3
4.00	51.2
8.00	45.2
10.00	43.3
16.00	39.2
20.00	37.2
25.00	35.3
31.25	33.4
62.50	27.3
100.00	23.3
200.00	17.2
250.00	15.3
300.00	13.7
400.00	11.2
500.00	9.3

12. Minimum ACRF at 20°C ± 3°C for cables [(328 ft.)] (100 m) or longer: Meet or exceed following:

Frequency (MHz)	ACRF (dB/100m)
1.00	67.8
4.00	55.8
8.00	49.7
10.00	47.8
16.00	43.7
20.00	41.8
25.00	39.8
31.25	37.9
62.50	31.9
100.00	27.8
200.00	21.8
250.00	19.8
300.00	18.3
400.00	15.8
500.00	13.8

13. Minimum PSACRF at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSACRF (dB/100m)
1.00	60.3
4.00	48.2
8.00	42.2
10.00	40.3
16.00	36.2
20.00	34.2
25.00	32.3
31.25	30.4
62.50	24.3
100.00	20.3
200.00	14.2
250.00	12.3
300.00	10.7
400.00	8.2
500.00	6.3

14. Minimum PSACRF at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	PSACRF (dB/100m)
1.00	64.8
4.00	52.8
8.00	46.7
10.00	44.8
16.00	40.7
20.00	38.8
25.00	36.8
31.25	34.9
62.50	28.9
100.00	24.8
200.00	18.8
250.00	16.8
300.00	15.3
400.00	12.8
500.00	10.8

15. Minimum TCL at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	TCL (dB/100m)
1.00	40.0
4.00	40.0
8.00	36.5
10.00	35.0
16.00	31.9
20.00	30.5
25.00	29.0
31.25	27.6
62.50	23.1
100.00	20.0
200.00	15.5
250.00	14.0
300.00	12.8
400.00	11.0
500.00	9.5

16. Minimum ELTCTL at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	ELTCTL (dB/100m)
1.00	30.0
4.00	18.0
8.00	11.9
10.00	10.0
16.00	5.9
20.00	5.0
25.00	2.0
31.25	n/s
62.50	n/s
100.00	n/s
200.00	n/s
250.00	n/s
300.00	n/s
400.00	n/s
500.00	n/s

17. Maximum Propagation Delay at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	Propagation Delay (ns)
1.00	580
4.00	562

8.00	557
10.00	555
16.00	553
20.00	552
25.00	551
31.25	550
62.50	549
100.00	548
200.00	547
250.00	546
300.00	546
400.00	546
500.00	546

18. Maximum Propagation Delay at 20°C ± 3°C for cables 100 m [(328 ft.)] or longer: Meet or exceed following:

Frequency (MHz)	Propagation Delay (ns)
1.00	570
4.00	552
8.00	547
10.00	545
16.00	543
20.00	542
25.00	541
31.25	540
62.50	539
100.00	538
200.00	537
250.00	536
300.00	536
400.00	536
500.00	536

19. Minimum average PSANEXT loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSANEXT (dB/100m)
1.00	67.0
4.00	67.0
8.00	67.0
10.00	67.0
16.00	67.0

20.00	67.0
25.00	67.0
31.25	67.0
62.50	64.3
100.00	62.3
200.00	57.7
250.00	56.3
300.00	55.1
400.00	53.2
500.00	51.8

20. Minimum PSAACRF loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSAACRF (dB/100m)
1.00	67.0
4.00	65.0
8.00	58.9
10.00	57.0
16.00	52.9
20.00	51.0
25.00	49.0
31.25	47.1
62.50	41.1
100.00	37.0
200.00	31.0
250.00	29.0
300.00	27.5
400.00	25.0
500.00	23.0

21. Minimum average PSAACRF loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSAACRF (dB/100m)
1.00	67.0
4.00	67.0
8.00	62.9
10.00	61.0
16.00	56.9
20.00	55.0
25.00	53.0
31.25	51.1

62.50	45.1
100.00	41.0
200.00	35.0
250.00	33.0
300.00	31.5
400.00	29.0
500.00	27.0

C. Acceptable Manufacturers:

1. Belden-Mohawk Cable Corp. #M59198, LanTrak OSP - 4-Pair, outside/underground duct rated, user-friendly cream-like gel, CAT6A cable for Campus or Emergency Phones located in the outside environment.
2. Belden-Mohawk Cable Corp. #M59202 – Versalan – 4-Pair, CMR, outside/aerial/above-ground rated NON-FLOODED, CAT6A cable. Not meant for underground duct where extended water intrusion may occur or extended exposure to water in direct burial environment.
3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

BACKBONE CABLE INSTALLATION

- 3.1 A. Prior to installation, physically inspect cable for damage to the jacket. Inspect cable jacket as cable is removed from reel. Do not install cable with damaged jacket or shield.
- B. Comply with the manufacturer's installation instructions, BICSI Information Transport Systems Installation Manual and best industry practices.
- C. Cables may be installed in conduit, cable support system, or in cable hangers spaced a maximum of (4 to 5 feet) on center.
- D. Cables shall not lay on the ceiling or the ceiling support structure. Anchor cables to not interfere with other services or space access.
- E. Do not exceed the maximum allowed pulling tension per the manufacturer's installation instructions. Contractor is responsible for determining minimum bend radiuses for cable being placed, using manufacturer's latest information. The following minimum bend radius information is provided only as general guidance:
 1. Short Term No Load: 10 times outer diameter
 2. During Installation: 20 times outer diameter
 3. At Rest After Installation: 10 times outer diameter
- F. Bend radius for four-pair balanced twisted-pair cable shall be 4 times the outside diameter of the cable.
- G. After installation, the cable should be free from tension over the entire length of each run.
- H. Vertical Cable Runs: Use gravity to assist in cable placement.
 1. Start installation from top of run to bottom of run.
 2. Hand-pull if possible.
 3. If machine assistance is required, monitor tension and do not exceed manufacturer's specified cable tension limits.
- I. Ensure that existing conduits are clean and free of obstructions prior to pulling cable. Install ground bushings on conduits where required before pulling cable.
- J. Maximum supportable distances for balanced twisted-pair cabling applications:
 1. Voice Transmissions: (2624 ft.).
 2. Data Applications using Category 6 or 6A: (328 ft.).
- K. If deviations from the drawings are required, they shall be approved by Owner's Representative prior to placement of affected cables.

- L. Take precautions during installation to prevent cable from being kinked, crushed, or being mishandled. Mechanical stress placed upon cable during installation shall be such that cable is not twisted or stretched.
- M. Where copper backbone cable passes through vertical riser closet or TR secure fiber to wall vertically every (36 inches). Review fasteners, strain relief and routing with Owner's Representative.

TESTING

- A. Test all cables in accordance with Section 270700 – Communications Testing.

IDENTIFICATION

- 3.2 A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

3.3 FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 - Common Work Results for Communications.

3.4

BONDING AND GROUNDING

- 3.5 A. Bond and ground shielded cables in accordance with Section 270526 – Grounding and Bonding for Communications.

CONFINED SPACES AND SAFETY

- 3.6 A. For work performed in confined spaces, refer to Section 270542 – Communications Confined Spaces and Safety.

END OF SECTION

SECTION 271323

COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
 - 1. Qualitative requirements for installation of optical fiber backbone cables.
 - 2. Minimum requirements for cable installations for connecting communications room (TR, MTR, ER, EF). Includes backbone transmission media between these locations. Installed in star topology with first-level backbone cables beginning at main cross-connect (MC).
 - 3. All fiber optic cables, including inter-building and riser applications, shall be manufactured by Corning Cable Systems, and shall meet the below performance characteristics. Inter-building cables shall be ALTOS or FREEDM cables as indicated in the scope of work section, and riser cables shall be CMR or CMP rated as required.
- B. Backbone:
 - 1. Intra-building optical fiber cables (indoor) between various communications room (TR, MTR, ER, EF).
 - 2. Inter-building optical fiber cable (outdoor) between various EF or between an EF and an OSP device or termination point.
 - 3. Routes: Approved by Owner's Representative prior to installation.
- C. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Singlemode Optical Fiber Cable.
- D. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270526 - Grounding and Bonding for Communications.
 - 3. Section 270553 - Identification for Communications Systems.
 - 4. Section 270700 - Communications Testing
 - 5. Section 271119 - Communications Termination Blocks and Patch Panels
 - 6. Section 271323.13 - Communications Optical Fiber Splicing and Terminations

REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of the following for the design, materials, fabrication, and installation of component parts:
 - 1. ANSI/ICEA S-83-596.
 - 2. ANSI/ICEA S-87-640.
 - 3. Telcordia GR-20.
 - 4. ISO/IEC 11801.

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit product data for each type of cable to be installed including but not limited to physical dimensions, configurations, construction and performance specifications
- C. Product Samples: As required.

PART 2 - PRODUCTS

OPTICAL FIBER CABLE

- A. Fiber in Cable Run: From same manufacturer and same type. Mix of fibers from different manufacturers not allowed..

SINGLE-MODE OPTICAL FIBER CABLE

- A. Physical Characteristics – Single-mode - Indoor:

1. Plenum [Non-plenum], indoor [outdoor], non-armored [armored] single-mode optical fiber cable recommended for use by the manufacturer for the specific application (i.e. aerial, direct burial, underground, etc.) and as required by the NEC Article 800.
2. NEC OFNR/OFN [OFNP] Flame Rated, UL 1666.
3. Jacket type: FEP [PVC].
4. Optical fiber waveguide with nominal 8.3/125 μm core/cladding diameter.
5. Indoor:
 - Suitable for indoor installations.
 - Mechanical and environmental specifications for inside plant optical fiber cable shall be in accordance with ANSI/ICEA S-83-596.
 - Primary coating diameter of 900 μm tight buffer UV cured acrylate buffer material.

- a6. Outdoor:

- b. Suitable for outdoor installations.
- c. Mechanical and environmental specifications for outside plant optical fiber cable shall be in accordance with ANSI/ICEA S-87-640.
- a. Primary coating diameter of 250 μm , loose-tube, or 900 μm tight buffer UV cured acrylate buffer material. Tight buffer only used for outdoor applications in indoor/outdoor optical fiber cable.
- b. Indoor/Outdoor optical fiber cables shall contain water-swallowable yarn to protect from moisture.
- c. Indoor/Outdoor optical fiber cables shall contain water-swallowable yarn to protect from moisture.
- d. Indoor/Outdoor optical fiber cables shall contain water-swallowable yarn to protect from moisture.
7. Strength Members: Aramid yarn.
8. Include secondary thermoplastic type buffer over each fiber.
9. Individual fiber tube colors per ANSI/TIA-598-C and overall yellow jacket.
10. Include ripcord for overall jacket.
11. Suited for operation at (-4 to +158 degrees F).
12. Fiber: TIA-492CAAA.

- B. Transmission Characteristics - Single-mode:

1. Indoor: Maximum attenuation at 1310/1550 nm, dB/Km: 1.0/1.0.
2. Outdoor: Maximum attenuation at 1310/1550 nm, dB/Km: 0.4/0.4.
3. Class IVa Dispersion-Unshifted single-mode optical fibers, ANSI/EIA/TIA-492CAAA with fiber counts as indicated on drawings.
4. Zero Dispersion Wavelength: Between 1300 and 1324 nm.
5. ANSI/TIA-455-175-B Maximum Value of Dispersion Slope: No greater than 0.093 ps/km-nm².
6. Dispersion Measurements: TIA/EIA-455-169-B or ANSI/TIA-455-175-B.

- C. Hybrid Optical Fiber Cable: Multimode and single-mode strands of hybrid optical fiber cable shall meet above specifications for multimode and single-mode optical fiber cables respectively.

- D. Acceptable Manufacturers:

1. Corning Altos Cable with Binderless FastAccess Technology for outdoor use, part numbers for single-mode cable - XXXZU4-T4F22D20. (Replace XXX with fiber count 012, 024, 036, 048, 072). For fiber count 006 and 144, use part numbers 006EU4-T4701D20 and 144EU4-T4701D20. These two cables use FastAccess Technology, but are not Binderless, as they are not available in those counts.
2. Corning Freedom Cable for indoor/outdoor use, part numbers for single-mode cable – XXXEUF-T4101D20. (Replace XXX with fiber count 012, 024, 036, 048, 072, 144).
3. Corning Riser "MIC" armored (metallic) Cable for indoor use only, #XXXE81-33131-A1, single-mode fiber cable. (Replace XXX with fiber count 006, 012, 024, etc.)
4. Corning Plenum "MIC" armored (metallic) Cable for indoor use only, #XXXE88-31131-A3, single-mode fiber cable. (Replace XXX with fiber count 006, 012, 024, etc.)

5. Corning Plenum "MIC-DX" armored (dielectric) Cable for indoor use only, #XXX-E88-31131-D3, single-mode fiber cable. (Replace XXX with fiber count 006, 012, etc.). Note: This cable is only offered in plenum rated version, non-plenum is not an option.
6. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

OPTICAL FIBER CABLE INSTALLATION

- 3.1 A. Contractor's company shall be a participating member of the Corning Optical Communications Network of Preferred Installers (NPI) and that participation must be current. Contractor's company shall provide a current letter of endorsement from Corning detailing its Preferred Installer status. Said letter is to be offered at time of bid. Contractor performing the work within the following scope must be Corning Optical Communications trained, preferably Corning certified. If Contractor's individual performing the fiber work is not Corning certified, a Corning Optical Communications certified individual from the Contractors company must supervise the first 20% of the fiber terminations. The Corning Optical Communications-certified individual must submit a copy of their certification to Owner five (5) business days prior to coming on site. Certifications are only valid if they are less than one (1) year old from issuance. The required training course for Certification is the Corning Optical Communications Corning Fiber Installation (CFI) class.
- B. The contractor shall at all times install the fiber optic cable in complete accordance with the recommended practices of the cable manufacturer, and shall not exceed the tensile ratings, minimum bending radius or any other fiber cable installation restrictions of the manufacturer. Excessive pulling tensions that might damage the inter-building cable shall be avoided at all times. Bends of small radii and twists that might damage the inter-building cables shall be avoided at all times.
- C. Outdoor Installation:
 1. All equipment shall be secured plumb and square with consideration being given not only to operational efficiencies, but also to overall aesthetic factors.
 2. All exposed cable shall be prominently labeled with a securely fastened warning tag stating that the equipment contains fiber optic cable and is transmitting potentially hazardous wavelengths of light if broken or exposed. A stenciled or anodized label shall be applied to the fiber termination equipment denoting a like message.
 3. All fiber optic cable shall be prominently and permanently labeled at building entrance/exit and cable termination points with to and from destinations. The fiber count of each cable is to be included on the labels.
 4. There shall be a service loop created at each building entrance origination and destination point, which shall be no less than a 35 ft. coil. This applies to inter-building cables as well as riser cables. The exact location of each service loop shall be indicated within the Scope of Work section of this document.
 5. Upon completion of installation of fiber optic cable thru existing conduit and inner-duct, the contractor shall supply and install one (1) Tyco Corp. Simplex Plug around the cable and into the inner-duct at all maintenance hole and building entrance locations.
 6. The inter-building cable facilities must not be trampled upon, run over by vehicles, pulled along the ground, over fences, metal fittings, or cross-arms.
 7. All metallic shielded or metallic strength member cabling shall be properly grounded and bonded at the building entrances as per applicable sections of the National Electrical Code.
 8. During all placements, a breakaway swivel set for the appropriate short term tensile rating suggested by the manufacturer for the cable shall be employed. When using a winch, a clutch and dynamometer shall control and monitor the pulling power.
 9. The Contractor is to note that the term "loaded" is the minimum allowable bend radius for the cable during maximum tensile loads during installation, and that the term "unloaded" refers to the minimum allowable bend radius during residual installed tensile loads (after installation).

10. Every instance of damaged fiber optic cable observed at any time prior to installation, during installation, or after installation, shall be immediately called to the attention of the University. The method of repair or correction of such damage shall be in accordance with the University's written instructions. The Contractor shall promptly repair such damage or make such corrections accordingly.
11. In maintenance holes which have horizontal duct offsets, the Contractor shall ensure that sufficient cable guides are placed to allow for as straight a pull through as possible.
12. As the fiber optic cables are payed off the reel, the Contractor shall carefully inspect the cable assemblies for any and all jacket defects. The pulling operation shall stop immediately if any substantial defects are observed. The Contractor shall then inform the University of defects and will require the University's instructions on what corrective action shall be taken before continuing the placement operation.
13. The Contractor shall immediately stop all cable placement operations if the cable becomes bound, entangled, or in any way does not pay off freely from the reel. Upon notifying the University, the cause of the binding must be cleared to the University's satisfaction before continuing the pulling operation.
14. All regulations and procedures as set forth by the University Department of Occupational Health and Safety must be strictly adhered to when entering Confined Spaces, such as maintenance holes. Information and procedures for confined space entry can be found at www.udel.edu/ehs/generalhs/construction/confined-space.html

D. Indoor Installation:

1. Cables may be installed in conduit, cable support system, or in cable hangers spaced a maximum of (4 to 5 feet) on center.
2. Cables shall not lay on the ceiling or the ceiling support structure. Anchor cables to not interfere with other services or space access.
3. Do not exceed the maximum allowed pulling tension per the manufacturer's installation instructions. Contractor is responsible for determining minimum bend radiuses for cable being placed, using manufacturer's latest information. The following minimum bend radius information is provided only as general guidance:
 - a. Cable During Installation: 20 times outer diameter
 - b. At Rest After Installation: 10 times outer diameter
 - c. Indoor Cable with Four or fewer Fibers Intended to be Pulled through Pathways During Installation: (2 inch).
- a4. After installation, the cable should be free from tension over the entire length of each run.
- b5. Vertical Cable Runs: Use gravity to assist in cable placement.
 - c. Start installation from top of run to bottom of run.
 - Hand-pull if possible.
 - If machine assistance is required, monitor tension and do not exceed manufacturer's specified cable tension limits.
6. Ensure that existing conduits are clean and free of obstructions prior to pulling cable. Install ground bushings on conduits where required before pulling cable.
7. If deviations from the drawings are required, they shall be approved by customer's representative prior to placement of affected cables.
8. Take precautions during installation to prevent cable from being kinked, crushed, or being mishandled. Mechanical stress placed upon cable during installation shall be such that cable is not twisted or stretched.
 - a. Cable shall be one continuous run of fiber unless otherwise specified.
- b10. For fiber runs, leave 10 ft. minimum service loop at communications room (TR, MTR, ER, EF) end.
11. Contractor: Responsible for verifying actual footages and distances identified on attached prints (i.e. wall-to-wall, pullbox-to-pullbox and ER to TR).
 - Responsible for verifying that conduits and raceways are ready for occupancy before cable placement.
 - Assume responsibility for difficulties or damage to cable during placement.

12. Where fiber optic cable passes through vertical riser closet or TR secure fiber to wall vertically every (36 inch]. Review fasteners, strain relief and routing with Owner's Representative.

TERMINATION OF FIBER OPTIC CABLING

- 3.2 A. The Contractor shall perform all terminations of the fiber optic cable at terminal points.
- B. All cables terminating in Corning WCH products shall be installed according to the most current Corning Corporation Standard Recommended Procedures (SRP's). A minimum of 6 ft. of color coded buffer tubing or fibers must be prepped into the WCH products shall be installed from top to bottom, back to front, as per standard buffer tube color coded sequence.
- C. All cables terminating in Corning CCH products shall be installed according to recommended practices, and have a minimum 6 ft. of color coded fiber prepped in the CCH.
- D. All fiber optic cable entering or leaving any and all fiber terminal equipment shall be securely fastened thereto and dust sealed.

TESTING

- A. Test all cables in accordance with Section 270700 – Communications Testing.

3.3 IDENTIFICATION

- 3.4 A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

FIRESTOPPING

- 3.5 A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 – Common Work Results for Communications.

3.6 BONDING AND GROUNDING

- A. Bond and ground armored cables in accordance with section 270526 – Grounding and Bonding for Communications.

3.7

CONFINED SPACES AND SAFETY

- A. For work performed in confined spaces, refer to section 270542 – Communications Confined Spaces and Safety.

END OF SECTION

SECTION 271323.13

COMMUNICATIONS OPTICAL FIBER SPLICING AND TERMINATIONS

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
 - 1. Qualitative requirements for splicing and termination of fiber backbone/tie cables.
 - 2. Minimum requirements for optical fiber splicing and termination equipment of cable installations for connecting communications rooms (TR, MTR, ER, EF).
- 1.1 B. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Optical Fiber Splice Closures.
 - 2. Optical Fiber Splice Hardware.
 - 3. Optical Fiber Termination Hardware.
- C. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270526 – Grounding and Bonding for Communications.
 - 3. Section 271119 – Communications Termination Blocks and Patch Panels.
 - 4. Section 271543 – Communications Faceplates and Connectors.

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 and Section 270500.

SUBMITTALS

- 1.3 A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Product Samples: As required.

2.1 PART 2 - PRODUCTS

OPTICAL FIBER SPLICE CLOSURES

- A. For Cross-connection, Interconnection, Splicing and Fiber Identification: Provide for designated racks.
- B. Meet or exceed all TIA/EIA-568-C.3 Optical Fiber Cabling Components Standard requirements.
- C. UL Listed.
- D. Rack-mountable.

FIBER TERMINATION AND INTERCONNECT ENCLOSURES

- 1. Corning Cable Systems #SPH-01P, single panel housing.
- 2. Corning Cable Systems #CCH-01U, #CCH-02U, #CCH-03U, #CCH-04U, Closet Connector Housing, with a capacity of 2, 4, 6, or 12 CCH connector panels or cassettes.
- 3. Corning Cable Splice Tray, reduced length, 12 fibers for splicing pigtails in WCH-12P.

FIBER CONNECTOR PANELS AND CASSETTES

- 1. Corning Cable Systems #CCH-CS12-6C-P00RE – 12 fiber SC APC Simplex, Single-Mode (OS2), single-mode fiber (250um).
- 2. Corning Cable Systems #CCH-CS12-59-P00RE – 12 fiber SC UPC Duplex, Single-Mode (OS2), single-mode fiber (250um).
- 3. Corning Cable Systems #CCH-CS12-A9-P00RE – 12 fiber LC UPC Duplex, Single-Mode (OS2), single-mode fiber (250um).

4. Corning Cable Systems #CCH-CS24-A9-P00RE – 24 fiber LC UPC Duplex, Single-Mode (OS2), single-mode fiber (250um).
 5. Corning Cable Systems #CCH-CS – Corning CCH Cassette, Empty, for splicing.
 6. Corning Cable Systems #CCH-CP06-59 - Connector Panel for CCH Closet Connector Housing, with a capacity of six (6) SC compatible connectors and sleeves for the termination of single mode fibers.
 7. Corning Cable Systems #CCH-CP12-59 – Connector panel for CCH Closet Connector Housing, with a capacity of twelve (12) SC compatible connectors and sleeves for the termination of single mode fibers.
 8. Corning Cable Systems #CCH-CP06-3C – Connector panel for CCH Closet Connector Housing, with a capacity of six (6) SC compatible connectors and sleeves for the termination of single mode fibers.
 9. Corning Cable Systems #CCH-CP12-3C - Connector panel CCH Closet Connect Housing, with a capacity of twelve (12) SC compatible connectors and sleeves for the termination of single mode fibers.
- G. Shelf: Protect from mechanical stress on cable and fibers, and from macro-bending losses.
1. Accessible from front and rear. Unit may slide out to allow access from top.
- H. FIBER SPLICE CASES
1. 3M Corp. #2178S (Small) Splice Case. Install two (2) 3M Corp. #2522 Small Fiber Splice Tray Organizers, and four (4) 3M Corp. #2521-F Fusion Splice Inserts (2 in each tray). Utilize 3M Corp. #2170 Fiber Optic Splice Sleeves for all fiber splices. Total splicing capacity in this configuration for this splice case = 48 fusion splices.
 2. 3M Corp. #2178LS, (Large) Splice Case. Install five (5) 3M Corp. #2522 Small Fiber Splice Tray Organizers, and ten (10) 3M Corp. #2521-F Fusion Splice Inserts (2 in each tray). Utilize 3M Corp. #2170 Fiber Optic Splice Sleeves for al fiber splices. Total splicing capacity in this configuration for this splice case = 120 fusion splices.
 3. 3M Corp. Cable Addition Kit(s) 2181-LS, for multiple entry and butt splices, if required.
 4. 3M Corp. #2178-XSB, Butt-type splice case, with short lid and three cable entry points.
 5. 3M Corp. #2178-XLB-B-02-01G-00N, Butt-type splice case, with large lid and three cable entry points.
 6. 3M Corp. #2532 Fiber Splice Organizer Tray, to be used with #2178-XSB and #2178-XLB butt-type splice cases.
 7. 3M Corp. #2181-XB Cable Addition Kit, for use with #2178-XSB and #2178-XLB butt-type splice cases, allowing for three additional cable ports.
- I. FIBER CABLE INNERDUCT PLUGS
1. Tyco Corp. #JM-SIM-10S035S – For use in 1" inner-ducts used for routing of cables with an O.D. of .20-.35.
 2. Tyco Corp. #JM-SIM-10S057SB – For use in 1" inner-ducts used for routing of cables with an O.D. of .35-.57.
 3. Tyco Corp. #JM-SIM-10S070SB – For use in 1" inner-ducts used for routing of cables with an O.D. of .51-.71.
 4. Tyco Corp. #JM-SIM-12S057SB – For use in 1-1/4" inner-ducts used for routing of cables with an O.D. of .35-.57.
 5. Tyco Corp. #JM-SIM-12S070SB – For use in 1-1/4" inner-ducts used for routing of cables with an O.D. of .51-.71.
 6. Tyco Corp. #JM-SIM-12S090SB – For use in 1-1/4" inner-ducts used for routing of cables with an O.D. of .71-.90.
- J. INNERDUCT ORGANIZER PLUG, required riser conduit for four (4) 1" Innerduct installation – Tyco (Jackmoon) Inc. #DPJM40Q142S
- K. Acceptable Manufacturers:
1. Corning.
 2. Siemon.
 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures

OPTICAL FIBER SPLICE HARDWARE

- A. FIBER FAN-OUT KITS AND SPLICE TRAYS
 - 1. 6-Fiber Fan-out Kit, 36", Corning Cable Systems #FAN-BT-36-06
 - 2. 12-Fiber Fan-out Kit, 36", Corning Cable Systems #FAN-BT-36-12
 - 3. 12-Fiber Splice Tray #M67-060
- 2.2 B. Fusion Splice Sleeves:
 - 1. Fusion splice sleeves shall be transparent plastic tube designed to prevent stress and protect fusion fiber optic splices in field.
- C. Acceptable Manufacturers:
 - 1. Corning.
 - 2. 3M
 - 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures

OPTICAL FIBER TERMINATION HARDWARE

- 2.3 A. Fiber Optic Pigtail:
 - 1. Optical Fiber Pigtail shall be compatible with optical fiber to which it is spliced (for fiber specifications see Section 271323 – Communications Optical Fiber Backbone Cabling). Also, optical fiber connectors shall be in accordance with Section 271543 – Communications Faceplates and Connectors.
 - 2. Acceptable Manufacturers:
 - Corning.
 - Siemon.
 - a. Accepted Substitute in accordance with Section 012500 - Substitution
 - b. Procedures.
 - c.
- B. Fiber Optic Patch Panel
 - 1. Provide labels for each cable in accordance with Section 270553 – Identification for Communications Systems.
 - 2. All equipment shall be secured plumb and square with consideration being given not only to operational efficiencies, but also to overall aesthetic factors.
- C. Fiber Optic Connector:
 - 1. See Section 271543 – Communications Faceplates and Connectors.

3.1 PART 3 - EXECUTION

INSTALLATION

- A. Terminate optical fiber backbone cables with connectors specified in section 271543 Communications Faceplates and Connectors.
- B. Route cables and fiber strands in a neat and orderly manner.
- 3.2 C. Terminate and splice all fibers in accordance with industry standards and manufacturer's written instructions.
- D.

3.3

TESTING

- A. Test all cables in accordance with Section 270700 – Communications Testing.
- 3.4 B. Pressure test all OSP splice enclosures per manufacturer's instructions.

IDENTIFICATION

- A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

BONDING AND GROUNDING

- A. Bond and ground armored cables in accordance with section 270526 – Grounding and Bonding for Communications.

END OF SECTION

SECTION 271333
COMMUNICATIONS COAXIAL BACKBONE CABLING

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
1. Qualitative requirements for installation of coaxial backbone/tie cables.
 2. Minimum requirements for cable installations for connecting communications room (TR, MTR, ER, EF). Includes backbone transmission media between these locations. Installed in home run or trunk and tap topology with first-level backbone cables beginning at headend located at main equipment room(ER).
- 1.1
- B. Backbone:
1. Intra-building coaxial cables (indoor) between various communications room (TR, MTR, ER, EF).
 2. Inter-building coaxial cable (outdoor) between various EF or between an EF and an OSP device or termination point.
 3. Routes: Approved by Owner's Representative prior to installation.
- C. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
1. Series 11 Coaxial Cable.
- D. Related Requirements: Comply with following:
1. Section 270500 - Common Work Results for Communications.
 2. Section 270526 - Grounding and Bonding for Communications.
 3. Section 271333.13 - Communications Coaxial Splicing and Terminations.

1.2 **REFERENCES**

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit product data for each type of coaxial cable to be installed including but not limited to physical dimensions, configurations, construction and performance specifications.
- 2.1 C. Product Samples: As required.

PART 2 - PRODUCTS

SERIES 11 COAXIAL CABLE

- A. For RISER application, the cable to be used shall be Belden RG11 type quad shield #1617R cable is required.
- B. ^aFor PLENUM application, the cable to be used shall be Belden RG11 type quad shield #7999AP ^ccable is required. ^d
- C. Riser Rated:
- ^a1. Physical Characteristics:
 - ^bCMR rated, as required by the NEC Article 800.
 - Conductor: 14 AWG, solid with foam dielectric of (0.280 inches).
 - Shield: Aluminum foil and 60 percent Aluminum braid.
 - Overall Diameter of Cable: Equal to or less than (0.395 inches).
 2. Transmission Characteristics:
 - Nominal Capacitance: Equal to or better than (16.0 pF/ft.).
 - Nominal Impedance: 75 ohms.

Nominal Attenuation: Equal to or less than following:

c.

RG-11 Frequency (MHz)	Max. Attenuation (dB/100m)
1	0.62
10	1.51
50	3.01
100	4.13
200	5.87
400	8.30
700	11.29
900	13.09
1000	13.88

D. Plenum Rated:

1. Physical Characteristics:

CMP rated, as required by the NEC Article 800.

Conductor: 14 AWG, solid with foam FEP dielectric of (0.280 inches).

a.

Shield: Aluminum foil and 60 percent Aluminum braid.

b.

Overall Diameter of Cable: Equal to or less than (0.351 inches).

c.

d2. Transmission Characteristics:

Nominal Capacitance: Equal to or better than (16.0 pF/ft.).

a.

Nominal Impedance: 75 ohms.

b.

Nominal Attenuation: Equal to or less than following:

c.

RG-6 Frequency (MHz)	Max. Attenuation (dB/100m)
1	0.49
10	1.54
50	3.58
100	5.22
200	7.71
400	11.55
700	16.21
900	19.00
1000	20.31

a.

b.

3.1

3. Acceptable Manufacturers:

Belden.

Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

COAX COPPER CABLE

A. Install one (1) RG11 riser cable from TR-XX to TR-XX.

B. Install one (1) RG11 riser cable from TR-XX to TR-XX.

- C. Prior to installation, physically inspect cable for damage to the jacket. Inspect cable jacked as cable is removed from the reel. Do not install cable with damaged jacket or shield.
- D. Comply with the manufacturer's installation instructions, BICSI Information Transport Systems Installation Manual and best industry practices.
- E. The contractor shall at all times install the coaxial cable in complete accordance with the recommended practices of the cable manufacturer, and shall not exceed the tensile ratings, minimum bending radius or any other coaxial cable installation restrictions of the manufacturer. Excessive pulling tensions that might damage the inter-building cable shall be avoided at all times. Bends of small radii and twists that might damage the inter-building cables shall be avoided at all times.
- F. All equipment shall be secured plumb and square with consideration being given not only to operational efficiencies, but also to overall aesthetic factors.
- G. Upon completion of the installation of coax cable thru existing conduit and inner-duct, the contractor shall install one (1) Tyco Corp. Simplex Plug around the cable and into the inner-duct at all maintenance hole and building entrance locations.
- H. The inter-building cable facilities must not be trampled upon, run over by vehicles, pulled along the ground, over fences, metal fittings, or cross-arms.
- I. All metallic shielded or metallic strength member cabling shall be properly grounded and bonded at the building entrances as per applicable sections of the National Electrical Code.
- J. During all placements, a breakaway swivel set for the appropriate short term tensile rating suggested by the manufacture for the cable shall be employed. When using a winch, a clutch and dynamometer shall control and monitor the pulling power.
- K. The Contractor is to note that the term "loaded" is the minimum allowable bend radius for the cable during maximum tensile loads during installation, and that the term "unloaded" refers to the minimum allowable bend radius during residual installed tensile loads (after installation).
- L. All splicing and terminations of the coaxial riser cable will be performed by the University of Delaware.
- M. Cables may be installed in conduit, cable support system, or in cable hangers (4 to 5 feet) on center.
- N. Cables shall not lay on the ceiling or the ceiling support structure. Anchor cables to not interfere with other services or space access.
- O. Do not exceed the maximum allowed pulling tension per the manufacturer's installation instructions. Contractor is responsible for determining minimum bend radiuses for cable being placed, using manufacturer's latest information.
- P. After installation, the cable should be free from tension over the entire length of each run.
- Q. Ensure that existing conduits are clean and free of obstructions prior to pulling cable. Install ground bushings on conduits where required before pulling cable.
- R. If deviations from the drawings are required, they shall be approved by an UD NSS Representative prior to placement of affected cables.
- 3.2 S. Take precautions during installation to prevent cable from being kinked, crushed, or being mishandled. Mechanical stress placed upon cable during installation shall be such that cable is not twisted or stretched.
- 3.3 T. Where coaxial backbone cable passes through vertical riser secure fiber to wall vertically every (36 inch). Review fasteners, strain relief and routing with Owner's Representative.

TESTING

- A. Test all cables in accordance with Section 270700 – Communications Testing.

IDENTIFICATION

- A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 - Common Work Results for Communications.

BONDING AND GROUNDING

- 3.4 A. Bond and ground shielded cables in accordance with section 270526 – Grounding and Bonding for Communications.

CONFINED SPACES AND SAFETY

- 3.5 A. For work performed in confined spaces, refer to section 270542 – Communications Confined Spaces and Safety.

- 3.6 **END OF SECTION**

SECTION 271513
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
 - 1. Minimum requirements for horizontal copper twisted pair cabling.
- B. Horizontal Cabling:
 - 1. Telecom:
 - 1.1 Horizontal copper twisted pair cabling for project shall consist of that portion of telecommunication cabling system that extends from the work area outlet (WAO) to the communications room (TR, MTR, ER, EF).
Telecom horizontal cabling for project shall use conventional hierarchical star topology that home runs cables, from the communications room (TR, MTR, ER, EF) to the WAO locations.
 - a. 2. Use point-to-point cable runs as indicated on drawings.
- C. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Category 6A UTP Cable.
- D. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 274100 - Common Work Results for Audiovisual Systems and Equipment.
 - 3. Section 270526 - Grounding and Bonding for Communications.
 - 4. Section 270553 - Identification for Communications Systems.
 - 5. Section 270700 - Communications Testing
 - 6. Section 271119 - Communications Termination Blocks and Patch Panels.

1.2 REFERENCES

- A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit product data for each type of cable to be installed including but not limited to physical dimensions, configurations, construction and performance specifications
- 2.1 C. Product Samples: As required.

PART 2 - PRODUCTS

CATEGORY 6A UTP CABLE

- A. Physical Characteristics:
 - a. 1. Plenum [Non-plenum], indoor [outdoor] Category 6A copper cable as required by the NEC
 - b. Article 800.
 - c. Pairs: 4.
 - d. 2. Conductor Size: 22 AWG to 24 AWG.
 - 3. Color Coding of Pairs:
 - Pair 1: W-BL; BL.
 - Pair 2: W-O; O.
 - Pair 3: W-G; G.
 - Pair 4: W-BR; BR.

5. Comply with ANSI/ICEA S-90-661-2002 for mechanical performance requirements, testing and testing methods.
 6. Maximum Cable Diameter: 9.0 mm [(0.354 in)].
 7. Ultimate Breaking Strength, ASTM D4565: 400 N [(90 lbf)] minimum.
 8. Cold Bend Radius, ASTM D4565: 4 times cable diameter minimum at -20°C ± 1°C without jacked or insulation cracking.
 9. Jacket type: FEP [PVC].
 10. Labeled and third party verified category 6A cables.
- B. Transmission Characteristics:
1. DC Resistance of any Conductor, ASTM D4566: Shall not exceed 9.38 Ohms per 100 m [(328 ft.)] at 20°C.
 2. DC Resistance Unbalance Between any Two Conductors of any Pair, ASTM D4566: Not exceed 4 percent at 20°C.
 3. Mutual Capacitance at 1 kHz, ASTM D4566: Shall not exceed 5.6 nF per 100 m [(328 ft.)] at 20°C.
 4. Capacitance Unbalance, Pair-To-Ground, at 1 kHz, ASTM D4566: Shall not exceed 330 pF per 100 m [(328 ft.)] at 20° C.
 5. [Minimum channel Return Loss at 20°C ± 3°C: Meet or exceed following, worst pair:

Frequency (MHz)	Return Loss (dB/100m)
1.00	19.0
4.00	19.0
8.00	19.0
10.00	19.0
16.00	18.0
20.00	17.5
25.00	17.0
31.25	16.5
62.50	14.0
100.00	12.0
200.00	9.0
250.00	8.0
300.00	7.2
400.00	6.0
500.00	6.0

6. Maximum Insertion Loss (Attenuation): Meet or exceed following, worst pair:

Frequency (MHz)	Insertion Loss (dB/100m)
1.00	2.3
4.00	4.2
8.00	5.8
10.00	6.5
16.00	8.2
20.00	9.2

25.00	10.2
31.25	11.5
62.50	16.4
100.00	20.9
200.00	30.1
250.00	33.9
300.00	37.4
400.00	43.7
500.00	49.3

7. Minimum Near End Crosstalk (NEXT) Loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	NEXT (dB/100m)
1.00	65.0
4.00	63.0
8.00	58.2
10.00	56.6
16.00	53.2
20.00	51.6
25.00	50.0
31.25	48.4
62.50	43.4
100.00	39.9
200.00	34.8
250.00	33.1
300.00	31.7
400.00	28.7
500.00	26.1

8. Minimum Power Sum Near End Crosstalk (PSNEXT) Loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSNEXT (dB/100m)
1.00	62.0
4.00	60.5
8.00	55.6
10.00	54.0
16.00	50.6
20.00	49.0
25.00	47.3
31.25	45.7
62.50	40.6

100.00	37.1
200.00	31.9
250.00	30.2
300.00	28.8
400.00	25.8
500.00	23.2

9. Minimum ACRF at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	ACRF (dB/100m)
1.00	63.3
4.00	51.2
8.00	45.2
10.00	43.3
16.00	39.2
20.00	37.2
25.00	35.3
31.25	33.4
62.50	27.3
100.00	23.3
200.00	17.2
250.00	15.3
300.00	13.7
400.00	11.2
500.00	9.3

10. Minimum PSACRF at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSACRF (dB/100m)
1.00	60.3
4.00	48.2
8.00	42.2
10.00	40.3
16.00	36.2
20.00	34.2
25.00	32.3
31.25	30.4
62.50	24.3
100.00	20.3
200.00	14.2
250.00	12.3

300.00	10.7
400.00	8.2
500.00	6.3

11. Minimum TCL at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	TCL (dB/100m)
1.00	40.0
4.00	40.0
8.00	36.5
10.00	35.0
16.00	31.9
20.00	30.5
25.00	29.0
31.25	27.6
62.50	23.1
100.00	20.0
200.00	15.5
250.00	14.0
300.00	12.8
400.00	11.0
500.00	9.5

12. Minimum ELTCTL at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	ELTCTL (dB/100m)
1.00	30.0
4.00	18.0
8.00	11.9
10.00	10.0
16.00	5.9
20.00	5.0
25.00	2.0
31.25	n/s
62.50	n/s
100.00	n/s
200.00	n/s
250.00	n/s
300.00	n/s
400.00	n/s
500.00	n/s

13. Maximum Propagation Delay at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	Propagation Delay (ns)
1.00	580
4.00	562
8.00	557
10.00	555
16.00	553
20.00	552
25.00	551
31.25	550
62.50	549
100.00	548
200.00	547
250.00	546
300.00	546
400.00	546
500.00	546

14. Minimum average PSANEXT loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSANEXT (dB/100m)
1.00	67.0
4.00	67.0
8.00	67.0
10.00	67.0
16.00	67.0
20.00	67.0
25.00	67.0
31.25	67.0
62.50	64.3
100.00	62.3
200.00	57.7
250.00	56.3
300.00	55.1
400.00	53.2
500.00	51.8

15. Minimum PSAACRF loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSAACRF (dB/100m)
1.00	67.0

4.00	65.0
8.00	58.9
10.00	57.0
16.00	52.9
20.00	51.0
25.00	49.0
31.25	47.1
62.50	41.1
100.00	37.0
200.00	31.0
250.00	29.0
300.00	27.5
400.00	25.0
500.00	23.0

16. Minimum average PSAACRF loss at 20°C ± 3°C: Meet or exceed following:

Frequency (MHz)	PSAACRF (dB/100m)
1.00	67.0
4.00	67.0
8.00	62.9
10.00	61.0
16.00	56.9
20.00	55.0
25.00	53.0
31.25	51.1
62.50	45.1
100.00	41.0
200.00	35.0
250.00	33.0
300.00	31.5
400.00	29.0
500.00	27.0

C. Acceptable Manufacturers:

1. Belden-Mohawk Cable Corp. #M59156 – non-plenum rated, CAT6A, gigalan-10, small diameter, color blue.
2. Belden-Mohawk Cable Corp. #M59146 - Plenum Rated CAT6A, Gigalan-10, small diameter, color blue.
3. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

CATEGORY CABLE

- 3.1
- A. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Department of Network & Systems Services for approval four (4) weeks prior to installation. Equipment shall include, but may not necessarily be limited to, the following.
 - B. The equipment and components included in this specification are manufactured and/or distributed by the Siemon Co, Mohawk Cable Corp., Graybar, Anixter, or similar.
 - C. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.
 - D. Installation shall include delivery, unloading, setting in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and all other related work whether or not expressly defined herein. Installation shall be performed in accordance with applicable standards, codes, requirements and recommendations of National, State, and Local authorities having jurisdiction, and the N.E.C. (National Electrical Code). All boxes, equipment, etc., shall be installed plumb and square, and firmly secured in place unless requirements of portability dictate otherwise.
 - E. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
 - F. Provide and install four-pair cables to outlets as indicated on drawings from the appropriate communications room thru one of the 1" conduits, then terminate onto twisted-pair modules for data. The modules shall be inserted into a double gang quad flush faceplate. Unused modules shall have blank covers installed.
 - G. At systems furniture locations, the furniture manufacturer will provide standard single gang openings in the telecomm channels of the furniture itself. Utilize single gang Siemon Co. Faceplates and associated hardware for this application. Install cabling as indicated on the building drawings.
 - H. Comply with the manufacturer's installation instructions, BICSI Information Transport Systems Installation Manual and best industry practices.
 - I. Pair assignments of all connections shall be uniform at all communications outlets and match those at terminations at patch panels in the communications equipment rooms.
 - J. Horizontal cable runs on each floor SHALL NOT EXCEED 295 ft.
 - K. All outlet cables shall be terminated at patch panels using a University of Delaware provided termination list which shall indicated assignments.
 - L. All cabling shall be run above the ceiling in cable trays or J Hooks. The cable shall be fastened to the building structure at regular intervals of no more than six (6) feet until reaching the station outlet location. No cable shall be exposed on any ceiling or wall.
 - M. In areas where the exterior finish of walls is disturbed, the Contractor shall repair and refinish damaged areas so as to restore the area to its original condition.
 - N. In areas where ceiling tiles are removed for cable pulling, or ceiling tiles are damaged as a result of cable pulling, the Contractor shall replace tiles with like tile.
 - O. All communications outlets shall be 18" above finished floor to the center line of the device, unless otherwise indicated on the Contract Documents.
 - P. Conceal in walls or soffits and install in metal conduits:
 - 1. Exposed Cabling: Installed in surface raceway.
 - 2. Cabling Below Raised Floors: Installed in cable tray and J-Hooks out to Work Area Outlet.
 - Q. Cables shall not lay on the ceiling or the ceiling support structure. Anchor cables to not interfere with other services or space access.
 - R. Replace horizontal copper cables that do not pass Category 6 and 6A requirements.
 - 1. Maximum Length: Not exceed 90 m [(295 ft.)].

- S. No physical defects such as cuts, tears or bulges in outer jacket. Replace cables with defects.
- T. Install cable in neat and workman-like manner. Neatly bundle and tie cable in closets. Leave sufficient cable for 90 degree sweeps at vertical drops.
- U. Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices.
- V. Each Run of Horizontal Copper Cable between Terminating Patch Panel and WAO: Continuous without any joints or splices.
- W. Make use of raceways built into furniture for open office furnished work areas.
- X. Do not install cable in common cable hangers with speaker cable.
- Y. Maintain following clearances from possible sources of electromagnetic interference (EMI) exceeding 5 kVA:
 - 1. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway: (6 inch).
 - 2. Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway: (12 inch).
 - 3. Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways: (24 inch).
 - 4. Electrical motors and transformers: (47 inch).
- Z. Do not install Category 6 and 6A cable using more than 110 N [(25 lbs.)] pull force in accordance with TIA/EIA and BICSI TDMM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on long pulls inside conduit. Use tensile rated cords (i.e. fishing line) for difficult or questionable pulls - to judge to go/no-go condition of conduit and pulling setup.
- AA. Replace cables with jackets that are chaffed or burned, exposing internal conductor insulation or have bare copper (shiners).
- BB. If there are areas where sleeves are required through walls or in concrete slabs, the contractor is responsible for providing those sleeves as required to accommodate his work. All holes must be core bored. After completion of the Communications Cabling System, the contractor shall fire seal all communications sleeves with a UL approved fire stop in accordance with the NFPA (National Fire Protection Agency).
- CC. All conduit and cabling raceway required is to be coordinated by this contract, but is the responsibility of the electrical contractor.
- 3.2 DD. If deviations from the drawings are required, they shall be approved by Owner's Representative prior to placement of affected cables.

3.3 **TESTING**

- A. Test all cables in accordance with Section 270700 – Communications Testing.

3.4 **IDENTIFICATION**

- A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

3.5 **FIRESTOPPING**

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 - Common Work Results for Communications.

BONDING AND GROUNDING

- A. Bond and ground shielded cables in accordance with Section 270526 – Grounding and Bonding for Communications.

END OF SECTION

SECTION 271523

COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
 - 1. Qualitative requirements for optical fiber cables used in horizontal cabling.
 - 2. Minimum requirements for 50/125 μm optical fiber cabling installed as horizontal cabling.
- 1.1 B. Horizontal Cabling: That portion of telecommunication cabling system that extends from work area outlet (WAO) to communications room (TR, MTR, ER, EF).
 - 1. Horizontal cabling for project shall use conventional hierarchical star topology that home runs cables from communications room (TR, MTR, ER, EF) to the WAO locations.
- C. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. 50/125 μm Optical Fiber Cable.
- D. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270553 – Identification for Communications Systems.
 - 3. Section 270700 – Communications Testing
 - 4. Section 271119 – Communications Termination Blocks and Patch Panels
 - 5. Section 271323.13 – Communications Optical Fiber Splicing and Terminations

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications. In addition to requirements indicated or specified, comply with applicable provisions of the following for the design, materials, fabrication, and installation of component parts:
 - 1. ANSI/ICEA S-83-596.
 - 2. Telcordia GR-20.
 - 1.3 3. ISO/IEC 11801.

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit product data for each type of cable to be installed including but not limited to physical dimensions, configurations, construction and performance specifications
- 2.1 C. Product Samples: As required.

PART 2 - PRODUCTS

2.2 OPTICAL FIBER CABLE

- A. Fiber in Cable Run: From same manufacturer and same type. Mix of fibers from different manufacturers not allowed.

50/125 μm MULTIMODE OPTICAL FIBER CABLE

- A. Physical Characteristics:
 - 1. Plenum [Non-plenum] multimode optical fiber cable as required by the NEC Article 800.
 - 2. NEC OFNR/OFN [OFNP] Flame Rated, UL 1666.
 - 3. Jacket type: FEP [PVC].
 - 4. Graded-index optical fiber waveguide with nominal 50/125 μm [(0.00197 inch)] core/cladding diameter.
 - 5. Suitable for indoor installations.

6. Mechanical and environmental specifications for inside plant optical fiber cable shall be in accordance with ANSI/ICEA S-83-596.
 7. Primary coating diameter of 900 μm [(0.0354 inch)] tight buffer UV cured acrylate buffer material.
 8. Strength Members: Aramid yarn.
 9. Include secondary thermoplastic type buffer over each tight buffer fiber.
 10. Individual fiber tube colors per ANSI/TIA-598-C and overall orange [aqua] jacket.
 11. [Include stiff central member with cables stranded around center.]
 12. Include ripcord for overall jacket.
 13. Suited for operation at -20 to +70 degrees C [(-4 to +158 degrees F)].
 14. Fiber: TIA-492AAAC-A (OM3) [TIA-492AAAD (OM4)]
- B. Transmission Characteristics - Multimode:
1. Each Cabled Fiber: Graded performance specifications below.
 2. Maximum attenuation at 850/1300 nm, dB/Km: 3.5/1.5.
 3. Bandwidth at 850nm, MHz-km: (1500 for overfilled launch) (2000 for laser launch) [(3500 for overfilled launch) (4700 for laser launch)].
 4. Bandwidth at 1300nm, MHz-km: 500 for overfilled launch.
 5. Measurements: Performed at -20 to +70 degrees C [(-4 to +158 degrees F)].
- C. Acceptable Manufacturers:
1. Corning.
 2. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

PART 3 - EXECUTION

OPTICAL FIBER CABLE

- 3.1
- A. Comply with the manufacturer's installation instructions, BICSI Information Transport Systems Installation Manual and best industry practices.
 - B. Install fiber optic cable in conduit, cable tray or supported from building structure. Additionally, protect fiber optic cable within innerduct for entire length of its run.
 1. Continuous from communications room (TR, MTR, ER, EF) to outlet.
 2. For fiber runs, leave (10 ft.) service loop at communications room (TR, MTR, ER, EF) end. At outlet end leave (3 ft.) service loop.
 - C. Do not exceed the maximum allowed pulling tension per the manufacturer's installation instructions. Contractor is responsible for determining minimum bend radiuses for cable being placed, using manufacturer's latest information. The following minimum bend radius information is provided only as general guidance:
 1. Cable During Installation: 20 times outer diameter
 2. At Rest After Installation: 10 times outer diameter
 3. Indoor Cable with Four or fewer Fibers intended to be Pulled through Pathways During Installation: (2 inch).
 - D. Verify actual footages and distances identified on attached prints (i.e. wall-to-wall, pullbox-to-pullbox and communications room (TR, MTR, ER, EF) to outlet).
 1. Verify conduits and raceways ready for occupancy before cable placement.
 2. Assume responsibility for difficulties or damage to cable during placement.
 - E. Where fiber optic cable passes through vertical riser secure fiber to wall vertically every (3 ft.). Review fasteners, strain relief and routing with customer's representative.
 - F. Conceal in walls or soffits and install in metal conduits.
 1. Exposed Cabling: Installed in surface raceway.
 - G. Cabling Below Raised Floors: Installed in cable tray and open-top cable support.
 - H. Schedule work in manner to complete above ceiling work/below raised floor work prior to tile/panel installation. In event installer required to remove tiles/panels, coordinate with Contractor and do not break or disturb grid.

1. Cable Above Accessible Ceilings: Supported (4 to 5 ft.) on center from cable support attached to building structure.
 2. Cable Below Raised Floor: Supported every (2 ft.) on center from cable support attached to floor pedestals.
- I. Cables shall not lay on the ceiling or the ceiling support structure. Anchor cables to not interfere with other services or space access.
 - J. Replace fiber cables that do not pass testing requirements.
 1. Maximum Length: Not exceed 90 m (295 ft.).
 - K. No physical defects such as cuts, tears or bulges in outer jacket. Replace cables with defects.
 - L. Install cable in neat and workmanlike manner. Neatly bundle and tie cable in closets. Leave sufficient cable for 90 degree sweeps at vertical drops.
 - M. Cable ties and other cable management clamps shall be no more than hand tightened and shall fit snugly, but not compress, crimp, or otherwise change the physical characteristics of the cable jacket or distort the placement of twisted-pair components. Replace any cable exhibiting stresses due to over tightening of cable management devices.
 - N. Each Run of Fiber Cable between Fiber Patch Panel and WAO: Continuous without any joints or splices.
 - O. Make use of raceways built into furniture for open office furnished work areas.
 - P. Replace cables with jackets that are chaffed or burned or exposing internal fiber insulation.
 - Q. If deviations from the drawings are required, they shall be approved by Owner's Representative prior to placement of affected cables.

TESTING

- 3.2 A. Test all cables in accordance with Section 270700 – Communications Testing.

3.3 IDENTIFICATION

- A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

3.4

FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 - Common Work Results for Communications.

END OF SECTION

SECTION 271533
COMMUNICATIONS COAXIAL HORIZONTAL CABLING

PART 1 - GENERAL

SUMMARY

- A. Section Includes:
 - 1. Qualitative requirements for coaxial cables used in horizontal cabling. The cable shall consist of 18 AWG center conductor that is surrounded by a foam dielectric, braid(s) and enclosed by an overall jacket.
 - 1.1 2. Minimum requirements for Series 6 (RG 6 type) coaxial cabling.
- B. Materials and Equipment:
 - 1. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved.
 - 2. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Department of Network & Systems Services for approval four (4) weeks prior to installation. Equipment shall include, but may not necessarily be limited to, the following:
- C. Horizontal Cabling: That portion of telecommunication cabling system that extends from work area outlet (WAO) to the supporting CATV Tap in the communications room (TR).
 - 1. In addition to satisfying current telecommunications requirements, horizontal cabling system shall facilitate ongoing maintenance and relocation requirements, as well as readily accommodating future equipment and service changes.
 - 2. Horizontal coaxial cabling for project uses conventional hierarchical star topology that home runs coaxial cables, from communications room (TR) to WAO locations throughout facility.
- D. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
 - 1. Series 6 Coaxial CATV Cable.
- E. Related Requirements: Comply with following:
 - 1. Section 270500 - Common Work Results for Communications.
 - 2. Section 270526 – Grounding and Bonding for Communications.
 - 3. Section 270553 – Identification for Communications Systems.
 - 1.2 4. Section 270700 – Communications Testing.
 - 5. Section 270548 - Communications Coaxial Splicing and Terminations.

REFERENCES

- 1.3 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

SUBMITTALS

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 - Common Work Results for Communications.
- B. Product Data: Submit product data for each type of coaxial cable to be installed including but not limited to physical dimensions, configurations, construction and performance specifications
- C. Product Samples: As required.
- D. Extra Materials: Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cable: 305 m (1,000 ft) spare Series 6 coaxial cable.

PART 2 - PRODUCTS

SERIES 6 COAXIAL CATV CABLE

A. Plenum Rated:

1. Physical Characteristics:

CMP rated, as required by the NEC Article 800.

Conductor: 18 AWG, solid with foam FEP dielectric of 4.3 mm (0.170 inches).

Shield: Aluminum foil and 60 percent Aluminum braid.

Overall Diameter of Cable: Equal to or less than 6.1 mm (0.239 inches).

2.1

2. Transmission Characteristics:

Nominal Capacitance: Equal to or better than 52.5 pF/m (16.0 pF/ft).

a. Nominal Impedance: 75 ohm.

b. Nominal Attenuation: Equal to or less than following:

c.

d.

a.

b.

c.

RG-6 Frequency (MHz)	Max. Attenuation (dB/100m)
1	0.85
10	2.30
50	4.85
100	6.59
200	9.38
400	13.87
700	19.55
900	22.83
1000	24.44

3. Acceptable Manufacturers:

a. For General Purpose and RISER applications, the cable to be used shall be Belden Cable Corp. #1189A – Riser Rated RG-6 coaxial 60-40 cable (2 braids 1 @ 60%, 1 @ 40%).

b. For PLENUM applications, the cable to be used shall be Belden Cable Corp. #1189AP – Plenum Rated RG-6 coaxial 60-40 cable (2 braids 1 @ 60%, 1 @ 40%).

c. Accepted Substitute in accordance with Section 012500 - Substitution Procedures.

3.1

PART 3 - EXECUTION

COAXIAL CABLE

- A. The contractor shall at all times install the coaxial cable in complete accordance with the recommended practices of the cable manufacturer, and shall not exceed the tensile ratings, minimum bending radius or any other coaxial cable installation restrictions of the manufacturer. Excessive pulling tensions that might damage the inter-building cable shall be avoided at all times. Bends of small radii and twists that might damage the inter-building cables shall be avoided at all times.
- B. All equipment shall be secured plumb and square with consideration being given not only to operational efficiencies, but also to overall aesthetic factors.
- C. All metallic shielded or metallic strength member cabling shall be properly grounded and bonded at the building entrances as per applicable sections of the National Electrical Code.
- D. All horizontal and riser coax cabling shall be routed and dressed into the Telecommunications Room cable tray, then routed down thru the cable tray bottom exit at the location of the CATV equipment area within the room. A cable tray drop-down #CABLEXIT shall be used at each exit location. All coax cables shall be labeled and left with 8ft of service loop for the CATV contractor to then install all splitter fields, trim cables back, and terminate with connectors to be plugged into the associated splitters.

- E. Comply with the manufacturer's installation instructions, BICSI Information Transport Systems Installation Manual and best industry practices.
- F. Install plenum rated cables where required by code.
- G. Conceal in walls or soffits and install in metal conduits.
 - 1. Exposed Cabling: Installed in surface raceway.
 - 2. Cabling Below Raised Floors: Installed in cable tray and open top cable supports (J-supports) out to WAO.
- H. Schedule Work in manner to complete above ceiling work/below raised floor work prior to tile/panel installation. In event installer required to remove tiles/panels, coordinate with Contractor and do not break or disturb grid.
 - 1. Cable Above Accessible Ceilings: Supported 1219 to 1524 mm (4 to 5 feet) on center from cable support attached to building structure.
 - 2. Cable Below Raised Floor: Supported every 609 mm (2 feet) on center from cable support attached to floor pedestals.
- I. Cables shall not lay on the ceiling or the ceiling support structure. Anchor cables to not interfere with other services or space access.
- J. Replace coaxial cables that do not pass testing requirements.
 - 1. Maximum Length: Not exceed 90 m (295 ft).
- K. No physical defects such as cuts, tears or bulges in outer jacket. Replace cables with defects.
- L. Install cable in neat and workmanlike manner. Neatly bundle and tie cable in closets. Leave sufficient cable for 90 degree sweeps at vertical drops.
- M. Each Run of coaxial cable between backbone cable and WAO or between equipment: Continuous without any joints or splices.
- N. Make use of raceways built into furniture for open office furnished work areas.
- O. Do not install cable in common cable hangers with speaker cable.
- P. Maintain following clearances from possible sources of electromagnetic interference (EMI) exceeding 5 kVA:
 - 1. Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway: 152 mm (6 inch).
 - 2. Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway: 305 mm (12 inch).
 - 3. Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways: 610 mm (24 inch).
 - 4. Electrical motors and transformers: 1194 mm (47 inch).
- 3.2 Q. Do not install coaxial cabling with more than manufacturer's recommended pull force. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on; long pulls inside conduit, pulls of multiple cables into single small bore conduit, on conduit runs greater than 30.5 m (100 linear feet) with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends. Use tensile rated cords (i.e. fishing line) for difficult or questionable pulls - to judge to go/no-go condition of conduit and pulling setup.
- 3.3 R. Replace cables with jackets that are chaffed or burned exposing internal conductor insulation or have exposed shields

TESTING

- 3.4 A. Test all cables in accordance with Section 270700 – Communications Testing.

IDENTIFICATION

- A. Label all cables in accordance with Section 270553 – Identification for Communications Systems.

FIRESTOPPING

- A. Firestop openings and penetrations through fire and smoke rated wall and floor assemblies in accordance with Section 078400 – Firestopping and Section 270500 - Common Work Results for Communications.

END OF SECTION

SECTION 271543
COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 - GENERAL

SUMMARY

- 1.1 A. Minimum composition requirements and/or installation methods for following materials and work are included in this section:
1. Category 6A Insert.
 2. F-Type Connector.
 3. F-Type Insert.
 4. Fiber Optic Connector.
 5. Fiber Optic Angled Physical Contact (APC) Connector.
 6. Fiber Optic Insert.
 7. Wall Phone Jack Assembly.
 8. Floor box Assembly Mounting Plate.
- B. Related Requirements: Comply with following:
1. Section 270500 – Common Work Results for Communications.
 2. Section 270526 – Grounding and Bonding for Communications.
 3. Section 270553 – Identification for Communications Systems.
 4. Section 271323.13 – Communications Optical Fiber Splicing and Terminations.

REFERENCES

- 1.2 A. Reference Standards: See Section 014200 – References and Section 270500 - Common Work Results for Communications.

1.3 **SUBMITTALS**

- A. General: Submit in accordance with Section 013300 – Submittal Procedures and Section 270500 – Common Work Results for Communications.
- B. Product Data and Installation Instructions: Submit for products included within this specification section.
- C. Colors and Finishes: Submitted and approved by Architect prior to order.
- D. Product Samples: As required.
- E. If providing pre-standards manufacturer system solution, submit installer/contractor certification documentation and channel certification information and requirements from manufacturer.

2.1

PART 2 PRODUCTS

CATEGORY 6A CONNECTOR/INSERT

- A. Functional from -10 to 60 degrees C (14 to 140 degrees F).
- B. Tested: TIA/EIA-568-C.2.
- C. Connector Body: High-impact, fire-retardant plastic rated UL 94V-0.
- D. Unscreened per IEC 60603-7-4 [Screened per 60603-7-5] 8-position/8-conductor connector.
- E. Spring Wire Contacts: Phosphor bronze, plated with 50 microinches of gold and over 100 microinches of nickel for lowest contact resistance.
- F. 110 IDC, RJ45 type suitable for eight 22-26 AWG wires and certified Category 6 compliant.
- G. System Components as defined by: TIA/EIA-568-C.2 ISO/IEC-11801 CLASS E channel performance.
- H. Modular Connector: Individual snap-in-style.
1. Comply with National Electrical Code; compliant with FCC Part 68; UL listed; and independently UL Certified.

2. In addition to Category 6 Compliance, Connector: Ability to support high megabit and shared sheath applications.
 3. Termination of Connectors: 110-type insulation displacement connectors (IDC).
 4. Provide ledge directly adjacent to 110 style termination against which wires can be directly terminated and cut in one action by installation craftsman.
 5. Connector Wiring Label: Provide installation color codes for both T568A and T568B wiring schemes.
- I. Modular Connector: Terminate using T568B wiring scheme.
 1. Fit other installed telecommunications wall plates, outlets and field-configurable patch panels and patch blocks.
 - J. Acceptable Manufacturers:
 1. Double gang quad faceplate as manufactured by Siemon Co. Inc. #10GMX-FPD08-02, eight port, unloaded, color white.
 2. Single gang faceplate as manufactured by Siemon Co. Inc. #10GMX-FPS04-02, four port, unloaded, color white. This faceplate is only to be used in special situations as indicated by The University of Delaware.
 3. Single port Modular Z-Max module/jack as manufactured by Siemon Co. Inc. #Z6A-02, color white.
 4. Blank inserts as manufactured by Siemon Co. Inc. #MX-BL-02, pack of 10, color white. Blanks shall be installed in all unused faceplate openings. Insert the computer/data icon for each Z-Max module installed.
 5. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

F-TYPE CONNECTOR

- 2.2 A. Series 6 crimp-type, male F-type connector.
 1. Terminate 75ohm coaxial cable.
 2. Meet SCTE and Bellcore specifications.
- B. Acceptable Manufacturers:
 1. Connector to be used for Belden #1189A, PVC Riser rated quad shield Cable shall be F-type RG-6 connector manufactured by the Belden Corp. #FSNS1P6QS-25, Snap-N-Seal, to terminate both ends of cable.
 2. Connector to be used for Belden #1189AP, Plenum Rated, quad shield cable shall be F-type RG-6 connector manufactured by the Belden Corp. #FSNS6PLQ-25, Snap-N-Seal, to terminate both ends of cable.
- 2.3 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

F-TYPE INSERT

- A. Connector Body: High-impact, fire-retardant plastic rated UL 94V-0.
- B. F-type Bulkhead: Designed for Series 6 applications.
- C. Modules: Individual snap-in style, female-to-female bulkhead adapters.
- D. Connectors: Comply with National Electrical Code; comply with FCC Part 68; UL listed; and independently UL Certified.
- E. Modular Connector: Fit other installed telecommunications wall plates, outlets and field-configurable patch panels and patch blocks.
- 2.4 F. Acceptable Manufacturers:
 1. F-type coax bulkhead for Max-type outlet faceplates as manufactured by Siemon Co., Inc. #MX-F-FA-02.
 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

FIBER OPTIC ANGLED PHYSICAL CONTACT (APC) CONNECTOR

- A. Physical Characteristics:
 1. Provide Singlemode pre-connectorized pigtails.
 2. Provide duplex 568SC (TIA-604-3) connectors.

3. Ceramic ferrule.
 4. Meet EIA and IEC standards for repeatability.
 5. Locking feature to coupler and assure non-optical disconnect.
 6. Optical axial pull strength of 2.2 N at 0 degree angle and optical off axial pull strength of 2.2 N at 90 degree angle, with maximum 0.5 dB increase in attenuation for both tests when tested, ANSI/EIA/TIA 455-6B.
- B. Transmission Characteristics:
1. Maximum Insertion Loss: Not exceed .3dB.
 2. Reflectance: ≤ -75 dB.
 3. Maximum Optical Attenuation per each Mated Field Installed Connector Pair: Not exceed 0.5 dB.
 4. Total Optical Attenuation through Cross-connect from any Terminated Optical Fiber to any other Terminated Fiber: Not exceed 1.0 dB.
 5. Sustain minimum of 500 mating cycles without degrading this performance.
 6. Tensile Strength: Equal to or better than 10 pounds < .21dB change.
 7. Temperature Cycling from minus 40 to plus 75deg. C with 21 Cycles: Result in no greater than .3dB change.
- C. Acceptable Manufacturers:
1. Corning Cable Systems #SOC-SCA-FAN-SM, FuseLite Splice-On connector.
 2. Corning Cable Systems #SOC-SCA-900-SM, FuseLite Connector.
 3. Accepted Substitute in accordance with Section 012500 – Substitution Procedures

FIBER OPTIC INSERT

- 2.5 A. Connector Body: High-impact, fire-retardant plastic rated UL 94V-0.
- B. Duplex 568SC (TIA-604-3): Zirconia ceramic sleeve.
- C. Load into connector housing from rear.
 1. Maintain minimum cable bend radius within area of minimum NEMA box enclosures.
- D. UL 1863 specifications.
- E. TIA/EIA-568-C.3 compliant; meets FCC part 68.
- F. Acceptable Manufacturers:
 1. Corning.
 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

WALL MOUNTED FACEPLATE

- A. Wall-mounted Faceplates: High impact, thermoplastic, flush-mounted design.
 1. Capable of accepting mixed multimedia.
 2. Rear-loading inserts.
 3. Single-gang
- B. Modular Furniture Faceplates: Snap-in type accepted by furniture manufacturer.
 1. Capable of accepting mixed multimedia.
 2. Rear-loading inserts.
 3. Contain at least one designation ID window for labeling.
- 2.7 C. Faceplates: UL listed.
- D. Acceptable Manufacturers:
 1. Simon Co. #MX-WP-Z6A-SS. Stainless Steel Max-series assembly with 8-position flat Max module.
 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

WALL PHONE JACK ASSEMBLY

- A. Mount to single gang outlet box.
- B. Mounting lugs designed to mate with corresponding telephone base plate or adapter.
- C. 8-pin jack configuration.

- D. UL listed.
- E. Acceptable Manufacturers:
 - 1. Siemon Co. See configuration under the execution section.
 - 2. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

FLOOR BOX ASSEMBLY MOUNTING PLATE

- A. Floor Box Type and Manufacturer: [Coordinated with electrical contractor.]
 - 1. Accept snap-in type inserts.
 - 2. Same manufacturer as floor box or designed to fit with floor box manufacturer.
 - 3. Mount permanently into floor box while maintaining proper cable bend radius.
 - 4. UL listed.
- B. Acceptable Manufacturers:
 - 1. FSR
 - 2. Hubbell
 - 3. Wiremold.
 - 4. Accepted Substitute in accordance with Section 012500 – Substitution Procedures.

PART 3 - EXECUTION

TWISTED PAIR OUTLET JACKS

- A. For UTP CAT6A Outlet:
 - 1. Terminated with high density modular jacks that snap into faceplate mounted on wall outlet box, modular furniture raceway or in floor box bracket.
 - 2. Fill extra openings with blank inserts.
- B. For Wall Jack Assemblies – Single Gang faceplate with mounting lugs as manufactured by the Siemon Co. #MX-WP-Z6A-SS. Stainless Steel Max-series assembly with 8-position flat Max module. This is meant for a wall-mount analog phone installation.
- C. For Emergency Phones – Terminate cable within Emergency Phone enclosure using a Siemon Co #MX-SM1-01 Surface Mount termination box, and one (1) Siemon Co. Inc #Z6A-02 module, color white. The #Z6A-02 module will allow a full Cat6A performance test.
- D. For Wireless Access Points – Terminate cable at WAP's using Siemon Co. #ZP1-6AS-01 Z-Plug Field Terminated Plug.
- E. Coordinate with Owner's Representative for proper termination standard (T568A or T568B).

F-TYPE CONNECTOR

- A. Furnish and Install F-Type Connector using the following guidelines:
 - 1. Stray Strands of Shield: Clipped or moved away from center conductor.
 - 2. White Center Conductor of Cable: Even with shoulder of attachment nut.
 - 3. BNC/F-type Connector: Completely cover exposed braid.
 - 4. Use proper crimp tool to do termination.
 - 5. RG6 coax drops at the Telecommunications Room end where splitters will be located shall have standard circuit labels installed upon Panduit Corp. Pan-Ty #PLF1MB Marker/Flag Ties.

F-TYPE INSERT

- A. Furnish and Install F-Type Insert using the following guidelines:
 - 1. Horizontal Cable: Screw onto backside of bulkhead.
 - 2. Bulkhead Module: Snap into adapter plate.
 - 3. Adapter Plate: Rear-loaded into faceplate.
 - 4. Fill extra openings with blank inserts.

N-TYPE CONNECTOR

- A. Comply with manufacturer installation recommendations.

FIBER OPTIC CONNECTOR

- A. Comply with manufacturer installation recommendations.
- B. Connector: Installed with less than .76dB of attenuation.

FIBER OPTIC APC CONNECTOR

- A. Comply with manufacturer installation recommendations.
- 3.5 B. Pigtail: Splice to fiber optic backbone cable.

FIBER OPTIC INSERT

- 3.6 A. Fiber Cable Connectors: Snap into modular SC [LC] inserts.
- B. Insert: Rear-loaded into faceplate.

FACEPLATE

- 3.7 A. Double gang quad faceplate as manufactured by Siemon Co. Inc. #10GMX-FPD08-02, eight port, unloaded, color white.
- 3.8 B. Single gang faceplate as manufactured by Siemon Co. Inc. #10GMX-FPS04-02, four port, unloaded, color white. This faceplate is only to be used in special situations as indicated by The University of Delaware.
- C. Secure outlet boxes to building with mechanical fasteners. Adhesive fasteners not allowed.
- D. Coordinate modular furniture faceplates with furniture provider.
- E. Fill extra openings with blank inserts.

TESTING

- 3.9 A. Test all connectors and inserts in accordance with Section 270700 – Communications Testing.

IDENTIFICATION

- 3.10 A. Label all faceplates in accordance with Section 270553 – Identification for Communications.

END OF SECTION

SECTION 273226
RING-DOWN EMERGENCY TELEPHONES

PART 1 - GENERAL

RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
 - B. The latest revision of the National Electrical Code and the American's with Disability Act (ADA) shall be followed in every case except where local regulations are more stringent, in which case local regulations shall govern.
- 1.1

SUMMARY

- A. Section Includes:
 - 1. Free-standing emergency phones.
 - 2. Free-standing phone stanchion for exterior use.
- 1.2

SYSTEM DESCRIPTION

- A. The unit shall be an easily identifiable, vandal resistant communications device that is Americans with Disabilities Act (ADA) compliant, multi-functional, freestanding, and constructed of heavy steel. The unit shall be aesthetically pleasing and virtually impervious to damage, and shall include a high quality, vandal resistant, hands-free communications device, a powerful strobe light, and a vivid blue beacon that serves to identify the unit from a great distance
 - B. The communication system shall be designed so that a single touch on the communications device button shall immediately and automatically dial a preprogrammed number.
 - C. The entire unit shall be weather and insect resistant when fully assembled.
- 1.3
- 1.4

SUBMITTALS

- A. General:
 - ^a1. Submit in accordance with Section 012500.
 - ^b. Product Data: For each component.
Bolt hole pattern template from manufacturer for stanchion anchors.
 - B. ^aInformation Submittals:
 - 1. Submit the following packaged separately from other submittals:
Field Test Reports: Indicate and interpret test results for compliance with manufacturer requirements.
 - C. ^bCloseout Submittals:
 - 1. Submit the following in accordance with Section 012500
Operation and Maintenance Data: For Equipment.
Include record of Owner's equipment-programming option decisions.
- 1.5

QUALITY ASSURANCE

- A. Installer Qualifications: Experienced installer who is an authorized representative of the equipment manufacturer for both installation and maintenance of equipment required for this Section.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCT

MATERIALS AND EQUIPMENT

- A. A complete information package of all materials and equipment shall be submitted to the University of Delaware for review by the Department of Network & Systems Services for approval four (4) weeks prior to installation. Equipment shall include, but may not necessarily be limited to, the following.
- 2.1 B. The equipment and components included in this specification are manufactured and/or distributed by the Siemon Co, Mohawk Cable Corp., Graybar, Anixter, or similar.
- C. All materials and equipment supplied shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects, and shall be UL (Underwriters Laboratory) approved. The Contractor shall supply the latest model available at the time of bidding of each piece of equipment.
- D. Equipment shall include, but may not be limited to, the following.

TWISTED PAIR CABLING PRODUCTS, MATERIALS AND EQUIPMENT

- A. TWISTED PAIR OUTSIDE PLANT COMMUNICATIONS CABLE
 - 2.2 1. Outside Locations at pole locations - Mohawk Cable Corp. #M58762, Versalan 4-Pair, outdoor rated CAT5E cable for Campus or Emergency Phones located in the outside environment.
 - 2. Locations on building exterior walls – Mohawk Cable Corp #M56167 riser rated cable, or #M56168 plenum rated cable.
- B. LIGHTNING PROTECTION AND TERMINATION MODULES
 - 1. ITW-Linx #CAT6-75-MM, RJ45 in/out– to be installed on all Emergency phones located outside the footprint of the building (exterior). There shall be one of these modules installed for each cable and device served.
- C. EMERGENCY PHONE EQUIPMENT AND PRODUCTS
 - 1. EXTERIOR or INTERIOR Surface Mount – ANALOG Emergency Phone, Gaitronics S.M.A.R.T. Phone #393-001, shall be supplied by the University of Delaware, Department of Network & Systems Services. UD-NSS will provide the back boxes/enclosures to the contractor so that the conduit stub into the bottom of the enclosure for 4-pair cable routing can be coordinated and installed. When installed on Hubbell/Spaulding Lighting Inc. Poles, the Emergency Phone shall be mounted to a mounting bracket, which will also be supplied by UD-NSS. There shall be no holes drilled thru the Emergency Phone back box/enclosure. The use of the mounting bracket will allow proper mounting of the phone to the Hubbell/Spaulding Lighting Inc. pole.
 - 2. INTERIOR Flush Mount Stainless Steel Emergency Phone, Gaitronics Phone #397-700, shall be supplied by the University of Delaware, Department of Network & Systems Services. UD-NSS will provide the back boxes/enclosures to the contractor so that the conduit stub into the top of the enclosure for 4-pair cable routing can be coordinated and installed. There shall be no holes drilled thru the Emergency Phone back box/enclosure.
- D. HUBBELL/SPAULDING LIGHTING INC. POLES
 - 1. Hubbell/Spaulding Lighting Inc. Pole for locations outside the footprint of the building shall utilize #SSS-10-40-1-AX-BL (Square, Straight, Steel, 10ft. long, 4" shaft, 11-gauge, single-sided, black in color).
 - 2. Hubbell/Spaulding Lighting Inc. Pole for locations outside the footprint of the building for combination Video Surveillance and Emergency Phone locations shall utilize #SSS-16-40-1-AX-BL (Square, Straight, Steel, 16ft. long, 4" shaft, 11-gauge, single-sided, black in color).
 - 3. Pole information above provided for infrastructure installation only. All camera work and installation to be performed by video surveillance camera integrator.
- E. CONDUIT
 - 1. Standard PVC Schedule-40 conduits, sized at one-inch. Utilize PVC cleaner, primer, and glue as defined previously in this specification.
- F. BLUE LIGHT

1. Fixture Body & Guard– Shall be Rab Lighting Corp. #VXBRLED26DG.
 2. Fixture Globe – Shall be Rab Lighting Corp. #GL100B, blue in color.
 3. Photo Cell – Intermatic Corp. #K4121C, 120V/1800W, non-swivel.
 4. Bulbs – Phillips #FLE15HT3/2/841, GE Spiral, Compact Fluorescent 15W/60W Equivalent.
- G. Phone Unit Labels:
1. Grade 2 Braille label for the visually impaired.
 2. Red Buttons:
"PUSH FOR HELP"
"EMERGENCY"
 3. Black Button:
"ASSISTANCE"
"INFO"
 - ^a4. Raised letters.
 - ^b5. May include international telephone symbol pictogram.
 - ^a6. May be integrated with the phone unit or added to the phone unit.
 - ^b7. Coordinate placement of label on unit with Architect.

PART 3 - EXECUTION

INSTALLATION

- 3.1 A. General Requirements:
 1. Install system according to NFPA 70, applicable codes, and manufacturer's recommendations.
 2. Provide necessary interconnections, services and adjustments required for a complete and operable system.
 3. Install power, communications and data transmission line grounding as necessary to preclude ground loops, noise and surges from adversely affecting system operation.
 4. Install equipment to comply with manufacturer's recommendations.
- B. Locations for Emergency Phones shall be accessible by wheelchair that would travel on a paved sidewalk surface. The coordination of the installation of the phone shall be such that the face of the Emergency Phone enclosure shall be flush with the edge of the sidewalk, so that proper forward reach to the phone can be made from a wheelchair and all existing ADA requirements are met.
- C. Locations for Emergency Phones within the interior of buildings shall be mounted so that the top plane of the surface mount phones are at 48" above finished floor. If the location calls for a flush mount metallic phone, the top of the metallic face of the phone shall be at 48" above finished floor (this will place the back-box/enclosure for this phone at 47").
- D. For interior Emergency Phones, conduit entries into surface mount phone enclosures shall be by way of one (1) ¾" EMT conduit installed into the bottom of the enclosures. Conduit entries into flush mount enclosure shall be by way of one (1) ¾" EMT conduit installed into the top of the enclosure, as the enclosure is installed within the wall cavity. If other penetrations are attempted without UD-NSS approval, the contractor shall be responsible for the cost of a new emergency phone.
- E. Locations for Emergency Phones on buildings shall include one (1) ¾" EMT sleeve installed thru the exterior wall for routing of AC power conductors for the installed blue-light. The installation shall also include (1) ¾" EMT sleeve installed thru the exterior wall for routing of the 4-pair telecommunications cable for dial tone to the phone itself. For 4-pair cable routing to the emergency phone, install a ¾" metallic stub-out below the emergency phone, then into the bottom of the emergency of the emergency phone enclosure. This penetration into the emergency phone enclosure must be done off-center because of the physical location of internal phone electronics within the enclosure. No other penetrations of the enclosure shall be acceptable. If other penetrations are attempted without UD-NSS approval, the contractor shall be responsible for the cost of a new emergency phone.

- F. For Emergency Phones mounted directly on buildings, the back enclosure of the phone itself shall be secured to the building exterior wall via the four supplied screw mounting holes. No other penetrations of the enclosure shall be acceptable. If other penetrations are attempted without UD-NSS approval, the contractor shall be responsible for the cost of a new emergency phone.
- G. For Emergency Phone locations beyond the footprint of the building (not on exterior wall), install Hubbell/Spaulding Lighting Inc. Steel-Straight-Square poles for mounting of the emergency phone and the blue light assembly.
- H. For pole mounted locations, install two (2) one-inch schedule 40 conduits to be used for AC power and the 4-pair cable installation. Install an 18" diameter concrete tube/base for the conduits to be routed up into, and the pole to be mounted upon. All underground conduits to be installed shall be installed as per most current UD Network & Systems Services pvc conduit specifications.
- I. Upon completion of the Hubbell/Spaulding Lighting Inc. pole, the Blue Light shall be installed at a height of 8ft-0" to the bottom of the light fixture from finished grade/paving. The blue light circuit shall be controlled by an installed photo cell unit.
- J. All pole mounted emergency phones shall be installed to the poles using a UD-NSS provided Emergency Phone mounting bracket. This mounting bracket shall be installed so that the top of the bracket is at 48" above finished grade. The mounting bracket shall be secured to the pole by way of screws that shall be installed in the middle of the bracket. The emergency phone back enclosure shall be installed onto the bracket using the four supplied screw mounting holes. No other penetrations of the enclosure shall be acceptable. If other penetrations of the emergency phone enclosure are attempted, the contractor shall be responsible for the cost of a new emergency phone.
- K. Mounting Hardware – Contractor shall supply and install all mounting hardware. Standard SSS type pole shall be drilled and tapped prior to installation of mounting hardware. To mount UD supplied bracket to pole, use four (4) stainless-steel ¼" x ¾" NC (national course) flat-head bolts with nuts. To mount the phone to the bracket, use four (4) standard, Phillips ¼" x 1" NC (national course) pan-head bolts with nuts.
- L. For 4-pair cable routing to the Emergency Phone, install a ¾" metallic conduit stub-out below the emergency phone mounting plate on the face of the pole, then into the bottom of the emergency phone enclosure. This penetration into the emergency phone must be done off-center because of the physical location of the internal electronics within the enclosure. No other penetrations of the internal phone enclosure shall be acceptable. If other penetrations are attempted without UD-NSS approval, the contractor shall be responsible for the cost of a new emergency phone.
- M. Utilize 4-pair CMR or CMP CAT6A rated Belden-Mohawk cable for phones mounted directly on exterior of buildings.
- N. Contractor shall route all Belden-Mohawk #M59198 OSP communications cabling for exterior emergency phones that are beyond the footprint of the building at pole locations thru conduit installed at the poles, into telecommunications room.
- O. At the emergency phone, terminate the cable within the phone enclosure using a Siemon Co. #MX-SM1-01 Surface Mount termination box, and one (1) Siemon Co. Inc. #Z6A-02 module, color white. Once all testing is complete, remove this module and replace with a Siemon Co. Inc. #MX3-F-U3-02 module, RJ11/USOC. This will allow for a standard RJ11 plug-in from the phone module itself, without play in the jack.
- P. At the video surveillance camera on same pole, terminate the cable at the top of the pole where the camera will be located with one (1) Siemon Co. Inc. #Z6A-02 module. The camera installer will connect a station cable to this module and plug directly into the camera itself
- Q. Install one (1) ITW-Linx Surgegate #CAT6A-75 protector on wall of telecommunications room for each emergency phone, per drawings.

- R. For the emergency phone cable, exit the conduit in the TR, route onto the wall in the TR, and punch down into the input side of the ITW-Linx protector. On the output side of the protector, terminate an inside-rated Cat6A cable, route to patch panel and terminate.
- S. For the video surveillance camera, cable, exit the conduit in the TR, and punch down on the input side of the ITW-Linx projector. On the output side of the projector, terminate an inside rated Cat6A cable, route to the patch panel and terminate.

FIELD QUALITY CONTROL

- A. Manufacturer's Field Service:
 - 1. Engage factory-authorized service representative to inspect field assembled components and equipment installations, including connections and initial systems.
- 3.2 B. Retesting:
 - 1. Correct deficiencies and retest. Prepare written record of tests.
- C. Inspection:
 - 1. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare list of final tap settings of paging speaker-line matching transformers.
- D. Schedule Tests:
 - 1. Schedule tests with at least seven days advanced notice of test performance.

DEMONSTRATION

- 3.3 A. Demonstration and Instruction of Owner's Personnel: Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment as specified below:
 - 1. Train on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining equipment.
 - 2. Review data in maintenance manuals.

END OF SECTION

SECTION 275318

WLAN AP

PART 1 - GENERAL

SUMMARY

- A. WLAN Cabling: That portion of telecommunication cabling system that extends from an wireless access point (WAP) to TR/ER.
 - 1. In addition to satisfying current telecommunications requirements, WLAN cabling system shall facilitate ongoing maintenance and relocation requirements, as well as readily accommodating future equipment and service changes.
 - 2. WLAN cabling for project uses conventional hierarchical star topology that home runs UTP, from TR/ER to WAP locations throughout facility.
- B. Section Includes:
 - 1. Minimum requirements for following:
 - Wireless Access Point Cabling.
 - Wireless Enclosure.
- C. Related Requirements: Comply with following.
 - 1. ^{a.} Section 270500 - Common Work Results for Communications.

REFERENCES

- 1. Reference Standards: See Section 014200 and Section 270500.

SUBMITTALS

- A. General: Submit in accordance with Section 014200 and Section 270500.
- B. Product Data and Installation Instructions - submit following:
 - 1. Wireless Access Point Cabling
 - 2. Wireless Enclosure.
- C. If providing pre-standards manufacturer system solution, submit installer/contractor certification documentation and channel certification information and requirements from manufacturer.

QUALITY ASSURANCE

- A. Comply with Category 6A installation practices when installing UTP data/voice cabling.

PART 2 - PRODUCTS

ACCESS POINT

- A. All Wireless Access Points will be supplied for installation by the contractor, by the University of Delaware IT-Network Services Department, as they are procured by way of existing internal contract pricing structure.

WIRELESS ENCLOSURES

- A. Wireless Enclosures, Ceiling-Mounted:
 - 1. Ceiling-mounted wireless enclosures shall be comprised of steel panel bridge, adjustable hanger wire, access point bracket, and trim for the appropriate Aruba model WAP.
 - 2. Each enclosure will be rectangular in shape sized to fit within a single 2' x 2' drop ceiling tile, as specified below.
 - 3. When installed into the ceiling, the body of the enclosure will be located above the drop ceiling supported from the ceiling tile support grid with included support brackets. One side of the enclosure will be flush with the drop ceiling.
 - 4. The junction box will be pre-punched with a knockout for trade size 1" conduit.
 - 5. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified by owner. Cable ports and mounting brackets will be mill finish.

6. The enclosure will be UL Listed for use within a plenum space. UL Listing will be stated in the manufacturer's product literature.
7. WAP Mounting for suspended, removable ceiling tiles – Contractor shall provide and install Oberon Inc. #1040 Series mounts.
8. WAP Mounting for solid, drywall ceiling – Contractor shall provide and install Oberon Inc. #1043 Series mounts. Provide and install single gang outlet for termination of horizontal cables in the back-box of the mounting kit, so it's accessible when removing the WAP itself. Provide and install in the following quantities:
9. WAP Mounting for "open" ceiling environments – Contractor shall provide and install Oberon Inc. #900-HC-BK Series hanging-conduit mounts in the following quantities, that shall be used for all models of Aruba WAP's (universal mount):
For all series Aruba WAP's, provide and install #900-HC-BK Kits.
10. Acceptable Manufacturers:
Oberon, Inc.
Accepted Substitute in accordance with Section Division 27.

PART 3 - EXECUTION

ACCESS POINT

- A. EXTERIOR BUILDING WIRELESS ACCESS POINT (WAP) LOCATIONS
 - 3.1 1. Exterior, beyond footprint of building – For locations that are within 295 ft. of TR, install outside rated Belden-Mohawk #M59198 CAT6A cables per previous section within these specifications.
 2. Outside conduit and poles for mounting independent cameras shall fall under the electrical contract.
- B. EXTERIOR WIRELESS ACCESS POINT (WAP) POLE INSTALLATION, EQUIPMENT AND PRODUCTS
 1. Hubbell/Spaulding Lighting Inc. pole for combination stand-alone WAP locations outside the footprint of the building shall utilize #SSS-16-40-1-AX-BL (Square, Straight, Steel, 16ft. long, 4" shaft, 11 gauge, single sided, black in color).
 2. Provide and install two (2) Belden-Mohawk #M59198 OSP communications cables for exterior WAP's that are beyond the footprint of the building at pole locations thru conduit installed at the poles, into telecommunications room
 3. Install one (1) UD-NSS provided WAP at each location, per contract drawings.
 4. Terminate both CAT 6A cables at the top of the pole where the WAP will be located with two (2) Siemon Co. Inc. #ZP1-6AS-01, Z-Plug Field Terminated Plug.
 5. Provide and install two (2) ITW-Linx Surgegate #CAT6A-75 protectors on wall of telecommunications room for each WAP, per drawings.
 6. For both CAT 6A cables, exit the conduit in the TR, and punch down into the input side of the ITW-Linx protectors. Provide, install, and punch down inside-rated CAT6A cables from the output sides of the protector locations, up into the cable tray, over to the patch panel field, and install two (2) Siemon Co. Inc. #Z6A-02 modules. Plug into the patch panel with all other horizontal cables. Patch Panel and associated panel ports shall be present and install under the "Intra-Building Cabling" contract.
- C. INTERIOR WIRELESS ACCESS POINT INSTALLATION
 1. Install above finished ceiling.
 2. Contractor shall install University of Delaware provided Aruba Access points. These access points will be programmed by the University of Delaware and shall be installed at exact locations defined by the contract drawings, and the University of Delaware assigned Network Engineer at the time of install.
 3. WAP Mounting for suspended, removable ceiling tiles – Contractor shall provide and install Oberon Inc. #1040 Series mounts.

4. WAP Mounting for solid, drywall ceiling – Contractor shall provide and install Oberon Inc. #1043 Series mounts. Provide and install single gang outlet for termination of horizontal cables in the back-box of the mounting kit, so it's accessible when removing the WAP itself. Provide and install in the following quantities:
 5. WAP Mounting for “open” ceiling environments – Contractor shall provide and install Oberon Inc. #900-HC-BK Series hanging-conduit mounts in the following quantities, that shall be used for all models of Aruba WAP's (universal mount):
For all series Aruba WAP's, provide and install #900-HC-BK Kits.
 6. Contractor shall provide/install TWO (2) 4-pair CAT6A cables from patch panel in associated floor telecommunications room to WAP location. Route cables into Oberon enclosures at each location. Terminate both cables onto Siemon Co. #ZP1-6AS-01 Z-Plug-Field Terminated Plug. Both cables shall be performance tested as per testing
a. section of this specification. Plug both cables into provided Aruba WAP ports, per UD-NSS connection data submittals. Horizontal cables shall be labelled as per UD NSS submitted circuit number on project drawings. Example for two cables at a WAP location: 105-100-1, 105-100-2 (room #, drop/location #, cable #). This is a slightly different scheme than the regular horizontal work area outlet labelling scheme.
 7. Locations for each model and associated model will be indicated in symbol set in project drawings. This equipment shall be picked up at the Computing Center on campus, and taken to the project site in coordination with the UD IT NSS Engineer.
 8. Contractor shall be responsible for picking up all of the above equipment from Network & Systems Services at the UD Computing Center, and transporting it to the project site telecommunications rooms.
- D. Coordinate with Owner's Representative for proper operating standard.

END OF SECTION