

SECTION 27 10 00
COMMUNICATION SYSTEMS

PART 1 - GENERAL

1.01 REQUIREMENTS

Contractor shall review all other documents for additional requirements and information that apply to the Work. If conflicts between this section and/or the general requirements and general conditions occur, the more stringent shall apply. Contractor shall deliver the complete communications system, including any design-build requirements of this section and the following drawings:

TN-001	Sheet Index and Notes
TN-100	Overall Floor Plans
TN-101A	First Floor Plan – Area A
TN-101Bn	First Floor Plan – Area Bn
TN-101Bs	First Floor Plan – Area Bs
TN-101C	First Floor Plan – Area C
TN-102C	Second Floor Plan – Area C
TN-501	Rack Elevations and Details
TN-701	Coordination Details
TN-801	MDF Room (1122) Enlarged Plans
TN-802	IDF Room (1810) Enlarged Plans
TN-803	IDF Room (2810) Enlarged Plans

1.02 PROJECT DESCRIPTION

- A. General:
1. Work includes the installation work for the entire voice/data infrastructure and cabling system throughout the addition space. All materials, installation and commissioning for the entire system is included under this scope of work, whether specifically delineated or not.
 2. Installation of backboxes and wall box connectivity points for OFE touch panel displays within each classroom.
 3. The Contractor shall be responsible for coordination with the work of all other trades for these systems.

1.03 SCOPE OF WORK

- A. The Contractor shall provide a turn-key system installation including, but not limited to, the installation of all low voltage, technology cable (backbone and horizontal station), jacks, faceplates, outlet housings, blank cover plates, patch panels, racks, cabinets, cable runway, TR cable trays and supports, cable ties, termination blocks, cross connect wire, patch cords, grounding, installed equipment, any miscellaneous items, labor and services required for a complete, standards and code-compliant communications system for the entire facility to meet the functional requirements outlined in this section.
- B. Labeling per TIA/EIA 606A:
1. At each workstation technology outlet, cable, faceplate and jack in the Work.
 2. At each telecommunications room, cable, patch panel port, punch-down location, rack, cabinet, and termination location in the Work.
- C. Fire stopping all telecommunication penetrations through the building structure as required by fire separations.

- D. Verification testing and documentation of each installed cable from the patch panel or termination block to the termination jack.
- E. Field verify site conditions including dimensions and clearances of all outlet locations (wall, floor, and furniture) prior to installation. Prior to installation by the Contractor, the Owner will confirm furniture termination locations.
- F. The Contractor will be held responsible to have examined the site and premises. They will be presumed to have satisfied themselves as to existing conditions under which they will be obligated to perform the work or that which will affect the work under this contract in any way.
- G. Permits: Obtain any necessary permits for the execution of this work in conformance with applicable union regulations, local, State and Federal codes and regulations.
- H. All aesthetic issues are to be coordinated and approved by the Owner, Architect, and Designer.
- I. Removal and reinstallation of any ceiling tiles that may be in place during the cable infrastructure installation that may hinder the telecommunication work. Contractor is also responsible for the replacement of any damaged ceiling tiles that are removed for the telecommunication work.
- J. Patch, repair, finish and paint any surfaces that are damaged or demolished for access during this work. Room finishes to be returned to initial condition.
- K. Coordinate with other trades to ensure that all required access and clearances to equipment and services are provided and maintained.
- L. Conduct testing and adjustment. Submit documentation required by this section. Participate in approval testing for acceptance by the Owner. Perform final adjustments as required to by this section.
- M. Verification testing and documentation for all backbone and tie cable as required by this section.
- N. Deliver to the Owner, bound "as-built" system documentation. Transfer all warranties and equipment guarantees to the Owner, at the time of acceptance of the work by the Owner.
- O. Provide system operation training as specified in Part 3 of this section.
- P. Provide, size, and install all conduit and penetrations, wire raceways, back boxes, and cabling connecting system components, as required by the communications system, not installed by the General Contractor.
- Q. Verify 120/208-volt AC power requirements and grounding busbar for each equipment location. Provide and coordinate installation of any additional or related cabling, or conductor circuits.
- R. Communications drawings depicting equipment installation and wiring are diagrammatic. The responsibilities for all types and final cable lengths throughout all phases of the Work are that of the Contractor.
- S. Provide size, and install all conduit and penetrations, wire raceways, back boxes, and cabling connecting system components as required by the Communication System, not installed by the General Contractor.

- T. Verify all conduit and penetrations, wire raceways, back boxes, mounting hardware to building structure, and cabling connecting system components, as required by the Communication System and installed by the General Contractor/Electrical Contractor as part of the base building fit out. Notify Owner of any discrepancies that may exist between the Shell Contract Documents and existing conditions.

1.04 QUALITY ASSURANCE

- A. All materials must be newly manufactured current production models and conform to all applicable codes and the relevant standards listed below:
 - 1. American National Standards Institute (ANSI)
 - 2. Institute of Electrical and Electronic Engineers (IEEE)
 - 3. Electronic Industries Alliance (EIA)
 - 4. Telecommunication Industries Association (TIA)
- B. Experience: The Contractor shall specialize in the installation of communications systems, have a minimum of five years of documented experience in the field of communications system installation and be a manufacturer approved vendor for all of the components installed.
- C. Supervision: Contractor shall designate a Project Manager and Foreman/Project Supervisor to oversee the installation work for the duration of the Work, to ensure that the system is installed in accordance with the section and drawings.
 - 1. Project Manager shall maintain adequate staff and be responsible for installing and testing the system on schedule.
 - 2. Project Manager and Foreman/Project Supervisor shall have at least five years of documented, recent and similar project experience.
- D. Contractor shall promptly notify the Owner, in writing, of any difficulties that may prevent proper coordination or time of completion of the Work. Failure to do so shall constitute acceptance of work and indicate that the site is suitable in all ways for this Work, except for defects that may develop in the work of others after commencement of system installation.
- E. Insurance: Provide evidence of insurance for the full value of equipment and material located on-site. Insurance shall cover losses due to fire, theft and vandalism, until the final acceptance of the system, by the Owner. Maintain additional liability insurance to protect the supplier and/or Owner, Architect, Designer against damage claims for personal injury, including death, which may arise during the performance of this work.

1.05 MANUFACTURERS QUALITY ASSURANCE

- A. Manufacturers must have a minimum of seven years experience manufacturing equipment designed specifically for voice and data communication networks. Manufacturers must be nationally known and recognized as competent in the construction and communication industries.
- B. Where this section and/or project drawings call for an installation to be made in accordance with the manufacturer's recommendations, a copy of such recommendations shall always be kept on the job site, and shall be available to the Owner's representative and the Architect.

- C. The Contractor shall follow manufacturer's instructions where they cover points not specifically indicated on in this section and/or project drawings. If the manufacturer's instructions differ from what is called for in this section and/or the project drawings, it is the responsibility of the Contractor to obtain clarification from the Owner's representative in writing before commencing work.

1.06 REFERENCES

A. General:

1. All work must conform to the most stringent of applicable codes. If during installation the Contractor identifies work that does not meet the most stringent code, the Contractor is to stop work immediately on that portion of the project and notify the Owner's representative in writing.
2. The Contractor must understand and have a working knowledge of all applicable codes and standards governing the Work.
3. The Contractor must follow the most current standard/code or the edition utilized by the authority having jurisdiction.

B. Codes:

1. National Electric Code, (NEC)
2. National Electric Safety Code (NESC)
3. National Fire Protection Association (NFPA) codes
4. State Codes:
 - a. STS-1000 Telecommunications Wiring Guidelines
 - a. Electric code
 - b. Building code
5. Local Municipal Codes:
 - a. Electric code
 - b. Building code

C. Industry Standard Requirements:

1. Underwriters Laboratories (UL)
2. Institute of Electrical and Electronic Engineers (IEEE):
 - a. IEEE 802.3 Ethernet
 - b. IEEE 802.11 Wireless LAN
3. ANSI/TIA:
 - a. ANSI/TIA-526-7-A Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant
 - b. ANSI/TIA-526-14-C Optical Power Loss Measurements of Installed Multi-mode Fiber Cable Plant
 - c. ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
 - d. ANSI/TIA-568-C.2 Balance Twisted Pair Communications and Components Standards
 - e. ANSI/TIA-568-C.2-2 Balanced Twisted-Pair Telecommunications Cabling and Components Standard, Addendum 2: Additional Considerations for Category 6A Patch Cord Testing
 - f. ANSI/TIA-568-C.4 Broadband Coaxial Cabling Components Standard
 - g. ANSI/TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard
 - h. ANSI/TIA-569-D Telecommunications Pathways and Spaces
 - i. ANSI/TIA-598-D Optical Fiber Cable Color Coding
 - j. ANSI/TIA-606-B Administration Standard for Telecommunications Infrastructure

- k. ANSI/TIA-606-B-1 Administration Standard for Telecommunications Infrastructure Addendum 1- Automated Infrastructure Management Systems - Addendum to ANSI/TIA-606-B
 - l. ANSI/TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - m. ANSI/TIA-758-B Customer-Owned Outside Plant Telecommunication Infrastructure Standard
 - n. TIA-862-B Building Automation Systems Cabling Standard
 - o. ANSI/TIA-942-A Telecommunications Infrastructure Standard for Data Centers
 - p. ANSI/TIA-942-A-1 Telecommunications Infrastructure Standard for Data Centers, Addendum 1 - Cabling Guidelines for Data Center Fabrics
 - q. ANSI/TIA-1005-A Telecommunications Infrastructure Standard For Industrial Premises
 - r. ANSI/TIA-1005-A-1 Telecommunications Infrastructure Standard For Industrial Premises, Addendum 1- M12-8 X-Coding Connector - Addendum to TIA-1005-A
 - s. ANSI/TIA-1183-1 Measurement Methods and Test Fixtures for Balun-Less Measurements of Balanced Components and Systems, Extending Frequency Capabilities to 2 GHz - Addendum to TIA-1183
 - t. ANSI/TIA-1152 Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
 - u. ANSI/TIA-1179 Healthcare Facility Telecommunications Infrastructure Standard
 - v. ANSI/TIA-1183 Measurement Methods and Test Fixtures for Balun-Less Measurements of Balanced Components and Systems
 - w. ANSI/TIA-4966 Telecommunications Infrastructure Standard for Educational Facilities
 - x. TIA-104-B, FOTP-104 Fiber Optic Cable Cyclic Flexing Test
 - y. TIA-455-25-D, FOTP-25 Impact Testing of Optical Fiber Cables
 - z. TIA-604-18, FOCIS 18 Fiber Optic Connector Intermateability Standard – Type MPO-16
 - aa. TIA-604-5-E, FOCIS 5 Fiber Optic Connector Intermateability Standard – Type MPO
 - bb. TIA-5017, Telecommunications Physical Network Security Standard
 - cc. TIA-TSB-155-A Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T
 - dd. TIA-TSB-184 Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling
 - ee. TIA-TSB-4979 Practical Considerations for Implementation of Multi-mode Launch Conditions in the Field
 - ff. TIA-TSB-190 Guidelines on Shared Pathways and Shared Sheaths
 - gg. TIA-TSB-162-A Telecommunications Cabling Guidelines for Wireless Access Points
 - hh. TIA-568-C.3 Optical Fiber Cabling Components Standard
 - ii. TIA-568-C.3-1 Optical Fiber Cabling Component Standard- Addendum 1, Addition of OM4 Cabled Optical Fiber and array connectors
4. ISO/IEC
- a. ISO/IEC 11801 - Information Technology – Generic Cabling For Customer Premises
 - b. ISO/IEC TR 11801-99-1 – Balanced cabling for 40Gbps channels
 - c. ISO/IEC 15018 - Information Technology – Generic Cabling for Homes
 - d. ISO/IEC 24702 - Information Technology – Generic Cabling – Industrial Premises
 - e. ISO/IEC 24764 - Information Technology – Generic Cabling Systems For Data Centres

- f. ISO/IEC 24764-1 - Data Centers - Amendment to add Intermediate Distributor (ID) for large or modular data centers
- g. ISO/IEC 14763-2 - Implementation and Operation of Customer Premises Cabling – Part 2: Planning and Installation
- h. ISO/IEC 14763-3 – Testing of Optical Fiber Cabling – methods for inspection and testing of installed optical fiber
- i. ISO/IEC TR 29125 - Information technology -- Telecommunications cabling requirements for remote powering of terminal equipment
- 5. ASHRAE:
 - a. ASHRAE Standard 90.4P, Energy Standard for Data Centers and Telecommunications Buildings
- 6. BICSI – Building Industry Consultative Services International:
 - a. BICSI 004, Information Technology Division Systems Design and Implementation Best Practices for Healthcare Institutions and Facilities
 - b. ANSI/BICSI 005, Electronic Safety and Security (ESS) System Design and Implementation Best Practices
 - c. Information Transport Systems Installation Methods Manual (ITSIMM)
 - d. ANSI/BICSI 002, *Data Center Design and Implementation Best Practices*
 - e. Network Systems and Commissioning (NSC) reference, 1st Edition
 - f. ANSI/NECA/BICSI 568, Standard for Installing Commercial Building Telecommunications Cabling
 - g. NECA/BICSI 607, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings
 - h. ANSI/BICSI 001, Information Transport Systems Design Standard for K-12 Educational Institutions
 - i. BICSI-003 Building Information Modeling (BIM) Practices for Information Technology Systems
 - j. Telecommunications Distribution Methods Manual
 - k. AV Design Reference Manual
 - l. Network Design Reference Manual
 - m. Outside Plant Design Reference Manual
 - n. Wireless Design Reference Manual
 - o. Electronic Safety and Security Design Reference Manual
 - p. Commercial Installation On-the-Job Training Booklet
 - q. Telecommunications Project Management (TPM) reference
- 7. Rural Utilities Service (RUS):
 - a. Bulletin 1753F-201: RUS Standard for Acceptance Tests and Measurements of Telecommunications Plant

1.07 SUBMITTALS

- A. Contractor shall comply with the general requirements and general conditions of this section.
- B. Bid submittals. Contractor shall submit the following qualification documents with the bid proposal:
 - 1. Firm description of the Contractor, and a copy of the Contractor's license, as well as a statement regarding the relationship of the license holder to the Contractor.
 - 2. Provide a minimum of ten related projects, four of which must have been completed within the last 12 months. Provide a full description of work, bid price, cost of change orders, reason for change orders, owner representative's name, telephone number and email address for each project.
 - 3. Résumé of Project Manager and Foreman/Project Supervisor documenting related experience. Foreman/Project Supervisor must have completed at least two similar installations in the past 12 months.

4. Submit a list including names, firm description, job foreman, copy of license and scope of work, for any subcontractors whose work would be part of this contract.
5. Submit insurance certificates - amount and type of liability as required by Owner.
6. Submit proof of Contractor's worker's compensation coverage.
7. Data manufacturers:
 - a. Specific pre-approved manufacturers are listed in this section. This list must be adhered to throughout the bidding and installation phases of the project. The bidder may suggest other paired manufacturers to be used based on the criteria outlined in this section, but these alternate manufacturers must be presented as an equal to the pre-approved manufacturers listed below. The suggested alternates may not be approved by the Owner and therefore must be presented secondarily with the approved manufacturers to be considered.
 - b. The bidding Contractor must also provide specific part numbers for all components in the channel/link solution. Only general guidelines are provided below with respect to manufacturers. Final approval of suggested/bid products is up to the Owner.
 - c. The preferred manufacturers/systems are:
 - i. Panduit/Belden
 - ii. Berktek/Leviton
 - d. Other acceptable manufacturers include:
 - i. Legrand/Superior Essex
 - ii. AMP/TE Connectivity
 - iii. Corning
 - iv. Ortronics
 - v. Hubbell
 - vi. Erico
 - vii. Siemon/CommScope
 - viii. Chatsworth
 - ix. Southwest Data Products
 - x. Nelson
 - e. The bidder is to take into consideration the consequences of pairing up component and cable manufacturers to the overall warranty of the system. The Owner considers this system as a whole and requires an integrated component/cable warranty on all material and labor as described below.
 - f. Refer to the project documents and this section for more detailed descriptions of products. The bidder is required to include all components necessary to provide a complete technology system as described in this section and noted in the associated project drawings.
8. Submit a detailed list of equipment and materials to be provided for the Work specified herein and on the project drawings. Include a list of the items for which submittals will be provided.
9. Submit manufacturer's product cut sheet documentation for the following materials and/or equipment, clearly noting each product and part number for review and approval:
 - a. Equipment racks
 - b. Equipment cabinets
 - c. All related seismic restraints
 - d. All cable types (copper and optical fiber)
 - e. All patch bays (fiber, copper and coax)
 - f. All connection/termination blocks (copper)
 - g. All technology outlets housing material
 - h. All technology outlet jack types and housings
 - i. All cable support material (cable runway, j-hooks, etc)
 - j. Fire stop material
10. Submit bid pricing worksheet for review with bid

- a. Bidder is to generate a pricing worksheet that indicates manufacturer, manufacturer part number and product costs plus installation costs for review by the Owner.
 - b. Bidder is to itemize any miscellaneous materials.
 - c. All costs in the bid pricing worksheet are to be inclusive of a turn-key communications system installation.
11. Submit a constant price affidavit - pricing good for one year from date of submittal.
 12. Submit manufacturer's 25-year extended warranty statement.
 13. Submit Contractor's 1-year warranty and service statement.
 14. Provide a statement indicating all materials are readily available. If not, provide a recommended solution as an alternate.
 15. Submit any other information and copies as required in the project's general requirements and Owners' supplemental information.
- C. Construction submittals:
1. Submittals to be submitted three weeks after written notification to proceed.
 2. Before ordering equipment, submit catalog data sheets, neatly bound with title page, space for submittal stamps and tabbed dividers between sections. List all equipment with reference to corresponding section paragraph numbers or equipment title. Denote all approved substitutions.
 3. Provide shop drawings and record drawings using the following scales:
 - a. Plans - not less than 0.125-inch = 1-foot
 - b. Details - not less than 0.25-inch = 1-foot
 4. Submit point-to-point wiring diagrams and typed wire lists identifying every connection. Indicate location of all components. Identify cables by type, color and wire number.
 5. Submit detailed floor plans, reflected ceiling plans, sections and elevations of all telecommunication rooms illustrating termination locations and associated wiring scheme.
 6. Submit system plans showing all device locations.
 7. Submit conduit riser diagrams showing connection of all devices along with types and quantities of cables to be used and cable identification tags.
 8. Submit conduit, sleeve and cable tray fill calculations.
 9. Submit rack layouts indicating the proposed arrangement of mounted equipment.
 10. Submit fully dimensioned construction details of all coordination items, such as panel or plate installation in casework or millwork.
 11. Submit a schedule of finishes indicating proposed materials and color selections options (from manufactures standard finishes) for approval by Owner/Architect.
 12. Submit samples of engraved labels, cable-marking system, and faceplate etching/finishes.
 13. Submit complete mockups of all faceplate types and verification that they are compatible with the locations and enclosures, including floor boxes and furniture, in which they will be installed.
 14. Submit samples of any cabling, device, or other IT system element that is being presented as an alternate.
 15. Submit mounting and support details for equipment racks, cable trays, and all other items mounted overhead, complete with parts lists and dimensions. Include a full plan view, front elevation and side elevation of each item, with corresponding support structure and mounting hardware. Verify load ratings of all hanging components including attachment hardware. A structural engineer registered in the State shall stamp details.
 16. Validation walkthrough submittals: Prior to requesting the validation walk through, submit copies of all "as-built and test report information" required in Part 3 of this section to the Designer.

1.08 PROJECT CLOSE OUT

- A. The Contractor shall provide type written and computer readable documentation, which indicates materials acceptance testing was conducted as outlined in this document. The Contractor shall also provide documentation that indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion for Owner/Designer analysis.

- B. After approval of the copy of all as-built and test report documents, submit the following to the Architect:
 - 1. Two sets of full size prints
 - 2. Three sets of reduced B or half size prints whichever is larger.
 - 3. Five bound sets of all paper test results in three-ring binders. Divide information into sections and binders as required to fit into a maximum of 3-inch D-ring binders.
 - 4. Five project close out DVD/CD-ROM disks.

- C. As-built drawings:
 - 1. Maintain a full set of shop drawings at the project site, marked up to indicate actual locations in general, the true state of the installation.
 - 2. Cableway and cable schematic illustrating point-to-point connections between all terminal points within the backbone cabling system.
 - 3. Complete riser diagram showing backbone interconnection and cable routing. Each cable type must be noted.
 - 4. Detailed elevations of the voice and data telecommunications room illustrating punch-down location and equipment rack locations.
 - 5. Equipment rack elevations illustrating vertical location of termination hardware (e.g. fiber boxes, patch panels, etc.) within all IT/telecom rooms and ceiling enclosures.
 - 6. Mounting and attachment details illustrating the connection of equipment racks and cabinets to the structure.
 - 7. Outlet layout floor plans including room/area numbers, outlet numbers and the corresponding cable identification numbers.
 - 8. Two sets of A size drawings showing the components and wiring in each individual rack. A drawing of each rack shall be mounted in a plastic jacket in the telecommunication room near the associated rack. The other complete drawing set shall be included in the manual.

- D. Bound Manuals:
 - 1. Bound manuals must be:
 - a. Neatly presented in a three-ring binder and tabbed into separate sections.
 - b. Divide information into sections and number of binders as required.
 - c. Binders are to be a maximum of 3-inch thick D-ring binders.
 - d. Provide spine and front cover labels for each binder, label to call out building name, general contents of binder and volume number if multiple binders are required.
 - e. Contain a table of contents.
 - f. Provide the company name, address, telephone number and contact name for system service or maintenance in a clear plastic sleeve in the very front of the binder.
 - g. Provide clear plastic three-ring binder sleeve for DVD/CD-ROM. DVD/CD-ROM to be located behind the table of contents of each bound manual.
 - 2. The "Test Report Manual" will contain the following:
 - a. Cable run sheets: The information included on the run sheet shall be:
 - i. Separated by each floor and then by each cable type
 - ii. Cable source
 - iii. Cable destination

- iv. Cable type (e.g. horizontal riser, vertical riser, technology outlet, etc)
 - v. Generic cable section (e.g. OSP, Cat-6, fiber, etc)
 - vi. Manufacturer's cable section number
 - vii. Cable jacket color
 - viii. Cable label number
 - ix. Test results for each cable
3. The "Warranty, Operations, Maintenance Manual" will contain the following:
- a. Narration of system and patching procedures for this system.
 - b. Small scale plans showing locations and circuit numbers for all system outlets and receptacles.
 - c. Single-line block diagrams showing all major system components.
 - d. Listing of all equipment and materials with names of manufacturers and model numbers or part numbers.
 - e. Catalog data sheets displaying manufacturer's names, addresses and telephone numbers.
 - f. Results of all tests called for in Part 3 of this section.
 - g. Provide a narration of any manufacturer suggested maintenance for any of the materials.
 - h. Provide copies of Contractor and manufacturer warranties.
4. DVD/CD-ROM format:
- a. Submit copies of all information presented in the bound manuals on DVD/CD-ROM media.
 - b. Files shall use long windows names file structure.
 - c. A disk master file list in text format shall be placed on the DVD/CD-ROM with a short description of files on that disk.
 - d. Architectural drawings shall be in AutoCAD 2004 or later drawing (.DWG) format. Drawing Exchange File Format (.DXF) shall not be acceptable. All XREFs, fonts, and other drawing parts necessary to the drawings shall be included.
 - e. Network drawings shall be in Visio 2010 and AutoCAD 2004 or later drawing (.DWG) format. Drawing exchange file format (.DXF) shall not be acceptable. All XREFs, fonts, and other drawing parts necessary to the drawings shall be included.
 - f. All test report data.
 - g. Complete working copy of electronic software used to generate the test results for review by the Owner/Designer.
 - h. Documents and spreadsheets shall be in Microsoft Office 2010 or later format.
 - i. All files to be converted to searchable PDF files in addition to the native drawing, document and spreadsheet formats.
 - j. Manufacturers' manuals provided by the manufacturer to the Contractor or documents that are similarly not otherwise available to the Contractor in electronic format shall be excluded from this requirement.

1.09 GUARANTEES AND WARRANTIES

- A. Transfer all manufacturer and subcontractor's warranties to the Owner at the acceptance of all work.
- B. Register warranty in the Owner's name for any product with a manufacturer's warranty of more than one year.
- C. The warranty must include, but will not be limited to, the following statements regarding the cabling system:

1. "Will support and conform to TIA/EIA-568-C sections covering ANY CURRENT OR FUTURE APPLICATION which supports transmission over a properly constructed horizontal cabling system premises network which meets the channel and/or basic link performance as described in TIA/EIA-568-C."
 2. "The Warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective product(s)."
 3. The warranty shall not be for less than 20-years.
- D. The warranty will not begin until after a 90-day period from the final date of acceptance, by the Owner. If during this period the installed system does not perform adequately, the Contractor must repair the installation within 24-hours to the satisfaction of the Owner and this section. Provide loaner equipment as required to keep the system operational if the system cannot be repaired within 24-hours of notification.

1.10 OWNER FURNISHED EQUIPMENT

- A. Certain equipment may be identified as owner furnished equipment (OFE). This OFE may presently be part of the Owner's systems or will be provided by the Owner, and will be delivered to the Contractor's off-site construction facility, delivered to the Contractor's on-site secured storage area or installed on site by others, as appropriate, for incorporation into the system.
- B. Clean and inspect the OFE, and notify the Owner in writing of damage or defect and the extent of repair and/or adjustment required to bring the OFE to original specification. Service OFE only as directed by the Owner under the arrangements of a separate contract.
- C. Incorporate into the system as if provided new, excepting warranty coverage.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Components are to operate on a 110-120 volt, 60 Hz electrical supply unless otherwise noted. Rack mounted equipment is to be mounted in a standard EIA 19-inch rack. The components listed in the equipment schedule are the basis of the system design and represent the minimum standards for each of the components. All of the properties of each component or system should be considered listed in full.
- B. The components listed in the equipment schedule are the basis of the communications system design and are the owners' preferred components. They represent the minimum functional and performance standards for each of the components. All of the properties of each component or system should be considered listed in full.
- C. Equipment, excepting the owner furnished equipment (OFE), and materials shall be new. The latest version at time of delivery and shall conform to applicable UL, CSA, ANSI, TIA/EIA provisions. Take care during installation to prevent scratches, dents, chips, etc.; equipment with significant or disfiguring cosmetic flaws will be rejected.

2.02 OUTLET JACKS AND CONNECTORS

- A. Materials:
 1. All modular data outlet jacks shall be rated to perform above the minimum TIA/EIA-568-C performance level for Category-6A.
 2. All Category-6A outlet jacks shall have an eight position, eight conductor module that accepts both RJ45 and RJ11 modular plugs. Outlet jacks must utilize the TIA/EIA-T568-C pin-out wiring scheme.

3. All Category-6A outlet jacks and the associated channel components must support gigabit Ethernet transmission speeds up to ninety meters.
4. All modular Category-6A outlet jacks shall be coordinated with faceplate color.
5. All optical fiber multi-mode modular outlet jacks shall be duplex LC connectors that are rated and approved by the manufacturer to perform at the level designated by the optical fiber strands terminated within each connector.
6. Preferred UTP copper jack manufacturers:
 - a. Belden
 - b. Leviton
 - c. Hubbell
 - d. Ortronics
 - e. Panduit
 - f. Siemon
 - g. CommScope
7. Preferred optical fiber termination connector manufacturer and systems:
 - a. Corning Unicam LC system
 - b. Panduit LC system

2.03 OUTLET HOUSING

- A. Materials:
1. Flush mounted faceplates in all technology outlet locations shall be a minimum of four, port plates. Color of each flush-mount faceplate must be coordinated with the Architect before purchase to match the electrical faceplate trim color.
 2. All outlet housing components must provide TIA/EIA-606 labeling spaces for each individual outlet jack and for the outlet housing.
 3. Faceplates for wall-mounted phones shall be one-port single gang faceplates that have wall-mount lugs allowing vertical phone mounting.
 4. Faceplates and connectors for floor-mounted outlets must be coordinated with the floor box that will be provided for the project.
 5. Furniture faceplates and connectors shall be capable of fitting in the furniture system selected by the Owner. Quantity of faceplates and connectors shall satisfy outlet jack requirements shown on drawings. Faceplate extenders shall be provided and used by the Contractor, if required, to maintain proper bend radii. Colors must be coordinated with the Owner before purchase.
 6. Preferred outlet housing manufacturers:
 - a. Belden
 - b. Leviton
 - c. Hubbell
 - d. Ortronics
 - e. Panduit
 - f. Siemon
 - g. CommScope

2.04 CABLE

- A. General:
1. All cable is to be plenum rated, unless otherwise noted.
 2. All plenum cable shall be designated "non" or limited combustible and be rated CMP-50 by the manufacturer with verification available, if requested, from an independent party.
 3. All cable shall be UL listed.
 4. All cable manufacturing shall be ISO 9001 certified.

- B. Category-6A cable:
1. All Category-6A, four pair cables will consist of eight, 20-26 gauge thermoplastic insulated solid twisted conductors that utilize the standard color code within a blue colored plenum jacket.
 2. The performance criteria for the Category-6A station cables shall be in accordance with the specific standards for the particular cable's rating. A Category-6A-rated cable must perform beyond the current section parameters for the published Category-6A rating by TIA/EIA-568-C series standards before, and after installation.
 3. All Category-6A cabling and the associated channel components must support ten gigabit Ethernet transmission speeds up to ninety meters.
 4. Preferred Category-6A cable manufacturer and systems:
 - a. Superior Essex 10Gain XP System
 - b. BerkTek LANmark-XTP System
 - c. Belden 10GXS System
 - d. CommScope GigaSPEED X10D System
- C. Multi-mode optical fiber cable:
1. All multi-mode optical fiber cable strands must be ISO/IEC 11801 Optical Multimode 3 (OM3) rated and have an outside cladding diameter of 125 micrometers and an inside core diameter of 50 micrometers with a dual operational wavelength of 850 nanometers and 1300 nanometers over distances less than 5 kilometers.
 2. All multi-mode optical fiber cables must contain a series of Kevlar strands for tensile strength reinforcement and contain a dry water propellant mechanism within the metallic interlocked armor if there is a possibility of water contamination at any point in the pathway.
 3. All multi-mode optical fiber cable shall exhibit stable performance in a building environment and the transmission performance of the optical fiber shall not be adversely affected by environmental fluctuations, installation conditions/methods, and/or aging.
 4. All multi-mode optical fiber cable shall be OFNP-rated, and all cable jackets shall have the industry standard orange coloring, that is constructed with a metallic interlocking armor directly encased within the jacket for protection, unless otherwise noted.
 5. The performance criteria for the multi-mode optical fiber cable shall be in accordance with the specific standards for the particular cable's rating by TIA/EIA-568-C.
 6. Preferred multi-mode optical fiber cable manufacturer and systems:
 - a. Corning Interlocking armored MIC cable system
 - b. CommScope Interlocking armored cable system
 - c. BerkTek Interlocking armored cable system

2.05 PATCH PANELS

- A. General:
1. All patch panels are to be rack mountable within industry standard TIA/EIA, 19-inch mounting rails.
 2. Unused ports or slots are to have blank inserts installed.
 3. Panels are to be UL-listed.
 4. All patch panels shall be produced by the same manufacturer that produces the outlet jacks for that system.
- B. UTP patch panels:
1. All installed UTP patch panels shall be forty-eight (48) port Category-6A patch panels with a 110-style termination connection on the back of the panels and a single RJ45 module on the front for each port, unless otherwise noted on the project drawings.

2. All installed UTP patch panels shall include horizontal cable management brackets directly behind the 110-style termination point.
 3. The performance criteria for the UTP patch panels must exceed the Category-6A parameters for frequency, attenuation, near end cross-talk (NEXT), attenuation to cross-talk ratio (ACR), power sum NEXT (PS-NEXT), power sum ACR (PS-ACR), equal level far end cross-talk (EL-FEXT), power sum far end cross-talk (PS-FEXT), and return loss (RL) as set forth in TIA/EIA-568-C.
 4. UTP patch panels are to utilize the TIA/EIA-T568-C pin-out termination scheme.
 5. UTP patch panel manufacturer and systems:
 - a. Panduit shall be the preferred patch panel manufacturer.
- C. Optical fiber patch panel trays:
1. All optical fiber patch panel trays shall be either 12-port, 24-port, 48-port or 96-port optical fiber trays that are modular in design and are able to accept various types of optical fiber connectors, and specifically LC connectors, unless otherwise noted on the project drawings.
 2. All optical fiber patch panel trays and associated bulkhead inserts shall have factory numerical labeling included in the design and presentation to the user side of the panel.
 3. All optical fiber patch panel trays must include bend radius control in the front of the panel for optical fiber patch cords and bend radius control inside the tray for optical fiber strand protection.
 4. The optical fiber patch panel bulkheads that house the terminating modules for the fiber cabling and any station optical fiber cabling shall accept TIA/EIA-568-C standard-compliant LC connectors.
 5. All fiber is to be terminated in fiber shelves/patch panel trays in counts indicated on the project drawings. In general, fiber will be terminated by type, i.e., all multi-mode terminated in one shelf and all single mode terminated in one shelf. However, the product must also have the capability of terminating both single-mode and multi-mode fiber in the same shelf/patch panel tray, if necessary.
 6. All termination modules are to have LC duplex connectors within the fiber tray(s).
 7. Optical fiber patch panel tray manufacturer and system:
 - a. Panduit shall be the preferred fiber panel manufacturer.

2.06 PATCH CORDS

- A. General:
1. All patch cords are to be shipped pre-assembled, verified and tested from the factory in sealed packages.
 2. On-site terminations will not be allowed under any circumstances.
 3. All patch cords shall be manufactured by the same manufacturer that produces the outlet and/or backbone connectivity components of system.
 4. All patch cords shall be approved by the Owner in writing prior to purchase.
- B. Category-6A copper patch cords:
1. All copper patch cords shall have stranded conductors that match the TIA/EIA-568-C performance characteristics of the solid conductor Category-6A cable specified.
 2. All Category-6A patch cords must utilize the TIA/EIA-568-C wiring scheme.
 3. All Category-6A voice and data patch cord colors are black.
 4. All Category-6A patch cord counts and lengths are noted in this section.
- C. Multi-mode optical fiber patch cords:
1. All multi-mode optical fiber patch cords must be LC duplex type cords.
 2. All multi-mode optical fiber patch cord colors are orange.
 3. All multi-mode optical fiber patch cord counts and lengths are to be confirmed with the Owner prior to purchase.

- D. The Contractor shall provide all patch cords required within the telecommunications rooms to meet functional requirements of the contract documents as well as the following additional category-6A patch cords in white:
 - 1. (70) – 5' patch cords
 - 2. (10) – 10' patch cords
 - 3. (10) – 20' patch cords
- E. The Contractor shall provide all patch cords required within each office and classroom to meet functional requirements of the contract documents as well as the following additional category-6A patch cords in blue:
 - 1. (6) – 10' patch cords
- F. The Contractor shall provide all patch cords required within each CTE room to meet functional requirements of the contract documents as well as the following additional category-6A patch cords in blue:
 - 1. (40) – 6' patch cords
- G. The Contractor shall provide all patch cords required within each Science Lab and Resource room to meet functional requirements of the contract documents as well as the following additional category-6A patch cords in blue:
 - 1. (15) – 6' patch cords

2.07 WIRE MANAGEMENT

- A. All horizontal wire management on 19-inch relay racks shall be one-RU and two-RU panels, as noted on the project drawings. All 19-inch horizontal managers must have sufficient depth to allow for TIA/EIA-568-C standard copper and fiber bend radii.
- B. All vertical wire management on 19-inch relay racks shall be six inches in width as noted on the project drawings. Vertical wire managers will be single and double sided, as noted. All 19-inch vertical wire managers must have sufficient depth to allow for TIA/EIA-568-C standard copper and fiber bend radii.
- C. Wire management manufacturer and systems:
 - 1. Panduit shall be the preferred wire management manufacturer.

2.08 CABLE RUNWAY SYSTEM

- A. All industry one and one-half inch high standard cable runway shall be manufactured with tubular steel rails 12-inches, 18-inches, or 24-inches, in width configured with industry standard one and one-half inch ladder cross bars positioned twelve inches on center perpendicular to the rails, as called for on the project drawings. Wire frame runway systems are not acceptable.
- B. Cable runway system shall include all components to install the support and bracing system including but not limited to: runway rails, end caps, wall angle support brackets, bonding straps, butt splice kits, junction splice kits, and top rack-to-runway mounting kits.
- C. All cable runway system components shall be grounded and bonded per TIA/EIA-607 standards.
- D. All cable runway system components shall be anodized, unless otherwise noted.

- E. Preferred cable runway system manufacturers and systems:
 - 1. Chatsworth Cable runway system
 - 2. SWDP Cable runway system
 - 3. Cooper B-Line Cable runway system

2.09 RELAY RACKS

- A. All open frame relay racks shall be aluminum, EIA standard 19-inches wide by 7-feet high height, with four posts and 45-RU of useable space.
- B. All open frame relay rack shall include components to brace it to the structure below and seismically braced from above as required for Zone 4, and noted on the project drawings.
- C. All open frame relay racks shall be grounded and bonded per TIA/EIA-607 standards.
- D. All open frame relay racks shall be anodized, unless otherwise noted.
- E. Racks are to be rated for the Uniform Building Code Seismic Zone 4.
- F. Power strips:
 - 1. Vertical mount power strips are to be provided at the rear of each rack, with pigtails connected to power receptacles provided by others.
 - 2. The power strip shall have a minimum of fourteen (14) 20Amp 120VAC receptacles.
 - 3. For racks with UPS, route pigtail to UPS receptacles.
- G. Relay rack manufacturers and systems:
 - 1. Panduit shall be the preferred rack manufacturer.

2.10 CABLE TIES

- A. All cable ties and all Velcro cable wraps shall be provided inside each IT/telecom room and where necessary per industry and TIA/EIA-568-C standards.
- B. Velcro cable wraps shall be used IT/telecom room; nylon style cable ties shall not be used in any of the wire management systems in the IT/telecom room.
- C. Velcro cable wraps shall be used for patch cords where installed to help manage patch cords.
- D. Acceptable cable tie manufacturers:
 - 1. Velcro Velcro cable ties
 - 2. Leviton Velcro cable ties
 - 3. Hubbell Velcro cable ties
 - 4. Ortronics Velcro cable ties
 - 5. Panduit Velcro cable ties
 - 6. Siemon Velcro cable ties

2.11 FIRE STOPPING

- A. All fire stopping material associated with the telecommunications transport system shall comply with all applicable laws, regulations, standards, and codes and shall be re-enterable by design.
- B. All fire stopping material shall re-establish the integrity of fire-rated walls, floors, ceilings, etc when these barriers are either partially or completely penetrated by cables, conduit, slots and other penetration elements.

- C. All fire stopping shall ensure that all floor and wall penetrations comply with the "F" and "T" ratings of ASTM E-814 after all work has been completed. Thickness or depth of fire stopping material(s) shall be as recommended by the material manufacturer and backed by formal ASTM E-814 tests.
- D. All fire stopping material shall provide fire-resistance protection using a mechanical fire stop system that consists of pre-manufactured elastomeric components shaped to fit around standard cables, tubes, and conduit.
- E. If a non-mechanical fire stop system is to be used, the Contractor shall state what form will be used and state the properties of the material to be used in each specific situation, i.e., putty (with intumescent sheet materials, ceramic fiber or rock wool fill), caulk, silicone foam, pre-manufactured "pillows", or other materials of a cement-like nature.
- F. All fire stopping materials and methods shall be approved by the Owner prior to purchase and installation.
- G. Preferred fire stopping manufacturer:
 - 1. Nelson Firestop material
 - 2. 3M Firestop material

2.12 CABLE TESTER

- A. The utilized cable tester shall be a Level-III compliant tester certified by an independent laboratory such as ETL.
- B. The Owner requires that the Contractor utilize the following specific testers to ensure proper verification of the installed cable plant:
 - 1. Fluke CableIQ Qualification Tester
 - 2. Ideal Networks LanTEK III

2.13 LABELS

- A. All labels shall be machine-manufactured by a labeling machine provided by the Contractor and must have a neat and uniform appearance.
- B. Handwritten labels will not be accepted.

2.14 INTERCOM

- A. Basis of design for the intercom system will follow (expand) the existing Bogen Communications, Inc Quantum Multicom IP specification as provided by Bogen Communications, Inc.
- ~~B. Loudspeakers are to be ceiling mounted devices.~~
- C. Ceiling mounted VOIP Intercom loudspeakers to be adjusted to 2W SPL level within the software.
- D. Exterior intercom to be Bogen ADP1 two-way terminal.
- ~~E. Paging Horns and Ceiling mounted Loudspeaker 25 Volt system.~~
- ~~F. Paging Amplifier 250 watts~~

PART 3 - EXECUTION

3.01 GENERAL

The following is required for acceptance of the communications system by the Owner:

- A. Install complete and functioning communications system.
- B. Label equipment and cables corresponding to functional diagram.
- C. Conduct adjustments and testing.
- D. Report results of testing along with system documentation.
- E. Participate in validation walkthrough and deliver final system and documentation.
- F. Conduct any adjustments or re-testing required to meet the performance sections.
- G. Provide training to an individual(s) designated by the Owner/Architect/Designer.
- H. Complete the work as called for in this section and on the project drawings.
- I. The Contractor's personnel shall be knowledgeable of the following communication practices:
 - 1. Color coding of telephone cables
 - 2. Bonding and grounding of shields
 - 3. Testing conductors for electrical continuity, polarity and sequence
 - 4. Special handling of fiber optic cable assemblies
 - 5. Industry-standard cable termination methods, such as, but not limited to: 110 connector blocks, RJ jacks, and fiber connectors
 - 6. TIA/EIA-568-C standards for UTP and optical fiber installation and testing procedures
 - 7. NEXT, signal attenuation, and noise burst test procedures for UTP
 - 8. Power metering of fiber optic cables
 - 9. Industry and manufacturer's installation, testing instructions and verification documentation for all other products specified in this document
- J. Work shall conform to all Owner, OSHA, State, job site, and labor requirements.
- K. All trade contractors must follow all rules of the job site specified by the Owner and by the project's General Contractor.
- L. All work must be completed in a timely fashion following the published start and completion dates.
- M. Coordinate construction schedule with the Owner and General Contractor before beginning installation.
- N. Ensure preceding trade's work is accurate before proceeding with the technology infrastructure installation. Examples of work which must be verified and approved, in writing include, but are not limited to:
 - 1. Electrical requirements (conduit installation and capacity, power receptacle location and type, grounding system, and pull strings by other trade contractors).
 - 2. Telecommunications rooms sizes and verification they have been constructed to the size shown on the project drawings.

- 3. Adequate clearances of doors, riser spaces, vertical dimensions and ceilings.
- O. Stage the installation equipment in dedicated telecommunications space to avoid damage and interference with other trades.

3.02 INSTALLATION

- A. All materials shall be firmly secured in place per the manufacturer's installation guidelines unless requirements of portability dictate otherwise in the project documents.
- B. Fastenings and supports shall be adequate to support their loads with a safety factor of at least three times. Requirements for Zone 4 seismic bracing and earthquake safety shall be met at all times.
- C. All boxes, equipment, materials, outlet housing, etc., shall be secured, plumb and square unless otherwise indicated by the project documents and/or the manufacturer's installation instructions.
- D. In the installation of equipment and cable, consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.
- E. Protective covers normally shipped with the connector shall remain over the connector after installation. The cover shall be held in place with electrical tape or plastic tie-wraps if there is any chance of it being dislodged during construction and move-in.
- F. Any connector (including all hardware) that is not normally shipped with a protective cover shall be covered with a clear non-conductive medium, such as heat-shrink or plastic wrap, to protect against dust, paint and moisture. Protective covering shall not cover cable or station identification.
- G. Leave nylon pull strings in all conduits and pathways for future installations. The nylon pull string must have a minimum tensile rating of 200-pounds.

3.03 COPPER CABLE

- A. Install all copper cable per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA-568-C, and in counts indicated on the project drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly unless otherwise indicated on the project drawings.
- C. Install the copper cable in groups according to quantities listed on the project drawings.
- D. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded.
- E. All cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the Owner.
- F. All cables shall be clearly labeled on both ends and in an accessible location no more than two-feet from the cable ends.

3.04 OPTICAL FIBER CABLE

- A. Install all optical fiber cable per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA-568-C, and in counts indicated on the project drawings.
- B. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly unless otherwise indicated on the project drawings. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded.
- C. Install the optical fiber cable in groups according to quantities listed on the project drawings.
- D. A minimum of six feet of each optical fiber strand shall be left protected within the termination shelf for any future re-termination of a particular optical fiber strand.
- E. All cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the Owner.
- F. All optical fiber cable shall be securely fastened to the termination shelf in a way that does not damage the optical fiber strands or impede the performance of the media. This secure fastening method shall also serve to insure a secure termination environment.
- G. All cables shall be clearly labeled on both ends and in an accessible location no more than two-feet from each cable end.

3.05 UNIVERSAL HORIZONTAL STATION CABLE

- A. All horizontal UTP cabling will be universal in nature and should be installed as such.
- B. Install all universal horizontal station cable per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA-568-C, and in counts indicated on the project drawings.
- C. Install all cables with proper attention paid to bend radii, pulling method, attachment method, and pulling forces. The cable manufacturer's specifications for each particular cable type shall be followed exactly unless otherwise indicated on the project drawings. All cable shall be pulled using an appropriate measuring device to ensure that the specified force is not exceeded.
- D. All cable shall be visually inspected for insufficient bend radius during and after pulling. Damaged cables, or those installed under questionable methods and/or circumstances shall be replaced at no additional cost to the Owner.
- E. All universal horizontal station cable shall be securely fastened to the termination shelf and at the station end in a way that does not damage the individual copper conductors or impede the performance of the media. This secure fastening method shall also serve to insure a secure termination environment.
- F. All cables shall be clearly labeled on both ends and in an accessible location no more than two-feet from each cable end.

3.06 PATHWAYS AND CABLE SUPPORT

- A. The electrical contractor shall install conduit systems and outlet boxes outside of the telecommunication rooms as called for by the project documentation.
- B. All cable transport systems outside of the telecommunication rooms excepting conduit systems and outlet boxes shall be provided by The Contractor.
- C. All cable transport systems within the telecommunication rooms shall be provided by the Contractor.
- D. Draping cables over other structures in the ceiling is unacceptable. Water pipes, ceiling grid, sprinkler system, electrical supports, air ducts or any other in-ceiling structure may not be used for cable support.
- E. Cable must be routed to follow existing corridors and parallel or ninety (90) degree angles from all walls and the cable tray.

3.07 TECHNOLOGY OUTLET HOUSING AND TERMINATION COMPONENTS

- A. The Owner reserves the right to specify a new location for any technology outlet without increasing contract cost - providing that the new location is specified prior to roughing-in and is not farther than ten (10) feet away from the original location specified.
- B. Install all technology outlet housing and termination component per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA-568-C, and in counts indicated on the project drawings.
- C. All technology outlets located on a wall shall be flush mounted, level and plumb. All technology outlets shall be mounted at right angles and parallel to the floor.
- D. The Owner, prior to installation by the Contractor, must confirm furniture termination locations and faceplates.
- E. Install blank inserts in spaces within the faceplates that are not being filled with cable connection ports.
- F. Mount all outlets at building standard outlet height, unless noted otherwise on the project drawings.
- G. All faceplates, as well as each individual utilized port, must be labeled in accordance with an Owner-approved labeling scheme.
- H. Terminate all technology outlet jacks and modules per the manufacturer's recommended installation instructions, under the guidelines of TIA/EIA-568-C, and in counts indicated on the project drawings.
- I. Specific attention shall be paid to the length of UTP cable jacket stripping so that it does not exceed 0.5-inch from the termination point within the outlet jack.

3.09 CABLE MANAGEMENT

- A. Install all vertical and horizontal cable management per the manufacturer's recommended installation instructions, as indicated on the project drawings.

- B. When dressing the cables, the top 24 ports shall route up into the horizontal cable manager above the patch panel, and the bottom 24 ports shall route down into the horizontal cable manager below the patch panel.
- C. All cable bundles inside the telecommunications rooms shall be secured with Velcro cable wraps.
- D. Cable ties and Velcro cable wraps shall not be pulled tight enough to kink the cable jacket.
- E. The maximum amount of cables per bundle in the telecommunications rooms is 24.

3.10 RELAY RACKS

- A. Install all relay racks per the manufacturer's recommended instructions for a Zone 4 installation, as indicated on the project drawings.
- B. Provide two-post and/or four-post open frame racks as indicated on the project drawings.
- C. Anchor all racks to the concrete floor and cable runway system above for support bracing.
- D. Label the top and bottom of all relay racks and cabinets as indicated on the project drawings.

3.11 GROUNDING

- A. All grounding shall be in accordance with the National Electrical Code and TIA/EIA-607.
- B. The Contractor is responsible for providing and installing all ground wire to every rack, cabinet, runway, cable tray, etc. from grounding busbars (installed by others).
- C. All non-active equipment in the telecommunications rooms must be grounded to the local busbar by an individual ground wire. Active equipment shall be grounded through the electrical system.
- D. Install the connecting ground wire in a star topology deriving from the main telecommunications ground bar within each IT/telecom room. Daisy-chaining ground wire is unacceptable.
- E. All telecommunications grounding and bonding from busbars to racks or cabinets shall comply with all applicable laws, regulations, standards and codes and any applicable amendments.
- F. Ground wire must be solid conductor or braided and in sheath(s). Stranded wire may not be used. Bare wire may not be used.
- G. Total DC resistance to ground must not exceed 1 ohm.

- H. At a minimum, Contractor shall use grounding conductors in accordance with the following table:

Distance (feet)	Wire Size (AWG)
Up to 100	6
101-160	4
161-250	2
251-350	1
351-400	0
401-500	00

- I. Gas and water pipes shall NOT be used as a grounding electrode.
- J. All bonds shall be suitably protected against corrosive atmospheres, vibration and/or mechanical damage.
- K. Each bonded joint shall be protected against corrosion by assuring that the metals to be bonded are galvanically compatible. Bonds shall be protected from vibration-induced deterioration by assuring that bolts and screws are adequately torqued.
- L. Compression bonds between copper conductors or between compatible aluminum alloys shall be located in easily accessible areas not subject to weather exposure, corrosive fumes or excessive dust and shall not require sealing.
- M. Any power strips provided in equipment cabinets and/or racks must be grounded to the electrical ground system.

3.12 FIRE STOPPING

- A. General:
1. Install all fire stopping material associated with the telecommunications transport system with methods that comply with all applicable laws, regulations, standards, and codes.
 2. Install all fire stopping material to be compliant with installed sleeve details.
- B. Fire stopping requirements:
1. Seal all penetrations for rigid conduit or sleeves using approved materials installed according to the manufacturer's sections and local codes.
 2. All slot or chase-type penetrations placed at time of casting shall be fire stopped.
 3. All individual cable or wire penetrations that are not in conduit shall be fire stopped.
 4. Penetrations in gypsum board wall for cable trays shall be boxed-out with gypsum board and sealed with a design-tested fire stopping system installed per the manufacturer's sections and instructions.
 5. All metal conduits/sleeves identified as serving the possible purpose of routing voice and data cabling, with or without wire and/or cable inside shall be fire stopped.

3.13 LABELING

- A. Install all labeling to comply with TIA/EIA-606 standard for labeling and administration of cable plants that is also consistent with the Owner's guidelines. Contractor shall confirm cable plant labeling system with Owner and Owner's representative, in writing, prior to installation as part of the submittal process.

- B. Each cable must be machine labeled on both ends and at all locations where the cable is accessible for administration.
- C. Each outlet shall be given a unique number outlined in a labeling scheme provided by the Owner. The labeling scheme will be prepared under the guidelines of TIA/EIA-606 standards for labeling and administration. The Contractor is responsible for utilizing the Owner's approved labeling scheme throughout the Work.
- D. Label each patch panel port with the same color and number of corresponding outlet as designated in the Owner's labeling scheme. Label each port on the technology outlet with a machine labeled port designation.
- E. Label cables with the number of pairs or fibers and the location of terminations. Use full wording for the names of termination points. Labels that refer to room numbers only are unacceptable and will be replaced at no additional cost to the Owner.
- F. Label the MDTR, BDTR and FDTR backbone voice fields with pair numbers. Begin with 0001 and work forward when designating a copper backbone cable, unless otherwise directed by the Owner. Label the FDTR station fields with unique technology port identifiers, as indicated in the Owner's labeling scheme.

3.14 TESTING

- A. The Contractor shall be responsible for all testing and performance parameters required by this section and all applicable TIA/EIA-568-C series standards.
- B. Furnish all equipment and personnel to conduct these tests in accordance with the performance section requirements.
- C. Prepare Test Reports Manual as described in this section documenting the results of these tests and readings.
- D. Test results must be submitted to the Owner as part of the project documentation prior to acceptance as required by this section.
- E. Testing of copper wiring shall be performed prior to system cutover (100 percent of the horizontal and riser wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage).
- F. Any pairs not meeting the requirements of the standards shall be brought into compliance by the Contractor, at no charge to the Owner.
- G. Category-6A data cable test procedures must comply with and meet the following standards:
 - 1. TIA/EIA-568-C
 - 2. NEMA Low Loss extended frequency requirements
 - 3. Any additional Owner standards attached to general conditions
- H. Complete four pair testing must be performed with full sweep frequency measurements from 1 MHz to 500 MHz, and the Power Sum Far End Cross-Talk test. This test will establish each channel's installed performance measurement. This is not a certification or compliance test, rather a measure of available headroom. Any copper cable failing to meet the above-indicated standards must be removed and replaced, at no cost to the Owner, with copper cable that proves in testing to meet the standards.

- I. Test all Category-6A cables with a third party approved tester noted above. The testing device must be provided by the Contractor and approved by the Owner's representative prior to use. It is the responsibility of the Contractor to get written authorization from the Owner's representative to commence testing with said device.

- J. All cables are to be tested for:
 - 1. Continuity
 - 2. Polarity
 - 3. Insertion Loss
 - 4. Length

- K. Test procedure - Category-6A cables
 - 1. All CAT-6A cables shall comply, must be tested, and meet the following TIA/EIA-568-C standards:
 - a. Insertion Loss
 - b. Near End Cross talk (NEXT)
 - c. Power Sum Near-End Cross talk (PSNEXT)
 - d. Attenuation to Crosstalk Ratio – Near End (ACRN)
 - e. Power Sum Attenuation to Crosstalk Ratio – Near End (PSACR-N)
 - f. Far End Crosstalk (FEXT)
 - g. Power Sum Attenuation to Crosstalk Ratio – Far End (PSACRF)
 - h. Return Loss (RL)
 - i. Wire Map
 - j. Propagation Delay
 - k. Delay Skew
 - l. Length

- L. Test procedure - fiber data cabling:
 - 1. All fiber testing shall be performed on all fibers in the completed end-to-end system. There shall be no splices. Testing shall consist of a bi-directional end-to-end power meter test performed per TIA/EIA-568-C. The Contractor shall test all fiber cable prior to the installation of the cable. The Contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
 - 2. Loss budget:
 - a. Fiber links shall have a maximum loss of: $(\text{allowable cable loss per km})(\text{km of fiber in link}) + (.4\text{dB})(\text{number of connectors}) = \text{maximum allowable loss}$.
 - b. A mated connector-to-connector interface is defined as a single connector for the purpose of this section.
 - c. Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two.
 - 3. Any link not meeting the requirements of the standard shall be brought into compliance by the Contractor, at no charge to the Owner.
 - 4. Optical fiber splices, fusion or mechanical, shall not exceed a maximum optical attenuation of 0.3dB when measured in accordance with ANSI/TIA/EIA--455-34, Method A (factory testing) or ANSI/TIA/EIA--455-59 (field testing).
 - 5. The testing of all Fiber optic cables must include tests using an Optical Time Domain Reflectometer (OTDR) or other Owner and Owner representative-approved test equipment. Documentation of the signature trace of the cable must include each of the following:
 - a. Attenuation per kilometer
 - b. Total length of each strand
 - c. The length of the longest cable run from each closet must be recorded and entered into the projects cabling database
 - 6. The test results must include the loss generated by each connector. Loss should be stated in dB. No fiber optic link will be accepted with a loss greater than 2dB.

7. Insertion Loss testing must be done using hand held units for the source and meter. Acceptance tests for all fiber strands shall include attenuation, attenuation uniformity, and end-to-end integrity. The Contractor is to ensure that losses are within budget levels. These tests shall be accomplished and documented using loss sets at the desired wavelength of 1300 and 850 NM. The loss test should be performed after all splicing, connectorization and interconnection has been completed. Loss tests should be zeroed using the test lead to be used making the measurements.

3.15 TESTING AND DOCUMENTATION

- A. A complete set of test results must be presented to the Owner and the Owner's representative at least one week before the placement of active electronics in all Owner IT/telecom rooms. The Contractor shall identify the types of cable testers used during the testing and verification when presenting the results.

3.16 SYSTEM ACCEPTANCE

- A. Provide a statement of completion certifying that the system is installed and is ready for initial review, demonstration that the system is operational and functional, and ready for owner testing.
- B. Schedule a time for the Designer and Owner to perform the validation walkthrough and owner testing with at least 14 days advance notice.
- C. Qualification for acceptance: Subsequent to completing the validation walkthrough and Owner testing, Contractor shall furnish the Owner/Designer with copies of initial project close out documentation as required in this section.
- D. Furnish all equipment and personnel to conduct spot tests as directed by the owner of the performance requirements outlined in this section, these tests will be completed in accordance with the performance section requirements.
- E. The installation will not be accepted by the Owner until all work, including training, documentation, and all punch list items are remedied to the Owner's satisfaction.
- F. The project manager must be available to answer questions about the installation and to attend site visits and meetings during the acceptance period.
- G. If the system does not meet criteria or if additional trips to the JOB SITE for testing or adjustment are required, the Contractor shall reimburse the Owner for all expenses and professional time encountered by the Design Consultant/Architect.

3.17 CLEANUP AND REPAIR

- A. The Contractor shall perform a daily cleanup of the installation site removing all debris created as a direct result of the installation of the voice data communication system.
- B. Remove all debris and repair any damage caused to the premises by installation activities.
- C. Upon completion of an installation task, the relevant areas and equipment shall be left clean and in an operational state.

3.18 TRAINING

- A. Provide four, non-contiguous, four-hour, (16 total hours) of post-installation training sessions by a suitably qualified instructor, to personnel designated by the Owner in the operation and maintenance of the installed cable plant.

END OF SECTION 27 10 00

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