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Section 27 00 00 – General Technology Requirements

Part 1 - General

1.01 Project Summary

- A. Scope: Successful bidder shall provide, install, configure, and provide warranty service for technology systems described herein.

1.02 Related Documents

- A. Documents: Provisions of General Conditions, Supplementary Conditions, and the sections included under Procurement & Contract Requirements are included as part of this section as though bound herein.

1.03 Related Work

- A. Section 27 10 00 – Communications Cabling General Requirements
- B. Section 27 10 05 – Grounding and Bonding for Technology Systems
- C. Section 27 11 00 – Communications Equipment Rooms
- D. Section 27 13 00 – Communications Backbone Cabling
- E. Section 27 15 00 – Communications Horizontal Cabling
- F. Section 27 16 00 – Communications Connecting Cords
- G. Section 27 18 00 – Communications Labeling and Identification

1.04 Owner design session:

- A. The Contractor shall pro-actively schedule a pre-installation coordination meeting with the Technology Department to review ground system design prior to completing design documents.
- B. Design review meetings shall cover the following systems:
 - 1. MDF/IDF layout and equipment schedules.
 - 2. Backbone and up-link requirements.
 - 3. Horizontal cable pathways, termination hardware, colors and labeling.
 - 4. Patch cords (qty, colors and lengths)

1.05 Definitions

- A. Approved or Approval: Where approval is called for, only persons with the authorized authority may grant approval. Owner reserves all rights to govern over and grant approval and will appoint authority of agents acting on their behalf.

- B. As Required: Contractor shall provide the quantity of said item that is necessary. Owner and Consultant reserve the right to make the final determination of necessary quantities to provide for a complete system.
- C. Basis of Design: The documentation of the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements. These Consultant produced documents are not shop drawings. Product selections depict minimum functionality and overall quality and are open to substitution requests.
- D. Consultant: True North Consulting Group.
- E. Contractor: The qualified party responsible to provide all items and perform services as described within these documents. The Contractor referred to within a specific specification section shall be the successful qualified party contracted to perform and complete that work.
- F. Documents: The complete package of Bid and Contract Requirements, General Technology Requirements, related Division 27 sections, drawings, schedules, and addenda that make up this Request for Bid.
- G. End-User: Individual(s) who will ultimately operate the completed system.
- H. ETR: Existing to Remain. Item is to remain in current location and maintain current functionality.
- I. Furnish: To supply and deliver to project site, ready for installation.
- J. Install: To place in a position of service or use.
- K. NIC: Not in Contract. Item will be the responsibility of others.
- L. Notice to Proceed: Formal communication from Owner to Contractor stating the date the Contractor can begin work subject to the conditions of the contract. The performance time of the contract starts from the Notice to Proceed date.
- M. OFCI: Owner Furnished Contractor Installed. Item will be provided by Owner and shall be installed by Contractor.
- N. OFE: Owner Furnished Equipment. Item will be provided and integrated by Owner.
- O. OFOI: Owner Furnished Owner Installed. Item will be provided and installed by Owner.
- P. Owner: The party named in the Procurement and Contract Requirements as the advertising party.
- Q. Provide: To furnish and install, complete and ready for intended use.
- R. Turnkey: Of or involving the provision of a complete product or service that is ready for immediate use.

- S. Work: The provision of products and/or services to meet the requirements specified in these documents.
- 1.06 Reference Standards and Codes
- A. Standards and other procedures referenced by this bid package are as follows:
1. ADA – Americans with Disabilities Act of 2010
www.ada.gov/2010ADASTandards_index.htm
 2. AIA – American Institute of Architects
www.aia.org
 3. ANSI – American National Standards Institute
www.ansi.org
 4. ASHE – American Society of Healthcare Engineering
www.ashe.org
 5. ASTM – American Society of Testing and Materials
www.astm.org
 6. BICSI – Building Industry Consulting Service International, Inc.
(RCDD Standards)
www.bicsi.org
 7. CFR – Code of Federal Regulations
www.gpo.gov/fdsys/browse/collectionCfr.action?collectionCode=CFR
(Available from the Government Printing Office)
(Material is usually first published in the Federal Register)
 8. U.S. Copyright Law, December 2011
www.copyright.gov/title17
 9. ECIA – Electronic Components Industry Association
ESC – EIA Standards Council
www.eciaonline.org
 10. IACS – International Annealed Copper Standard
www.ndt-ed.org/GeneralResources/IACS/IACS.htm
 11. IEC – International Electrotechnical Commission
www.iec.ch
 12. IEEE – Institute of Electrical and Electronics Engineers
standards.ieee.org
 13. ISO – International Organization for Standardization
www.iso.org
 14. ITU-T – International Telecommunication Union – Telecommunication
www.itu.int

15. NEC – National Electrical Code (NFPA 70)
maintained by NFPA – National Fire Protection Association
www.nfpa.org
16. NECA – National Electrical Contractors Association
www.necanet.org
17. NEMA – National Electrical Manufacturers' Association
www.nema.org
18. OSHA – Occupational Safety and Health Administration
(U.S. Department of Labor, OSHA)
www.osha.gov
19. TIA – Telecommunications Industry Association
www.tiaonline.org/standards
20. UL – Underwriters' Laboratories
www.ul.com

- B. Standards: Referenced standards and/or procedures shall be binding on the Contractor and work shall be judged against such standards and procedures unless otherwise stated in writing.
- C. Local/State Codes: Contractor shall comply with all local and state code requirements as determined by the authority having jurisdiction (AHJ).
- D. Owner Standards: Contractor shall obtain and abide by all published Owner standards as they pertain to the work described herein.
- E. Contractor shall use the latest versions of all standards and codes unless otherwise directed by the authority having jurisdiction (AHJ) or expressly noted herein.

1.07 Drawings and Basis of Design

- A. General: Work, equipment, or material delineated on any drawing in this package is expected to be provided by Contractor unless noted otherwise.
- B. Interpretation: Work shall be installed in accordance with the basis of design diagrammatically expressed on the drawings and described in the written specifications and equipment schedule(s). Contractor shall not make limiting interpretation that provides for incomplete work or a non-functioning system.

1.08 Product Substitution Procedures

- A. Requests for Substitutions: Should the Contractor request a change in the material that is to be supplied, from that which was specified in the contract, the Contractor shall provide the Owner and the Consultant with a written request for said change.

- B. Substitutions for Non-specified Products: Where no product specification is provided, Contractor may use manufacturer's specification for the identified product as a guide for suggesting appropriate substitutions.
- C. Requirements: The Request for Substitution shall include:
 - 1. Reason for substitution.
 - 2. Material data sheets for both the proposed item(s) and the item(s) to be replaced.
 - 3. Any cost impact to the Owner.
- D. Changes: Proposed changes to Contract Documents shall be clearly identified in the pre-construction submittals.
- E. Approval: The Owner may approve or deny any Requests for Substitution. The Owner reserves the right to govern over and proclaim whether proposed products are equal to the specifications. The Contractor shall not procure any substitute materials until the Owner has approved and signed the Request for Substitution and passed copies to the Contractor and the Consultant. Any procurement or work performed prior to this approval is at the Contractor's own risk.
- F. Deviation: Products provided or installed that deviate from the products specified in make, model, color, or other significant characteristic (i.e., non-approved substitutions) shall be removed and replaced with specified products at no additional expense to Owner.

1.09 Software

- A. Versions: Consultant used the following software versions for this project:
 - 1. Microsoft Office 2016
 - 2. Autodesk Revit MEP 2014 (floor plans)
 - 3. Autodesk AutoCAD MEP 2014 (detail sheets)

1.10 Submittal Conditions

- A. The Contractor shall not consider the Consultant or Owner's review of submittals to be exhaustive or complete in every detail. Approval of shop drawings or submittals including substitutions indicates only the acceptance of the Contractor's apparent intent to comply with general design or method of construction and quality as specified. The finished product shall meet functional requirements, operations, arrangements, and quantities and comply with the contract documents unless specifically approved otherwise.
- B. The Contractor shall be held responsible for delivery of systems as specified. Any errors or omissions in the submittals shall not relieve Contractor of responsibility to deliver complete systems as specified.

1.11 Pre-Construction Procedures

- A. Pre-Construction Submittal Meeting: Contractor shall schedule web conference (WebEx or similar) with Owner and Consultant to review basis of design and submittal expectations.
- B. Prior to Work: Pre-construction submittals shall be provided to Consultant with appropriate promptness as to cause no delay to the work.
- C. Project Timeline: Project timeline will not be altered due to lateness of submittals. Contractor is bound to deliver a timely, complete, and finished project as stipulated in their contract and specified herein.
- D. Format and Distribution: Contractor shall provide one (1) electronic copy in PDF format to Consultant of all pre-construction submittals. The Contractor shall provide hard copies sets as required up to five (5) sets.
- E. Provision: Contractor shall submit pre-construction submittals including any corrections or additions to Consultant prior to the procurement of equipment or commencement of work.
- F. Review: Pre-construction submittals shall be received and formally approved by Consultant prior to the procurement of material or the commencement of work. Any procurement or work performed prior to this approval is at Contractor's own risk.
- G. Failure to Provide: The failure of Contractor to provide pre-construction submittals as required herein may result in the withholding of payment for work and/or the cancellation of the contract.

1.12 Pre-Construction Submittals

- A. Pre-construction submittals are intended to document the details of installation. Exact copies of original drawings and specifications are not acceptable as pre-construction submittal drawings. Consultant schematic diagrams describe the basis of design as defined herein.
- B. Contractor shall provide to Consultant the following pre-construction submittals for approval in addition to specific requirements identified in subsequent sections.
 - 1. Qualifications: Shall include documentation of all required qualifications.
 - 2. Shop Drawings:
 - a. Title: Each drawing shall have a descriptive title and all subparts of each drawing shall have unique identifiers.
 - b. Floor Plans: Shall include device locations, Contractor provided furniture and installation notes.

- c. System Drawings: Shall include functional diagrams for each system detailing system flow including all equipment, routing, inputs/outputs, wiring signal type, cable identification detail, connectors, adapters, intra/inter-rack power distribution, installation notes and any other information required to convey the complete turnkey system design.
 - d. Equipment Rack and Cabinet Elevations: Shall include placement of all mounted equipment.
 - e. Structurally Mounted Elements: Shall include both plan view of placement as well as a detail of structural mounting techniques to be used.
 - f. Furniture: Shall include all Contractor provided furniture showing dimensional drawings, cable management and finishes with samples for Owner approval.
3. Product Data:
- a. Equipment Schedules: Shall include manufacturers, part numbers, quantities and unit pricing.
 - b. Product Cut Sheets: Shall identify (highlight, arrow, etc.) actual part numbers to be utilized including but not limited to equipment, mounting hardware, cabling, connectors, software and power distribution equipment.
4. Manufacturer's Recommendations:
- a. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, copies of these recommendations shall be provided prior to installation. Installation of the items will not be allowed to proceed until the recommendations are received and approved.

1.13 Construction Progress Procedures

- A. Meeting Attendance: Contractor is required to attend job progress meetings in accordance with requirements set by Owner or Consultant.
- B. Additional Coordination: Contractor shall request additional job construction coordination meetings it deems to be necessary to ensure coordination of their responsibilities with other parties.
- C. Progress Inspection: Consultant may perform periodic progress inspections. At Consultant's request, Contractor shall make Project Manager and/or Lead Technician available.
- D. Test Plan: Ten (10) business days prior to the proposed Contractor test date, Contractor shall provide a test plan defining the tests required.
 - 1. The test plan shall be approved by Consultant prior to any testing.

1.14 Construction Progress Submittals

- A. Completion: Contractor shall complete and submit via email all construction progress documentation in PDF format as requested by Owner and Consultant.
- B. Contractor shall provide to Consultant the following construction progress submittals in addition to specific requirements identified in subsequent sections.
 - 1. Weekly Report: Weekly written report to be submitted to Consultant through appropriate project channels in PDF format outlining progress from previous week, plans for progress in the current week, and any coordination issues that may require Consultant or Owner attention.
 - 2. Test Plan: Shall ensure the system meets Owner operational and performance specifications and include the following:
 - a. Identification of the capabilities and functions to be tested.
 - b. Detailed instructions for the setup and execution of each test.
 - c. Procedures for evaluation and documentation of the results.
- C. Failure to Complete: Failure to complete requested construction progress documentation may result in the withholding of payment by Owner.

1.15 Closeout Procedures

- A. Notification: Contractor shall provide written notification to Consultant and Owner when Contractor is satisfied that the work has reached Substantial Completion and is ready for inspection.
- B. Pre-Inspection Submittals: Contractor shall submit an electronic copy of all closeout submittals to Consultant in accordance with the requirements found in these documents no less than ten (10) business days prior to the scheduled Final Inspection.
 - 1. Test Results
 - 2. As-built drawings (full-size sheets)
 - 3. Operation and Maintenance Manuals
 - 4. End User Software
- C. Punch List: Work or materials found to be incomplete, of unsatisfactory quality, failing to meet the specifications in these documents, and/or unacceptable to Consultant or Owner shall be documented by Consultant and provided to Contractor to rectify at no additional cost. Contractor shall provide written notification to Consultant and Owner when all punch list items have been completed.

- D. Final Inspection: Contractor shall coordinate, schedule and participate in final project inspection and walk thru. Owner shall be notified and included in final walk thru inspections.
- E. Re-Inspection: If more than one (1) re-inspection is necessary, the costs of the additional travel, time, and expenses of Owner and Consultant may be deducted by Owner from the contract amount due to the Contractor.
- F. Punch List Approval: Once all punch list items are complete, the Contractor shall return an initialed punch list to the Consultant and Owner for verification. Punch list shall be considered complete only after having been signed by Owner and Consultant.
- G. Closeout Submittals: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide three (3) electronic copies to Owner and Consultant in format(s) noted below.
1. Record Drawings – AutoCAD 2010 editable .dwg format AND PDF.
 2. Operation and Maintenance Manuals – USB Flash Drive, CD, OR DVD.
 3. End User Software – USB Flash Drive, CD, OR DVD.
 4. Documentation of testing and system certification.
- H. Closeout Submittal Format and Distribution: Upon approval of closeout submittals and prior to final acceptance, Contractor shall provide a total of three (3) bound hard copies with labeled dividers of all record drawings (full-size sheets) and operation and maintenance manuals, two (2) copies to Owner and one (1) copy to Consultant. Title on front and spine of binder shall be “Operation and Maintenance Manual – [PROJECT NAME]”. The following additional items shall be identified on the binder cover:
1. Client Name
 2. Contractor Name and Contact Information
 3. Consultant Name and Contact Information
 4. Date
- I. All documentation prepared by the Contractor, including hard copy and electronic forms, shall become the property of the Owner.
- J. Payment Authorization: Final payment will be authorized only after all closeout procedures and requirements have been followed and fulfilled by Contractor and approved in writing by Owner and Consultant, including punch list(s) and/or re-inspection(s) and delivery of closeout deliverables.

1.16 Closeout Submittals

- A. Closeout submittals are intended to document the details of the final installation that substantially conforms to the construction documents and functions as intended to meet the Owner's needs.
- B. Contractor shall provide to Consultant the following closeout submittals for approval in addition to specific requirements identified in subsequent sections.
 1. As-built drawings: As-built drawings are prepared by the Contractor. They show, in red ink, on-site changes to the Consultant-approved pre-construction submittal documents. As-built drawings shall be submitted to Consultant for approval prior to submitting record drawings and include:
 - a. Changes made by Addenda, Change Orders, Requests for Information (RFIs), Architect's Supplemental Instruction (ASIs), or Requests for Proposal (RFPs) in addition to any other changes to the original documents.
 - b. Actual device locations, conduit routing, wiring and relationships as they were constructed.
 - c. Nomenclature showing as-built wire designations and colors.
 - d. Room numbers coinciding with Owner space planning numbering.
 2. Record drawings: Record drawings are the final drawings prepared by the Contractor and incorporate all as-built drawing changes previously approved by Consultant. Record drawings should be electronically produced without any handwritten, red ink, or clouded changes.
 3. Operation and Maintenance Manuals: Notwithstanding requirements specified elsewhere, submit one (1) copy of each of the following per binder:
 - a. A final Bill of Materials for each system.
 - b. Usernames and passwords by device for all applicable products.
 - c. Manufacturers Instruction Manuals: Specification sheets, operation manuals and service sheets published by the manufacturers of the components, devices and equipment provided.
 - d. Replacement parts list with current prices. Include list of recommended spare parts, tools, and instruments for testing and maintenance purpose.
 - e. Performance, Test and Adjustment Data: Comprehensive documentation of performance verification according to parameters specified herein.
 - f. Warranties: Provide an executed copy of the Warranty Agreement and copies of all manufacturers' Warranty Registration papers as described herein.

- g. Sufficient information, (detailed schematics of subsystems, assemblies and subassemblies to component level) clearly presented, shall be included to determine compliance with drawings and specifications.
- h. Any other items defined herein.

1.17 Project Management

- A. Project Manager: Contractor shall appoint a Project Manager who will be the main point of contact for Owner and Consultant regarding the project.
- B. Responsibility: Project Manager is responsible for the following:
 - 1. Successfully completing the contract in a timely manner.
 - 2. Overseeing work and performance of all employees and Subcontractors who have been hired by Contractor and ensuring compliance with specification.
 - 3. Completing and submitting required documentation.
 - 4. Attending project coordination meetings as required by Owner, Consultant, and Contractor. Contractor is responsible for taking minutes of these meetings and distributing copies to all participants.
 - 5. Coordinating with Owner, Consultant, Architect, General Contractor, and other Contractors involved in the project to ensure smooth flow of work and on-time project completion.
 - 6. Providing a written weekly progress update to the Owner and Consultant in a PDF format emailed to the project team.
 - 7. Reporting all unexpected conditions and problems that may result in delay or expense to Owner and Consultant immediately upon discovery.
- C. Change of Project Manager: If Contractor seeks to change Project Manager during the course of the Project, such change is subject to prior written approval from Owner.
- D. The Owner reserves the right to request a change of project manager at any time for any reason.

1.18 Examination of Existing Conditions

- A. Examination: Contractor shall examine the facility and construction documents to the extent necessary to plan for efficient installation strategies prior to the delivery of materials to the site or the commencement of work. Other documents (Architectural Drawings, hardware schedules...) may be made available upon request. Failure to adequately complete the examination shall not result in change order requests.

- B. Acceptance of Conditions: Commencement of work by Contractor shall indicate acceptance of existing conditions, unless a written notice of exceptions has been provided to Owner prior to commencement.
- C. Observation: If Contractor observes—during preliminary examinations or subsequent work—existing violations of fire stopping, electrical wiring, grounding, or other safety- or code-related issues, Contractor shall report these to Owner in a timely manner.
- D. Pre-Existing Damage: If Contractor observes damage to finished surfaces before they begin installation in any area, Contractor shall document by taking digital photos of the damaged area(s) and immediately notifying Construction Manager and Consultant via email, with attached photos.
- E. Damage during Installation: Any damage caused by, or reasonably believed by the Construction Manager to be caused by the Contractor shall result in back-charges for said damages. Repairs shall match preexisting color and finish of walls, floors, and ceilings. Any Contractor damaged ceiling tiles, floor, and carpet shall be replaced to match color, size, style, and texture.

1.19 Product Storage and Handling Requirements

- A. Storage: Storage of materials shall remain the full responsibility of Contractor until Acceptance.
- B. Protection: Contractor shall take all necessary precautions to protect materials from the following:
 - 1. Theft
 - 2. Vandalism/Tampering
 - 3. Dents
 - 4. Scratches
 - 5. Dust
 - 6. Temperature
 - 7. Weather
 - 8. Cutting
 - 9. Paint
 - 10. Other hazardous conditions
- C. Replacement: Contractor shall replace any damaged or lost material as required by Owner or Consultant.

- D. Installed Materials: Installed materials remain the responsibility of the Contractor until Acceptance. Contractor shall take necessary precautions to ensure the safety and security of installed materials.

1.20 On-Site Conduct

- A. Tobacco Free: Alamo Colleges are 100% smoke free campuses and also prohibit e-cigarette use, hookah use, and prohibit smoking/vaping.
- B. Conduct: Any demonstration of rudeness, use of profanity, or lack of respect by Contractor Personnel to a building tenant will be cause for immediate removal from the premises, and such Personnel will not be allowed to return. Contractor and Contractor's Personnel are to remain in project area.
- C. Vandalism: Graffiti or vandalism will not be tolerated. Any Contractor/Personnel caught in the act shall be immediately removed from the premises and will not be allowed to return.
- D. Hazardous Conditions: No one shall be allowed to endanger the building, its premises, and its occupants in any manner whatsoever. In the event that a situation occurs which threatens the building or its occupants in any manner, Contractor, Contractor Personnel, Subcontractor, etc. shall take steps to correct hazardous condition. In the event that Contractor's Personnel fail to correct hazardous condition, Owner reserves the right to immediately take steps to correct the situation at Contractor's expense.

1.21 Safeguards and Protection

- A. Barriers: Provide and maintain suitable barriers, guards, fences and signs where necessary to accommodate the safety of others relative to and/or for the protection of this work.
- B. Regulations: Comply with OSHA, Federal, State, Local, and Owner regulations and standards pursuant to this work.
- C. Protection: Protect all materials and equipment to prevent the entry or adhesion of any and all foreign material. If necessary, cover equipment with temporary protective material suitable for this purpose.
- D. Finishing: Check, clean and remove defects, scratches, fingerprints and smudges if necessary from all equipment and devices immediately prior to Acceptance of the Installation.
- E. Damage: Replace all damaged or defective material or work at no additional cost prior to Final Acceptance.
- F. Documentation: Provide written description of accidents by workers, staff, and general public of any incident occurring on the project. Report incident in writing to Owner's representative immediately and to the Project Manager for follow up.

1.22 Owner-Furnished Products

- A. Delivery: Owner is responsible for delivery of Owner-furnished products to the project site, unless otherwise specified in this document.
- B. Placement: Contractor is responsible for locating, inspecting, and moving Owner-furnished products to their final installation position.
- C. Inspection: Contractor shall report any damage, discrepancies in quantity, type, or function to Owner and Consultant immediately upon discovery.
- D. Warranty: Contractor assumes no responsibility for any material warranty for Owner-furnished products. Contractor shall be responsible for integrating, cabling, and installing Owner-furnished products under the same warranty conditions as other products furnished by Contractor.

1.23 Quality Assurance

- A. Assurance: It is the intent of these specifications to describe and provide for a complete, professional, and reliable installation.
- B. Qualifications: Contractor employees who are engaged in installation shall be properly trained in the tasks they are expected to perform.
- C. Acceptability: Owner shall determine the acceptability of work.
- D. Regulatory Requirements: Contractor shall comply with code requirements that apply to the work being performed.
- E. Certifications: Where manufacturer certifications are required for warranty or for authorized resale, installation personnel shall have received such certification prior to the start of installation of those manufacturers' materials.

1.24 Quality Control

- A. Installation: During installation period, when connections are made to the Owner's existing infrastructure, Contractor shall use care to ensure that no negative results occur that could reduce or hamper existing systems.

1.25 Owner's Right to Use Equipment

- A. The Owner reserves the right to use equipment, material and services provided as part of this work prior to Acceptance of the Work, without incurring additional charges and without commencement of the Warranty period.

Part 2 - Products

2.01 Basic Equipment and Materials Requirements

- A. Standards: Equipment and materials used to accomplish the goals of this project shall meet standards for good engineering practice as defined within this document.
- B. Quality: Products specified in these documents are intended to establish a baseline or operational, functional, and performance-based standards that all proposed products shall meet or exceed by functionality and quality.

2.02 Ancillary Hardware

- A. General: Contractor shall provide ancillary and required accessory items necessary to provide a complete and fully functional system to Owner.
- B. Interpretation: Exclusion of or limitation in the language used in the drawings or specifications shall not be interpreted as meaning that ancillary or accessory items of work or equipment necessary to complete or make the installed system fully functional can be omitted.

2.03 Grounding Hardware

- A. Refer to Section 27 10 05 for specific Grounding and Bonding requirements.
- B. Provide data/telecommunication grounding systems indicated in the project drawings and specifications. Products shall include, but are not limited to, cables/wires, connectors, terminals, compression lugs, grounding rods/electrodes and plate electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE, ANSI/TIA and established industry standards for applications indicated.

2.04 Fire Stopping Materials

- A. All penetrations of walls shall be approved by the General Contractor before any penetrations are made. Should the Contractor find it necessary to penetrate any walls extending to the slab, it will be the responsibility of that Contractor to provide satisfactory sleeving and fire caulking both inside and outside of that sleeving. If existing sleeving is to be utilized, it will be the responsibility of the Contractor to fire caulk inside the sleeving.
- B. The Contractor is responsible for adhering to the following standards:
 - 1. Fire-Rated Cable Pathways: STI EZ-PATH® Fire-Rated Pathway device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill shall be used for all wall penetrations at an IDF or MDF room or any penetrations with greater than 20 horizontal cables

2. Small Conduit penetrations through fire-rated or smoke walls (less than 20 horizontal cables: Completely seal around the conduit penetration with Hilti fire-rated sealant Tremco, EZ PATH, 3M or approved equal.
 3. Completely seal inner opening of the conduit sleeve with fire wool packing and Hilti intumescent firestop sealant.
- C. A submitted response to this specification assumes that all firestopping will be provided as specified. The firestop manufacturer's specifications and instructions shall be submitted with the final documentation.
 - D. Firestop Sealants: STI SpecSeal® Brand single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
- 2.05 Compatibility of Related Equipment
- A. Existing Equipment: Equipment and systems specified in these documents shall be assumed to be compatible with the systems already installed at Owner site(s) and as identified in this document as related to this project.
 - B. Installed Equipment: Specified equipment and systems shall be compatible with all other equipment and systems as offered by Contractor, thus placing the responsibility on Contractor to ensure proper interaction.
- 2.06 Spare Parts
- A. Suggested List: Contractor is requested to submit a list of suggested spare parts with an offered price, allowing Owner to select appropriate parts.
 - B. Means of Obtainment: Contractor shall state where spare parts can be obtained after the installation.
- 2.07 Maintenance Manuals
- A. Contractor shall produce a maintenance manual showing interconnection of equipment and any special procedures necessary for proper operation and maintenance of the systems.

Part 3 - Execution

- 3.01 General
- A. Contractor shall provide, furnish, deliver, transport, erect, install, connect and configure all of the material and equipment described herein or depicted on any bid package document or drawing, as required for a turnkey solution.
- 3.02 Coordination
- A. General: Contractor shall cooperate with other Contractors for proper provisioning, anchorage, placement, and execution of all work. Interference between the work of

various Contractors shall be resolved before installation. In the event of conflict on space requirements or location of devices, refer the matter to Owner and Consultant for decision.

- B. Related Work: References to the following related work do not limit or release Contractor from the responsibility of coordination with other trades or from having the necessary knowledge of other non-referenced work.
 - 1. Work by General Contractor.
 - 2. Work by other Technology Contractors.
 - 3. Work by Electrical Contractor, including electrical rough-ins and surface-mounted raceway.
- C. Delays: Contractor shall coordinate with all other trades to avoid causing delays in the installation schedule.
- D. AC Power: Contractor shall coordinate with General Contractor its requirements for proper AC power to service all equipment installed by Contractor.
- E. Low Voltage Sleeving: Contractor shall provide openings through walls as necessary, with sleeving and fire-stopping materials installed in a professional manner to meet local and national codes.
- F. Grounding and Bonding: Contractor shall coordinate with General Contractor its requirements for proper grounding and bonding to their equipment.
- G. Surface-Mounted Raceway Coordination
 - 1. General and Electrical Contractors: Contractor shall coordinate with General Contractor and Electrical Contractor the installation of surface-mounted-raceway where not provided but made necessary by non-penetrable wall.
 - 2. Verification: Contractor shall field verify and coordinate the proposed use of surface-mounted raceway at any location with Architect, GC, and Owner.

3.03 Basic Execution Requirements

- A. General: Contractor is responsible for following industry standards of good practice for telecommunications and networking equipment.
- B. Aesthetic Factors: With the installation of equipment and cables, consideration shall be given not only to operation efficiency but also to overall aesthetic factors. Contractor shall redo, at no cost to Owner, any work deemed by Owner to appear sloppy, hastily done, or unprofessional. Owner shall make final decision over whether work shall be redone.
- C. Manufacturers' Recommendations: Manufactured items, materials, and equipment shall be applied, installed, connected, erected, used, and adjusted as recommended

by the manufacturers or as indicated in their published literature unless otherwise noted herein.

- D. Protection of Work Area: Work shall be properly protected during construction, including the shielding of soft or fragile materials, protecting against dust and dirt, protecting and supporting cable ends off of the floor and from other traffic, protecting floor box lids, and temporarily plugging open conduits during construction. Upon completion, installation shall be thoroughly cleaned and all tools, equipment, obstructions, or debris present as a result of work shall be removed from the premises.
- E. Protection of Cable and Equipment: Contractor shall make appropriate preparations to protect all cabling and equipment from foreign material. Foreign material is defined as any substance or material that would void the manufacturer's performance warranty, impact ratings (UL, Plenum, etc.), or cover up markings needed for inspection. Foreign material includes, but is not limited to, paint overspray (intentional or not), fire-stopping material, drywall compound, or any other chemical, liquid, or compound that could come in contact with cables, cable jackets, cable termination points, or other equipment.
 - 1. Cleaning of cables or equipment with harsh chemicals from a failure to comply with Protection of Cable and Equipment clause is unacceptable. Contractor shall replace any affected cable, cable components, or equipment in their entirety at no additional cost to the project.
- F. Waste Materials: Contractor shall keep work area neat, orderly, and free from accumulation of waste materials. Remove trash and debris from the building and job site as required to maintain a clean work environment at all times. Rubbish shall be moved to a common trash point or receptacle on the job site as determined and directed by General Contractor or Owner.
- G. Dumpsters: No construction debris shall be placed in building's dumpsters. Contractor shall provide a dumpster for construction waste and debris at own expense. Said dumpster shall be emptied on a regular schedule. Location of dumpster shall be arranged through Building Management.
- H. Ceiling Grid: Contractor shall not hang cable supports from ceiling grid wire.
- I. Roof Deck: Contractor shall not shoot into the roof deck for mounting cable hangers.
- J. Mounting: Equipment and enclosures shall be mounted plumb and square in relation to the structure.
- K. Raised Floor: All cabling installed below the raised floor shall be placed in the provided cable trays with appropriate means to hold cable in place. If no cable tray exists, Contractor shall provide J-hooks to hold cables in place. Sleeves shall be utilized for cable egress.

3.04 Preparation

- A. Existing Equipment: Prior to any installation, the Contractor shall prepare the site by removing any remaining debris, leveling equipment racks (where appropriate), and verifying information and systems stated to be in-place are ready for use.
- B. Equipment for Installation: Prior to installation, Contractor shall ensure that required major equipment has been secured and is ready for installation.

3.05 Cleaning

- A. Daily: At the end of each work period or day, Contractor shall remove excess packing, drilling remnants, and other non-equipment related parts, materials, or debris to ensure a clean, safe, and professional working environment.
- B. Carpet: Contractor shall ensure that no damage to carpeting occurs as a result of their work. Contractor shall cover carpets in areas of work to prevent wire debris from entering the carpet.

3.06 Fire Stopping

- A. Contractor is responsible for applying fire-stopping material in and around all openings that it creates or are created for it, whether or not specifically indicated in specifications or project drawings, where code requires the use of fire stopping material.
- B. Contractor shall ensure that all fire-stopping materials meet appropriate codes and are installed in a neat and workman like manner.
- C. If Contractor removes anything from an opening in a fire-rated wall, Contractor shall restore the fire-rating condition of the wall to the same condition as before Contractor started its work. Depending on the size of the opening, this may involve sheetrock patching, in addition to use of other appropriate fire-stopping materials.
- D. Where non-mechanical pathways must be utilized, such as sealing (caulking) around single or grouped conduits, provide products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction. Provide letter from manufacturer certifying compliance with this section.
- E. Cable pathway shall replace conduit sleeves in walls and floors, and;
- F. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
- G. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.

- H. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates or integrated flanges.
- I. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.
- J. Cable tray shall terminate at each barrier and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of the barrier

3.07 Waterproofing

- A. Contractor is responsible for creating a waterproof seal in and around any openings to the outside environment that are created by Contractor or for systems being installed.
- B. Contractor shall ensure that all waterproof materials meet appropriate codes and are applied according to good engineering practice.

3.08 Installation Requirements

- A. All cable shall be pulled by hand unless installation conditions require mechanical assistance. Where mechanical assistance is used, care shall be taken to ensure that the maximum tensile load for the cable as defined by the manufacturer is not exceeded. This may be in the form of continuous monitoring of pulling tension, use of a “break-away”, or other approved method.
- B. Qualified personnel utilizing state-of-the-art equipment and techniques shall complete all installation work. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of pathway entry and exit.
- C. Cable pulling shall be done in accordance with cable manufacturer’s recommendations and ANSI/IEEE C2 standards. Recommended pulling tensions and pulling bending radius shall not be exceeded. Any cable bent or kinked to radius less than recommended dimension shall not be installed.
- D. All cable shall be free of tension at both ends.
- E. PLENUM rated cable shall be used in areas used for air handling.
- F. Contractor shall replace any cables that have been damaged or abraded during installation.
- G. Pulling lubricant may be used to ease pulling tensions. Lubricant shall be of a type that is non-injurious to the cable jacket and other materials used. Lubricant shall not harden or become adhesive with age.
- H. A pull cord (nylon; 1/8” minimum) shall be co-installed with all cable installed in any conduit or surface mount raceway.

3.09 Equipment Installation

- A. General: Contractor shall make system properly operational and physically secure by mounting equipment and related accessories into furniture, consoles, and racks as required. Manufacturer's guidelines for installation shall be followed. Discrepancies in installation procedure or inability to complete a given task due to a shortage of materials or malfunctioning equipment shall be reported to Consultant immediately upon discovery.
- B. Equipment Placement: Contractor shall locate equipment as indicated on drawings and as specified herein. Where such information is not provided, follow industry best practices and locate operable devices at convenient positions; heat generating devices at the top and seldom-accessed equipment below.
 - 1. Unless otherwise specified, end user-operable devices shall be positioned within the range of front wheelchair access per ADA standards.
- C. Equipment Installation: Equipment shall be installed as directed by the manufacturer using equipment manufacturer's desktop mounting frames, equipment tubs, installation hardware, and techniques. Contractor shall be responsible for moving equipment from storage and for providing necessary personnel or devices to carry and lift equipment around obstacles and into operating position.

3.10 Rough-In

- A. Scheduling: Contractor shall make every effort to install systems per this specification in a timely manner including rough-in of cabling and other apparatus where appropriate to stay on schedule.
- B. Protection of Environment: Where cabling and/or equipment is installed prior to other trades completing their work in an area, Contractor shall take necessary precautions to cover, wrap, or otherwise protect to reduce possible damage due to plastering, painting, cleaning, or other such work.

3.11 Cutting, Drilling, Patching, and Painting

- A. Coordination: Contractor is responsible for coordinating the work when any cutting or drilling is required in the performance of installing the specified systems.
- B. Restoration: Contractor is responsible for returning all surfaces (including walls, floors, and ceilings) to their previous condition after any cutting.

3.12 Labeling

- A. General: Rack-mounted equipment and hardware shall be labeled as required herein. Connectors, jacks, receptacles, outlets, cables, cable terminations, terminal blocks, rack mounted equipment, active slots of card frame systems, etc. shall be clearly, logically, and permanently labeled in a manner acceptable to Consultant.

- B. Approval: Proposed wording and/or numbering schemes for labeling shall be provided to Consultant for review and written approval prior to procurement or installation.
- C. Labels used shall be permanent and secure. Provide labeling as follows unless otherwise noted in a specific section:
 - 1. Like Size: Labels shall be sized to match other labels used for same purpose. Similarly, provide engraved labels of like size in other locations.
 - 2. Equipment Racks: For enclosed racks containing equipment, provide labels on each equipment rack rear door or console rear panel reading “No user serviceable parts. Refer service to qualified technician.”
 - 3. Installer and Consultant Identification: Position at the front top center section of each equipment rack a label that states the names of system Installer and Consultant.
 - 4. Custom Panels: Custom panel nomenclature shall be engraved, etched, or screened. Markings are to be designed to ensure consistency and clarity within and without of system. Verify markings and placements by submitting label sample layouts to Consultant for approval prior to procurement.
 - 5. Documentation: Labeling information shall appear on the as-built drawings.

3.13 Demolition – [RENOVATION PROJECTS ONLY]

- A. General: Where demolition is indicated in Project Documents, Contractor shall be responsible for removal, collection, transportation, and recycling of all indicated cabling and components, including the delivery of cable to the recycling center. If material is to remain on site for more than seven days after removal, Contractor shall coordinate with Owner for acceptable storage location.
- B. Verification: Contractor shall field-verify existing conditions prior to beginning demolition work. Any discrepancies between existing conditions and Owner’s written instructions shall be reported to Owner prior to the start of work in order to prevent disturbance of existing installation(s). Beginning work shall indicate acceptance of existing conditions. Contractor is responsible for immediately restoring any outages caused as a result of removing or damaging adjacent cabling, systems, or services.
- C. Cable Removal: Where it is not possible to remove cables without damaging other cables that are to remain, such as in a shared conduit, Contractor shall cut cables at entry and exit point of constriction, leaving a minimum of 24” of cable at each end.
- D. Cover Plates: Contractor shall provide and install blank cover plates for any outlets that are to be left in place and from which all cables have been removed. Cover plates shall match the Project standard color and finish.

3.14 Additional Engineering Services

- A. General: Contractor is responsible for securing necessary engineering services where needed to meet the needs of the installation.
- B. Change Orders: Only when Contractor can show that additional engineering services are needed as a result of changes to the scope of the services being requested will Owner entertain a Change Order for these services.

3.15 Grounding

- A. All systems and equipment shall be grounded per manufacturer recommendations and TIA/EIA/BICSI 607 standards.

3.16 Warranty and Maintenance Program

- A. Contractor shall provide the following warranty in addition to specific requirements identified in subsequent sections.
- B. As part of the base proposal cost, the Proposer shall include a 15-year, system channel assurance warranty period with full support costs.
- C. The Warranty period shall begin once the system is complete and all punch list items are confirmed as being complete per the construction documents. The Contractor shall receive a letter of completion from the Consultant and Owner once the project is complete starting the warranty period.
- D. The warranty and support work included in this contract shall cover Labor, travel, equipment, materials and transportation cost.
- E. Response Time: Response time for service calls.
 - 1. The Owner reserves the right to make the final determination of emergency or normal service calls and the right to coordinate the best times for service of any system failure.
 - 2. Emergency service calls are defined as failures that prohibit the use of a typical system function(s) that pose a life safety concern or such failures that create a major impact to the Owner's daily operations.
 - a. The Contractor shall provide remote service diagnosing the impact within two (2) hours after notification by the Owner.
 - b. If remote service does not correct the reported issue, the Contractor shall provide on-site service correcting the impact within four (4) hours after notification by the Owner.
 - 3. Normal service calls are defined as failures that prohibit the use of typical system function(s) that do not inhibit critical system usage, do not pose life safety concerns and do not create a major impact to Owner's daily operations.

- a. The Contractor shall provide remote service correcting the impact within twenty-four (24) hours after notification by the Owner.
4. The Contractor shall supply Service Request forms and or proper contact procedure to the Owner with instructions for proper notification of the Contractor for warranty service. By following said instructions, the Owner shall constitute proper notification for any need warranty service
- F. Repair Time: Contractor shall locally stock critical parts in sufficient quantities such that emergency repair or replacement shall be guaranteed within 12-hours. Temporary replacements within this time period shall be acceptable, provided temporary replacements do not compromise system functionality, and provided permanent replacement is achieved within 96 hours. Contractor may contact the Owner for use of Owner supplied spare parts where delay of system repair will have negative impact on system performance.
 - G. Transmittal: A copy of this Warranty shall be delivered to, and signed for by the Owner's representative whose primary responsibility is the operation and care of these systems. A copy of the signed Warranty document shall be delivered for review as part of the Final Submittals.
 - H. Registration: Register Warranty papers for all equipment and software in the name of the Owner. Furnish reproductions of all equipment Warranty papers to the Owner with the Final Submittals.
 - I. Subcontracting: Warranty service work may not be subcontracted except with specific permission and approval by the Owner.
 - J. Resolution of Conflicts
 1. The Owner retains the right to resolve unsatisfactory warranty service performance at any time by declaring the work unsatisfactory, stating specific areas of dissatisfaction in writing.
 - K. If the Contractor or his approved Subcontractor does not resolve such stated areas of dissatisfaction within ninety-six (96) hours, the Owner may appoint an alternative service agency or person to fulfill the terms of the Warranty at the expense of the Contractor. This action may be taken repeatedly until the Owner is satisfied that Warranty service performance is satisfactory. Satisfactory resolution of a malfunction shall be considered adequate when the device, equipment, system or component which is chronically malfunctioning is brought into compliance with the standards of performance as contained herein and published by the manufacturers of the equipment installed

End of Section

Section 27 10 00 – Communications Cabling General Requirements

Part 1 - General

1.01 Scope

- A. Each campus shall contain one MDF, typically within the Administration Building.
- B. Connectivity to the MDF and between buildings shall be provided via underground duct bank. IDF rooms shall be allocated on each floor of each building. Contractor shall provide cable tray, conduit, or sleeves as detailed on the drawings.
- C. IDF rooms are identified with the prefixes "IDF-1" and "IDF-2", followed by the architectural room number. An IDF-1 serves as the entrance facility for a building. Only one IDF-1 exists per building. Subsequent distribution in the building is routed through the IDF-2's. One or more IDF-2's are typically present on each floor. The Cabling Contractor shall build-out MDF and IDF-1 and IDF-2 space(s) as described within the Contract Drawings.
- D. The Cabling Contractor shall provide and install equipment racks, enclosures and cabinets, cable runway, patch panels, wire managers, and miscellaneous hardware as shown on the drawings as part of the complete and working telecommunications cabling system.
- E. Intra-building cable required to support network connectivity shall be installed within the plenum space, in conduit, duct and cable support accessories such as cable tray, cable ladder, surface mounted raceway, and/or power pole type assemblies
- F. This section describes the products and execution requirements related to furnishing and installing Category 6/6A Cabling and Termination Components and related subsystems as part of a Structured Cabling System.
- G. Backbone system comprising copper and fiber optic cabling and horizontal (station) cabling is covered under this document.
- H. Others will provide the network electronics for the LAN within the Telecom Rooms (TRs) and will be responsible for connecting the new cabling infrastructure to the LAN. This Contractor, however, shall supply the Category 6 patch cords. The Contractor shall be available on site during the crossover to assist with any cabling issues that may occur during the connection.
- I. The Electrical Contractor shall install conduits and surface raceway for new technology outlet locations unless otherwise noted.
- J. The Cabling Contractor shall provide and install all sleeves through the wall penetrations as required whether or not specifically marked on Project Drawings, unless otherwise noted.

- K. All cables and related terminations support, and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Contractor, as detailed in the following section(s).
- L. All work and materials shall conform in every detail to the rules and requirements of the National Fire Protection Association, the TX Electrical Code, and present manufacturing standards.
- M. All materials shall be listed by UL and shall bear the UL label. If UL has no published standards for a particular item, then other national independent testing standards shall apply and such items shall bear those labels. Where UL has an applicable system listing and label, the entire system shall be so labeled.
- N. A limited amount of broadband analog video distribution (CATV) cabling will be required as part of the SOW if identified on the drawings. In these instances, inter-building video signals are to be distributed via singlemode optical fiber cables and broadband coaxial cable using traditional CATV techniques within the buildings as defined on the project drawings. Plenum rated RG-6 coaxial cables shall be homerun from the serving area MDF, IDF-1, or IDF-2 to video outlet locations and installed within cable tray and/or conduit. All broadband distribution passive devices, labeling, testing and balancing, etc. shall be included as part of the Cabling Contractors SOW

1.02 Related Work

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 10 00 – Communications Cabling General Requirements
- C. Section 27 10 05 – Grounding and Bonding for Technology Systems
- D. Section 27 11 00 – Communications Equipment Rooms
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.03 Reference Standards and Codes

- A. All references relate to the current version adopted by the city/county according to the authority having jurisdiction (AHJ). If the city/county has not adopted a version the latest version shall be utilized.
- B. ASTM B633: Specification for Electrodeposited Coatings of Zinc on Iron and Steel
- C. ASTM A653: Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process

- D. ASTM A123: Specification for Zinc (Hot Galvanized) Coatings on Iron and Steel
- E. ASTM A510: Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
- F. ANSI/TIA 569-C: Telecommunications Pathways and Spaces
- G. ANSI/TIA 568-C.0, 1, 2, 3, 4: Commercial Building Telecommunications Standard
- H. ANSI/TIA-598-C-2005 – Optical Fiber Cable Color Coding
- I. ANSI/TIA 606-B: Administration Standard for Telecommunications Infrastructure
- J. ANSI/TIA 942-A: Telecommunications Infrastructure Standard for Data Centers
- K. ANSI/TIA 607-B: Generic Telecommunications Grounding (Earthing) and Bonding for Customer Premises
- L. IEEE: National Electrical Safety Code® (NESC®)
standards.ieee.org/about/nesc

1.04 Qualifications

- A. Premises Distribution System: Written certification that the premises distribution system complies with the EIA ANSI/TIA/EIA-568-C.0,1, 2, 3, EIA ANSI/TIA/EIA-569-B, and ANSI/TIA/EIA-606-A.
- B. Materials and Equipment: Where materials or equipment are specified to conform, be constructed, or be tested to meet specific requirements, certification that the items provided conforms to such requirements. Certification by a nationally recognized testing laboratory that a representative sample has been tested to meet the requirements, or a published catalog specification statement to the effect that the item meets the referenced standard, will be acceptable as evidence that the item conforms. Compliance with these requirements does not relieve the Contractor from compliance with other requirements of the specifications.
- C. Installers
 - 1. All installing personnel shall have completed and be certified in manufacturer training or BICSI (Building Industry Consulting Service International) installation training for UTP infrastructure systems, or the Contractor shall contract with manufacturer for installation of all proposed components. Company Certifications shall accompany the proposal response.
 - 2. The Contractor's technicians shall be certified and trained in the connectivity hardware that is being installed.
 - 3. The Contractor shall submit certification that installers are factory certified to install and test the provided products. No less than half of the crew to be used for the telecommunications installation shall be trained by that manufacturer for the work.

1.05 Pre-Construction Submittals

- A. Shop Drawings in addition to requirements in Section 27 00 00:
 - 1. Equipment rack elevation details
 - 2. Elevations of telecommunication room walls mounted equipment
 - 3. Outlet faceplate details for all outlet configurations, sizes, and cable types
 - 4. Overhead telecommunication room enlargements, provide dimensions of room and clearance for maintenance and operation

1.06 Closeout Submittals

- A. Refer to Section 27 00 00 for requirements. In addition provide three (3) sets of the following:
 - 1. Data cable test results
 - 2. USB Drive containing:
 - a. As-built drawings (autoCAD format)
 - b. As-built drawings (PDF format)
 - c. Detailed test results in original tester format (Fluke Linkware)
 - d. Detailed cable test results in PDF format
 - e. Summary test results in PDF format
 - 3. Warranty certification from connectivity manufacturer

1.07 Delivery, Storage, and Handling

- A. Vendor shall be responsible for all materials until completion of Project.
- B. Cable shall be stored according to manufacturer's recommendations at minimum. In addition, cable shall be stored in a location protected from vandalism and weather.
- C. If cable is stored outside, it shall be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees Fahrenheit, the cable shall be moved to a heated (minimum 50 degrees Fahrenheit) location. If necessary, cable shall be stored off site at the Contractor's expense.
- D. If the Contractor wishes to have a trailer on site for storage of materials, arrangements shall be made with the Owner.
- E. Commercial off-the-shelf manuals shall be furnished for operation, installation, configuration, and maintenance for all products provided as a part of the premises distribution system. Specification sheets for all cable, connectors, and other equipment shall be provided.

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

Part 3 - Execution

3.01 Warranty

- A. Refer to Section 27 00 00 for additional requirements.
- B. The Contractor shall provide to the Owner a manufacturer's 15 year minimum warranty certificate for all materials, equipment, etc. Upon successful completion of the installation and subsequent inspection, the Owner shall receive a numbered certificate, from the manufacturing connectivity hardware (patch panels, jacks, patch cords 110 blocks, etc.) company, registering the installation. This warranty shall include all labor, materials, and travel time.
- C. The warranty shall ensure against product defects and guarantee that all approved cabling components exceed the specifications of TIA/EIA-568-C, and ISO/IEC IS 11801 for cabling links/channels, and that the installation will exceed the loss and bandwidth requirements of TIA/EIA 568-C ISO/IEC IS 11801 for fiber links/channels, for a fifteen (15) year period. The warranty shall apply to all passive structure cabling system components.
- D. The warranty shall cover the failure of the wiring system to support the application that it was designed to support, as well as additional application(s) introduced in the future by recognized standards or user forums that use the TIA/EIA 568-C or ISO/IEC IS 11801 component and link/channel specifications for cabling, for a minimum of a fifteen (15) year period.
- E. The warranty shall cover the replacement or repair of defective product(s) and labor for the replacement or repair of such defective products(s), labeling of the new components, and testing of the circuit(s) at no cost to the Owner.

3.02 Examination

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper and timely completion.
- B. Verify cable lengths comply with published standards.
- C. Notify Owner of installation that would exceed maximum lengths prior to installation of cable.
- D. Contactor shall consult with Owner regarding alternative routing or location of cable.

- E. Do not proceed until unsatisfactory conditions have been corrected.

3.03 Spare Parts

- A. Cable Spool(s) – Include 5% of base project total.
- B. Cable Jacks – Include 5% of base project total.
- C. Faceplates – Include 5% of base project total.
- D. Patch Cords – Include 5% of base project total.
- E. Patch Panels – Include 5% of base project total.
- F. Contractor shall deliver 5% spare parts to Owner and receive sign-off that product was delivered and received.

3.04 Installation Requirements

- A. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment shall include, but not be limited to, sheaves, winches, cable reels, cable reel jacks, duct entrance tunnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices that may move or wear in a manner to pose a hazard to the cable shall not be used.
- B. Service Loops: A surplus of cable, typically located at or near the point of termination to facilitate potential future changes. Cables shall have a minimum cable slack of 10ft (3m) at the telecommunication room(s) and 3.28ft (1m) at each telecommunications outlet in the suspended ceiling unless noted otherwise. Service loops shall be stored in an extended loop or in a figure-eight configuration, not in bundled loops.
- C. Cable Support (TIA 569-C.9.7):
 - 1. Non-continuous supports shall be located at intervals not to exceed 1.5 m (5 ft). Non-continuous supports shall be selected to accommodate the immediate and anticipated quantity, weight, and performance requirements of cables.
 - 2. It is recommended not to make long runs exactly 5 ft apart due to “harmonics” issues per cable manufacturers
 - 3. Non-continuous pathways do not need to be bonded together or grounded (see 2011 NEC 250.92.A.1
- D. Maximum pulling tension (TIA 568-C.5.3.1):
 - 1. The pulling tension for a 4-pair balanced twisted pair cable shall not exceed 110 N (25 lbf) during installation. For multipair cable (12-pair and above), manufacturer’s pulling tension guidelines shall be followed.

2. Sags between supports shall be a maximum of 300 mm (12 inches).

3.05 Cooperation

- A. The Contractor shall cooperate with other trades and General Contractor's personnel in locating work in a proper manner.
- B. Should it be necessary to raise, lower, or move longitudinally any part of the work to better fit the general installation, such work shall be done at no extra cost to the Owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

3.06 Testing and Acceptance

- A. The Contractor shall perform acceptance tests as indicated below for each subsystem (backbone, station, etc.) as it is completed.
- B. The Contractor shall supply all equipment and personnel necessary to conduct the acceptance tests. Prior to testing, the Contractor shall provide a summary of the proposed test plan for each cable type, including equipment to use, setup, test frequencies or wavelengths, results format, etc. The Consultant will approve the method of testing.
- C. The Contractor shall visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. The Contractor shall provide the Consultant with a written certification that this inspection has been made.
- D. The Contractor shall conduct acceptance testing according to a schedule coordinated with the Consultant. Representatives of the Owner may be in attendance to witness the test procedures. The Contractor shall provide a minimum of one (1) week advance notice to the Consultant and Owner to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.
- E. Tests related to connected equipment of others shall be done only with the permission and presence of Contractor involved. The Contractor shall ascertain that testing only as required to prove the wiring connections are correct.
- F. The Contractor shall provide test results and describe the conduct of the tests, including the date of the tests, the equipment used, and the procedures followed. At the request of the Consultant, the Contractor shall provide copies of the original test results.
- G. All cabling shall be 100% fault free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the Contractor's expense. The applicable tests shall then be repeated.

- H. Backbone voice cables shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g., 110). Any mispositioned pairs shall be identified and corrected. The percentage of “bad” pairs shall not exceed 1% in any backbone (riser or tie) cable based on total pair count. All bad pairs shall be identified and documented.
- I. The Consultant or Owner may request that a 10% random field re-test be conducted on the cable system to verify documented findings.
 - 1. If requested, the Contractor shall test up to 10% of cable links at no cost to the Owner.
 - 2. Tests shall be a repeat of those defined above and under Testing and Acceptance. If findings contradict the documentation submitted by the Contractor, additional testing shall be performed to the extent determined necessary by the Consultant, including a 100% re-test. This re-test shall be at no additional cost to the Owner.

3.07 Fire Stopping

- A. Contractor shall seal any openings created for cable pass-through between floors or through fire rated walls. Sealing material and application of this material shall be accomplished in such a manner that is acceptable to the local fire and building authorities having jurisdiction over this work.
- B. Creation of such openings as are necessary for cable passage between locations as shown on the Drawings shall be the responsibility of the Contractor. Any openings created by or for the Contractor and left unused shall also be sealed as part of this work.
- C. Firestopping materials shall be asbestos free and capable of maintaining an effective barrier against flame, smoke, and gasses in compliance with requirements of ASTM E 814, and UL 1479. Only listed firestopping material acceptable to the City of San Antonio Fire Marshal shall be used within each of the following conditions:
 - 1. Duct, cables, conduit, piping, and cable tray penetrations through floor slab and through time-rated partitions or fire walls.
 - 2. Openings between floor slab and curtain walls, including inside hollow curtain walls at the floor slab.
 - 3. Penetrations of vertical service shafts.
 - 4. Openings and penetrations in time-rated partitions of fire walls containing fire doors.
 - 5. Locations where specifically shown on the drawings or where specified in other sections of the project manual.
 - 6. The rating of the installed firestop system shall in no case less than the rating of the time-rated floor or wall assembly.

3.08 Acceptable Products.

- A. Manufacturers acceptable contingent upon products' compliance with the specifications and City of San Antonio requirements:
 - 1. STI EZ-Path assemblies shall be used for all wall penetrations coming into an MDF or IDF rooms. Assemblies shall be sized to accommodate 50% growth over initial installation.
 - 2. 3M Brand Caulk CP-25, Putty 303, Wrap/Strip FS-195, Composite Strip CS-195, or Penetrating Sealing Systems 7900 Series.
 - 3. Dow Corning Fire Stop Foam, liquid component Part A (black) and liquid component Part B (off-white).
 - 4. Dow Corning Fire Stop Sealant.
 - 5. Fibrex Safing Insulation.
- B. Damming Materials permitted are those products compatible with the above materials as certified by the manufacturer in their respective published data.

End of Section

Section 27 10 05 – Grounding and Bonding for Technology Systems

Part 1 - General

1.01 Scope

- A. Refer to Section 27 00 00 for additional project scope information.

1.02 Related Work

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 10 00 – Communications Cabling General Requirements
- C. Section 27 11 00 – Communications Equipment Rooms
- D. Section 27 13 00 – Communications Backbone Cabling
- E. Section 27 15 00 – Communications Horizontal Cabling
- F. Section 27 16 00 – Communications Connecting Cords
- G. Section 27 18 00 – Communications Labeling and Identification

1.03 Reference Standards and Codes

- A. IEEE C2-2007 - National Electrical Safety Code
- B. IEEE Std. 837-2002, or latest version – Standard for Qualifying Permanent Connections Used in Substation Grounding
- C. ANSI/TIA-607-B-2011 - Commercial Building Grounding and Bonding Requirements for Telecommunications
- D. NFPA 70E - Standard for Electrical Safety in the Workplace
- E. ANSI/NECA/BICSI-607 - Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings
- F. UL 467 - Standard for Grounding and Bonding Equipment

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Grounding and Bonding Cable

- A. The grounding and bonding cable shall be solid stranded copper conductors. Gauge size as specified on project drawings or specifications.
- B. The grounding and bonding cables shall have a green jacket color and riser or plenum rated as required.
- C. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications, or as required by NFPA 70, whichever is larger. Differentiate between normal ground and isolated ground when both are used on the same facility.

2.03 Grounding and Bonding Busbars

A. Telecommunications Main Grounding Busbar (TMGB)

- 1. Factory-drilled solid copper with holes to accommodate lugs. Field manufactured busbars are not acceptable.
- 2. 0.25" thick x 4" wide
- 3. Sized for current applications and future growth
- 4. Insulated from its support
- 5. Shall be an electro-tin plated busbar
- 6. Maintain a minimum of 2" of clearance from wall
- 7. UL listed and BICSI certified

B. Telecommunications Grounding Busbar (TGB)

- 1. Factory-drilled solid copper with holes to accommodate lugs. Field manufactured busbars are not acceptable.
- 2. 0.25" thick x 2" wide
- 3. Sized for current applications and future growth
- 4. Insulated from its support
- 5. Shall be an electro-tin plated busbar
- 6. Maintain a minimum of 2" of clearance from wall
- 7. UL listed and BICSI certified

C. Horizontal Equipment Rack or Cabinet Busbar

- 1. Mounts to standard 19" Rack or Frame
- 2. Capacity: 6 Double hole lugs
- 3. Shall be an electro-tin plated busbar

4. UL listed and BICSI certified
- D. Vertical Equipment Rack or Cabinet Busbar
1. Mounts to vertical rail or inside of cabinet in 19" or 23" equipment rack or frame.
 2. Capacity: 9 Double hole lugs
 3. Shall be an electro-tin plated busbar
 4. UL listed and BICSI certified
- E. Acceptable Manufacturers:
1. Chatsworth Products Inc (CPI)
 2. Approved equivalent
- 2.04 Mechanical Connectors
- A. Mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers, and lock washers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.
- B. Split bolt connector types are not allowed.
- C. Connectors shall meet or exceed UL 467.
- 2.05 Compression Lugs
- A. Shall be UL & CSA listed
- B. Shall meet or exceed the performance requirements of IEEE 837, latest revision
- C. Compression type
- D. Shall be manufactured from pure wrought copper. Conductivity of this material shall be no less than 99% by IACS standards.
- E. Lugs shall be 2-hole. Single hole lugs are not allowed
- F. Long barrel that will allow a minimum of two crimps with standard industry colors
- G. Each connector shall be filled with an oxide-inhibiting compound
- H. Crimped with a compression, tool and die system, according to manufacturer's recommendation

2.06 Taps

- A. Connections to the Conductor shall be made with irreversible compression connectors
- B. Shall be UL & CSA listed
- C. Requires a minimum of (2) crimps for C Tap or H Tap, 1 crimp for I-Beam and busbar Tap
- D. Crimp according to manufacturer's recommendation

Part 3 - Execution

3.01 General

- A. Install products in accordance with manufacturer's instructions.
- B. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- C. Mechanical connections shall be accessible for inspection and maintenance.
- D. No insulation shall be installed over mechanical ground connections.
- E. Ground connection surfaces shall be cleaned and all connections shall be made so that disconnection or removal is impossible.

3.02 Resistance Measurement

- A. Measure ground resistance from system neutral connection at service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 2 ohms.

3.03 Telecommunications Bonding Backbone (TBB)

- A. The intended function of a TBB is to reduce or equalize potential differences between telecommunications systems. While the TBB will carry some current under ac power ground fault conditions, it is not intended to provide the only ground fault return path.
- B. The TBB shall:
 - 1. Be connected to the TMGB & TGB connecting MDF and IDF rooms within the same structure. TGB shall not connect separate buildings.
 - 2. Be a continuous copper conductor that shall be sized no less than 6 AWG to a maximum of 3/0 AWG. The TBB shall be sized in accordance to the following table:

Linear Length – ft.	Size (AWG)
Less than 13	6
14 - 20	4
21 - 26	3
27 - 33	2
34 - 41	1
42 - 52	1/0
53 - 66	2/0
Greater than 67'	3/0

3. The TBB conductors shall be installed and protected from physical and mechanical damage.
4. The TBB conductors should be installed with limited number of splices.
 - a. Where splices are necessary, the number of splices should be kept to a minimum and they shall be accessible and located within telecommunications spaces or j-box labeled as a telecommunications bonding backbone splice.
 - b. Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors or equal.
- C. A metallic cable shield shall not be used as a TBB.

3.04 Grounding Equalizer (GE)

- A. The GE shall be a continuous copper conductor that shall be sized no less than 6 AWG to a maximum of 3/0 AWG. The GE shall match the size of the TBB.
- B. The GE shall connect to the telecommunications grounding busbar(s) in the same-floor telecommunications rooms on the first, top, and every third floor in a building greater than 4 floors.
- C. A metallic cable shield shall not be used as a GE.

3.05 Telecommunications Equipment Bonding Conductor (TEBC)

- A. Connects the TMGB/TGB to equipment racks and cabinets.
- B. Shall be a continuous copper conductor that shall be sized per the length of cable.
- C. Shall be separated from ferrous materials by 2" or be bonded to the ferrous metal.
- D. May be routed within cable trays or suspended 2" under or off the side of the cable tray or ladder rack.
- E. Shall be supported every 3ft.

- F. 8" minimum bend radius.
- G. May come cross other cable groups at a 90 degree angle only.
- H. A metallic cable shield shall not be used as a TEBC.

3.06 Rack or Cabinet Bonding Conductor

- A. A bonding conductor shall be used to connect the equipment racks and cabinets directly to the TMGB, TGB or underfloor ground mesh network.
- B. All metallic enclosures, including remote mounted equipment cabinets and racks for telecommunications, security or audio/visual shall be bonded to the nearest TMGB or TGB using a minimum sized conductor of 6 AWG. Remote bonds shall be labeled on both ends stating the destination of the bond.

3.07 Electrical Distribution Panel (EDP)

- A. The AC EDP serving the Telecommunications Room shall be bonded to the TMGB or TGB using a minimum of a 6 AWG cable.
- B. A qualified electrician shall make all connections within an AC electrical distribution panel.

3.08 Optical Fiber Conductive Cables

- A. Conductive fiber-optic cables should be bonded and grounded as specified in the NEC.

3.09 Ladder Rack and/or Cable Tray

- A. All low voltage cable runway sections shall be bonded together and bonded back to the nearest Telecommunications Room the runway is serving as close TMGB or TGB as practical.
- B. Maintain an 8" minimum bend radius on the TEBC.
- C. Keep a 2" separation from other cables both power and telecommunications.
- D. Remove any paint, oxidation, etc. from the runway surfaces that are being bonded.
- E. Drill two holes as required to accommodate the 2-hole compression lug.
- F. Apply a thin coat of antioxidant around the holes and on the surface where the lug will be in contact.
- G. Attach straps to the runway using stainless steel hardware sized for the lug holes.
- H. Wipe off any excess antioxidant after installation of the lug.

3.10 Labeling

- A. Each grounding/bonding cable shall be labeled at the TMGB or TGB.
- B. All taps to the TBB shall be within an enclosure and labeled as to its purpose.

3.11 Testing

- A. Refer to Section 27 00 00 for additional requirements.
- B. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

End of Section

Section 27 11 00 – Communications Equipment Rooms

Part 1 - General

1.01 Scope

- A. Refer to Section 27 00 00 for additional project scope information.
- B. This section describes the products and execution requirements relating to telecommunications cabling, termination components, racks, pathways, telecommunication rooms and related subsystems. Covered systems include the following:
 - 1. Equipment room cable management system and equipment racks
 - 2. Horizontal and backbone cable terminating equipment
 - 3. Telecommunications grounds and related components

1.02 Related Work

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 23 – Pathways for Technology Systems
- C. Section 27 10 00 – Communications Cabling General Requirements
- D. Section 27 10 05 – Grounding and Bonding for Technology Systems
- E. Section 27 13 00 – Communications Backbone Cabling
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Category 6 Patch Panels

- A. Standard Data Cables shall be terminated at the telecommunication rooms on high-density integrated patch panels incorporating Category 6 jacks (non-keyed 8-pin), meeting the specifications for the telecommunications outlet detailed in the section above.

- B. Patch panel configuration shall be 48 ports.
- C. The patch panel shall exceed ANSI/TIA/EIA 568-C.2-1 Category 6 component compliance standard. All pair combinations shall be considered, with the worst-case measurement being the basis for compliance.
- D. The patch panels shall be interoperable and backwards compatible to lower performing cabling systems.
- E. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers' minimum bend radius specifications are adhered to.
- F. The patch panel shall have color-coded designation strips to identify cable count.
- G. Manufacturers:
 - 1. Leviton 69586-U48

2.03 Category 6a Patch Panels

- A. All specialty cables (WAPS, UPLINK) shall be terminated at the telecommunication closets on high-density integrated patch panels incorporating Category 6a jacks (non-keyed 8-pin), meeting the specifications for the telecommunications outlet detailed in the section above. Specialty cable shall not be mixed with standard data cables within the patch panels.
- B. Patch panel configuration shall be 48 ports.
- C. The patch panel shall exceed ANSI/TIA/EIA 568-C.2-1 Category 6a component compliance standard. All pair combinations shall be considered, with the worst-case measurement being the basis for compliance.
- D. The patch panels shall be interoperable and backwards compatible to lower performing cabling systems.
- E. Panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers' minimum bend radius specifications are adhered to.
- F. The patch panel shall have color-coded designation strips to identify cable count.
- G. Manufacturers:
 - 1. Leviton 6A586-U48

2.04 Voice Backbone Termination Field

- A. Wall Mounted 110 Blocks

1. At the MDF room, voice “backbone” cables shall be terminated on high-density wall mounted 110 blocks.
2. The Proposer shall provide 100-pair 110 panels. The panel shall allow voice backbone cables to be terminated directly on the wall.
3. The panels shall incorporate the openings between rows to allow cables to be routed from behind the panel directly to the point of termination.
4. The panels shall be with cable managers and covers. Termination strips on the base shall be notched and divided into 5-pair increments.
5. The mechanical termination shall:
 - a. Have the ability of terminating 22-26 AWG plastic insulated, solid, and stranded copper conductors.
 - b. Provide a direct connection between the cable and jumper wires.
 - c. Have less than 0.2-dB of attenuation from 1 - 100 MHz.
 - d. Have less than 100 mw of DC resistance.
 - e. Have less than 5 mw of resistance imbalance.
 - f. Have minimal signal impairments at all frequencies up to 100 MHz.
6. Blocks shall identify pair position by a color designation: blue, orange, green, brown, and slate (backbone only).
7. OSP Protectors shall be solid-state type units for all cable pairs to be used for data transmission; Circa 3B1S-300 or approved equivalent.
8. Interior backbone 110 panels shall be Leviton 41AW1-50 or equal.

2.05 Fiber Optic Patch Panels

- A. The Contractor shall provide a fiber optic patch panel at each location where a fiber optic cable terminates.
- B. All terminated fibers shall be mated to duplex LC couplings mounted on enclosed patch panels. Couplers shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types, including SC, ST, Fixed Shroud Duplex (e.g., “FDDI Connector”), Biconic, and FC by changing panels on which connector couplings are mounted.
- C. The patch panel enclosure shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and Drawings, including those not terminated (if applicable), PLUS 50% future growth.

- D. The Contractor shall provide all required connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated.
 - E. Patch panels shall be designed for easy installation, front removal, and expansion of snap-in adapter panels.
 - F. Patch panels shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to protect the connector couplings and fiber optic jumpers.
 - G. The patch panel's enclosure shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturer's recommended minimums or 1.2", whichever is larger.
 - H. Access to the inside of the patch panel enclosure during installation shall be from the front and rear. Panels that require any disassembly of the cabinet to gain entry will not be accepted.
 - I. All patch panels shall provide protection to both the "facilities" and "user" side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (backbone, riser, etc.) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.
 - J. Where singlemode fibers are installed, the fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtailed") or (2) use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering (such as an Aramid reinforced tube, for example) with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.2 dB.
 - K. Fiber optic patch panels shall be:
 - 1. Leviton 5R2UH-S06 in IDF rooms.
 - 2. Leviton 5R4UH-S12 in MDF or Server Rooms.
 - L. 50-micron LC adaptor panels shall be Leviton SDX 12-port Aqua #5F100-2QL.
 - M. Singlemode LC adaptor panels shall be Leviton SDX 12-port Blue #5F100-2LL.
- 2.06 Cable Management System
- A. The cable management system shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall be a complete cable

management system comprising 4-post and 2-post floor mount racks, wall mount racks, equipment cabinets and vertical and horizontal cable managers to manage cables on both the front and rear of the rack. The system shall protect network investment by maintaining system performance, controlling cable bend radius, and providing cable strain relief.

1. 2-Post Equipment Racks

- a. The Contractor shall provide and install 2-post adjustable equipment racks to house cable termination components (e.g., copper data and fiber optic) and network electronics (by others) as shown on the drawings. Prior to installation, the Contractor shall coordinate exact placement with Owner.
- b. Rack shall be 84" in height and shall be self-supporting.
- c. Channel uprights shall be spaced to accommodate industry standard 19" mounting and have pass-through holes with smooth edges to protect cables.
- d. Rack shall be constructed of aluminum.
- e. Rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per EIA/TIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.
- f. Rack shall be supplied with at least 24 spare screws.
- g. Rack shall be supplied with a ground bar and #6 AWG ground lug.
- h. Manufacturers:
 - i. Chatsworth #55053-703
 - ii. Approved equal.

B. Vertical Cable Management

1. At the telecommunication rooms, vertical cable management shall be furnished and installed to adjacent racks to organize cables on front and rear of telecommunication racks.
2. Vertical cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" or 23" racks.
3. Vertical cable management system shall feature the following:
 - a. Open cabling section on the rear that provides easy access and routes cable bundles feeding into the back of patch panels and 1 RMU cable guide on the front designed for fanning and managing patch cords.

- b. Edge-protected pass-through ports designed for easy routing of cable from front channel to back.
 - c. Vertical slots along the center separator to allow securing cable bundles neatly with management straps.
 - d. Door/cover (front only) that is easily opened from the right or left and still easily removed to allow for quick moves, adds, and changes.
 - e. Movable wire retainers to retain the cables during cover removal.
4. Vertical cable management at the end of rack rows shall be 6”.
 5. Vertical cable management between racks shall be 10”
 6. Manufacturers:
 - a. Chatsworth Products Industries (CPI) 30165-703
 - b. Approved equal

2.07 Horizontal Cable Management

- A. Horizontal cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief. Panels shall be a universal design mounting to EIA 19" racks and constructed of steel bases with PVC duct attached. The duct fingers shall include retaining tabs to retain the cables in place during cover removal. The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.
- B. The cable managers shall be provided with movable wire retainers to retain the cables during cover removal and #12-24 mounting screws. An integral strain relief bracket shall be provided on either end of the duct to allow for easy cover placement.
- C. Double-Sided horizontal cable managers shall be placed above and below each patch panel.
- D. The Contractor shall also supply (1) additional manager for every horizontal patch panel installed for network electronics (electronics provided by others).
- E. Manufacturers
 1. Chatsworth Products Industries (CPI) #30130-719
 2. Cooper/B-Line
 3. Approved equal

2.08 Telecommunication Ground

- A. The Telecommunication Contractor is responsible for providing an appropriate ground for all racks, trays, and telecommunications equipment installed by this Contractor.

2.09 Ladder Rack

- A. Within each Telecommunications Room, the Contractor shall provide and install ladder rack as shown on the Project Drawings.
- B. Within each Telecommunications Room with a vertical conduit riser the Contractor shall provide and install vertical ladder rack connecting the ground conduit sleeve penetrations with the ceiling conduit sleeve penetrations.
- C. The Contractor shall provide all necessary labor, supervision, materials, equipment, tests, and services to install a complete ladder rack system in the telecommunications room as shown on the Drawings.
- D. Specifications and Drawings are for assistance and guidance, but exact routing, locations, distances, and levels will be governed by actual field conditions.
- E. All splicing assemblies shall be the 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.
- F. Cable Drop Out/Waterfall
 1. Where cables bundles transition from tray and drop into the racks/cabinets, the Contractor shall provide and install a radius control device. This device shall be a waterfall or drop out device and shall be properly sized to accommodate cable bundle plus 20% future growth.
- G. Size ladder rack as indicated on the Contract Documents.
- H. Accessories (connectors, splice plates...) shall be painted to match tray finish.
- I. Manufacturers:
 1. Chatsworth Products Industries (CPI)
 2. Cooper/B-Line
 3. Approved equal

Part 3 - Execution

3.01 Equipment Rack and Cabinets

- A. Prior to permanently securing racks or cabinets, the Contractor shall coordinate a walk through with the Owner to determine exact placement of racks.

- B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Rack shall also be stabilized by extending a brace extending to the wall. Alternately, overhead cable tray over which the cabling accesses the equipment rack(s) shall provide this function.
- C. A space between the rack upright and the wall (~6") shall be planned to allow for cabling in that area. The rear of the rack shall be ~40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed shall be brought to the attention of the Consultant for resolution prior to installation.
- D. All hardware and equipment is to be mounted at least 18" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware shall be reviewed and approved by the Consultant and Site Coordinator(s) prior to installation.
- E. Equipment rack shall be equipped with cable management hardware to allow an orderly and secure routing of twisted pair cabling to the data patch panels. At minimum, one such horizontal jumper management panel shall be placed below each fiber optic patch panel installed by the Contractor. Additional jumper management panels may be required pending installation of other cable types on the rack. The rack shall be grounded to the telecommunications ground (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket).

3.02 Ladder Rack Runway

- A. Runway shall be installed in accordance with recognized industry practices, to ensure that the cable tray equipment complies with requirements of NEC, applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
- B. Coordinate installation of runway with other electrical work as necessary to properly interface installation of wire basket runway with other work.
- C. Provide sufficient space encompassing runways to permit access for installing and maintaining cables.
- D. Test runways to ensure electrical continuity of bonding and grounding connections and to demonstrate compliance with specified maximum grounding resistance.

End of Section

Section 27 13 00 – Communications Backbone Cabling

Part 1 - General

1.01 Scope

- A. Refer to Section 27 00 00 for additional project scope information.
- B. This section describes the products and execution requirements relating to telecommunications voice, data and video backbone cabling and termination components.
- C. Backbone Cabling is the cable and hardware interconnecting telecommunication rooms (TRs), building demarcation rooms, equipment rooms and server rooms. The backbone cabling shall consist of the following cable types:
 - 1. 50-micron Multimode Fiber Optic Cable
 - 2. Singlemode Fiber Optic Cable
 - 3. Multi-Pair Copper Voice Backbone Cable

1.02 Related Work

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 23 – Pathways for Technology Systems
- C. Section 27 10 00 – Communications Cabling General Requirements
- D. Section 27 10 05 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 15 00 – Communications Horizontal Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

1.03 Test Data – Fiber Optic Media

- A. The test result information for each link shall be recorded in the memory of the field tester upon completion of the test.
- B. The test result records saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test.

- C. The database for the completed job shall be stored and delivered on CD-ROM. This CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.
- D. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:
 - 1. The identification of the link in accordance with the naming convention defined in the overall system documentation.
 - 2. The overall Pass/Fail evaluation of the link-under-test including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value as defined in this document).
 - 3. The date and time the test results were saved in the memory of the tester.
- E. The following general information is to be provided in the electronic database containing the test result information for each link:
 - 1. The identification of the customer site as specified by the end user.
 - 2. The overall Pass/Fail evaluation of the link-under-test.
 - 3. The name of the standard selected to execute the stored test results.
 - 4. The cable type and the value of the 'index of refraction' used for length calculations.
 - 5. The date and time the test results were saved in the memory of the tester.
 - 6. The brand name, model, and serial number of the tester.
 - 7. The revision of the tester software and the revision of the test standards database in the tester.
- F. The detailed test results data to be provided in the electronic database for each tested optical fiber shall contain the following information:
 - 1. The identification of the link/fiber in accordance with the naming convention defined in the overall system documentation.
 - 2. The insertion loss (attenuation) measured at each wavelength, the test limit calculated for the corresponding wavelength, and the margin (difference between the measured attenuation and the test limit value).
- G. The link length shall be reported for each optical fiber for which the test limit was calculated.
- H. Contractor shall provide accurate as-built Construction Drawings at the site during construction.
- I. The Drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document.

Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The Owner will provide floor plans in paper and electronic (".dwg", AutoCAD rel. 2004 and ".dxf") formats on which as-built construction information can be added. These documents will be modified accordingly by the Contractor to denote as-built information as defined above and returned to the Owner.

- J. The Contractors shall annotate the base Drawings and return to the Consultant in hard copy (same plot size as originals) and electronic (AutoCAD rel. 2004 and ".dxf") form.

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Backbone Voice Cabling

- A. The voice backbone cable shall link the Main Closet and Telecommunications Rooms serving the building. The cables shall be CMP rated. These cables shall be terminated on wall-mounted 110 type blocks at MER and TR.
- B. Voice backbone cable shall incorporate 24 AWG solid annealed copper conductors insulated with a polyvinyl chloride skin over expanded polyethylene. Conductors shall be twisted to form pairs and fully color-coded.
- C. The voice backbone cable shall be sized as detailed on the Drawings.
- D. Conductors shall be identified by the insulation color of each conductor. The color code shall follow the industry standard composed of ten (10) distinctive colors to identify 25 pairs in accordance with ICEA publication S-80-576-1988. Marking of each mate of the primary conductor in a pair with the color of that primary conductor is optional.
- E. The voice backbone cable shall meet or exceed the EIA/TIA Category 3 performance requirements.
- F. When cables of larger than 25 pairs are required, the core shall be assembled into 25-pair subunits, each color-coded in accordance with ICEA publication S-80-576-1988. Cables with over 600 pairs shall have 25-pair binder groups combined into super units. These super units shall be wrapped with a solid color thread that follows the primary color scheme of white, red, black, yellow, and violet. Binder color code integrity shall be maintained wherever cables are spliced.
- G. All cables and equipment shall be furnished, installed, wired, and tested by the Contractor.

H. Acceptable Manufacturers:

1. Berk-Tek, General, Hitachi
2. Or Approved Equivalent.

2.03 Intra-building Backbone Copper Cabling

- A. General: Copper backbone cable shall be used to provide voice connectivity between the MDF or IDF-1 and IDF-2 Spaces. Cable shall be installed within conduits, sleeves/cores and/or the cable tray system between spaces.
- B. Codes and standards: Multi-conductor cable shall be acceptable for IEEE 802.3 applications. Cables shall be type CMP (communications plenum cable) or type CMR (communications riser cable) as required per the installation environment and as outlined in NEC Sections 800-51(a) and 800-51(b) respectively. Cable shall also conform to Bell Laboratories specification L-780011 and be UL listed.
- C. Conductors: Conductors shall be #24 AWG solid annealed copper twisted to form individual non-shielded pairs. The twisted pairs shall be color-coded using standard telephone industry color codes.
- D. Insulation: Polyvinylchloride skin over polyethylene or a Teflon material as required per the installation.
- E. Jacket: Riser rated cable jacket shall be of fire resistant riser rated material equivalent to polyvinylchloride plastic or better. Cable jacket shall enclose an overlapped corrugated aluminum shield. Plenum rated cable jacket shall be of fire resistant plenum rated material equivalent to a copolymer or better.
- F. The total number of cable pairs supplied in each run shall equal the total pair count as shown on the drawings.
- G. Acceptable Manufacturer/Product:
1. Berk-Tek, General, Hitachi
 2. Or Approved Equivalent.

2.04 Outside Plant (OSP) Inter-building Fiber Optic Cable

- A. General: Armored loose tube fiber optic backbone cable shall be used for connectivity between buildings. Cable will be run within innerduct in underground conduit between buildings and within the building.
- B. Fiber construction shall consist of singlemode with a core/cladding size of 9/125 micron. Contractor shall furnish and install the appropriate fan out or breakout materials as required and dictated by the application and fiber optic cable type.
- C. The total number of fibers supplied in each cable run shall equal the total number of fibers shown on the contract drawings. The cable structure shall be such that the

fibers are grouped for easy handling. The cable shall contain appropriate strength members to satisfy the mechanical and environmental specifications provided herein.

- D. The core shall consist of filled buffer tubes surrounding a central dielectric strength member. Water-Swellable and Flame Retardant Tape and yarns shall surround the fibers to provide further weather and mechanical protection. The Contractor shall ensure that the core construction of the cable proposed for installation is such that the environmental and mechanical requirements of the installation are met.
- E. The maximum attenuation of loose tube fiber optic strands shall be:
 - 1. 9.0/125 singlemode (1310 nanometers): 0.4 dB/km
 - (1550 nanometers): 0.3 dB/km
- F. All finished fibers must be color-coded by the manufacturer for identification. The fibers shall be connectorized utilizing field-installed terminations or spliced pigtails. The nominal connector loss using either termination method shall not be greater than 0.40 dB per mated pair.
- G. The fiber cable shall be able to withstand a short-term tensile load of 2700 N (600 lbf.) and a long-term tensile load of 600 N (135 lbf.) with maximum elongation of less than 0.5% and no breakage of fibers.
- H. The minimum static or no load (0-180 lb.) bending radius for the cable shall be no less than 10 times the outside diameter of the cable. Cables shall be able to withstand being flexed at their minimum static bending radius +/- 90 degrees for at least 20 cycles at 20-40 cycles per minute at 20 degrees C. The minimum dynamic or loaded (181-600 lb.) bending radius shall be no greater than 20 times the outside diameter of the cable.
- I. The cable shall be able to withstand twisting of +/-360 degrees over a length of 2 meters for at least 10 cycles at 10 cycles per minute. The cable shall be able to withstand storage and operating temperatures of -40 to +70 degrees C. The cable shall withstand a compressive force of 600 N/cm without breakage, and there shall be no attenuation increase after the force is removed.
- J. Acceptable Product:
 - 1. Berktek
 - 2. General
 - 3. Hitachi
 - 4. Or Approved equivalent

2.05 Tight-Buffered Optical Fiber Cables for Indoor Distribution Applications

- A. General Considerations

1. The cable shall meet the requirements of the National Electrical Code (NEC) Section 770.
2. For plenum applications, the cable shall meet applicable flame tests: ANSI/UL 910 (NFPA 262-1994).
3. Cables shall be listed OFNP (OFCP).
 - a. Berktek
 - b. General
 - c. Hitachi
 - d. Approved equivalent.
4. Finished cables shall conform to the applicable performance requirements of Tables 8-6 and 8-7 of the Insulated Cable Consultants Association, Inc. (ICEA) *Standard for Fiber Optic Premises Distribution Cable* (ICEA S-83-596).

B. Cable Construction

1. The coated fiber shall have a layer of Teflon placed between the acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be $900 \pm 50 \mu\text{m}$. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass for connectorization or splicing.
2. Cables with 2 to 24 fibers layered aramid yarns shall serve as the tensile strength member of the cable.
3. A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal.
4. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness. The jacket shall be smooth, as is consistent with the best commercial practice.
5. The fibers shall be stranded around a dielectric central member.
6. For cables containing 12-24 fibers, the fibers shall be arranged in two layers.
7. The central member shall be over coated with a thermoplastic, when required, to achieve dimensional sizing to accommodate and support the $900 \mu\text{m}$ buffered fibers.
8. Cables with 24 to 60 fibers shall have unitized riser and plenum constructions.
9. The buffered fibers shall be grouped in six-fiber subunits.
10. The fibers shall be stranded around a dielectric central member in the subunit.

11. Layered aramid yarns shall serve as the tensile strength member of the subunit.
 12. A ripcord may be applied between the aramid yarns and the subunit jacket to facilitate jacket removal.
 13. The subunit jacket shall be extruded over the aramid yarns for physical and environmental protection. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness. The jacket shall be smooth, as is consistent with the best commercial practice.
 14. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the subunits. The strength members shall be of a high modulus aramid yarn. The aramid yarns shall be helically stranded around the buffered fibers. Non-toxic, non-irritant talc shall be applied to the yarns to allow them to be easily separated from the fibers and the subunit jacket.
- C. Outer Cable Jacket
1. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand stresses. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.
 2. The indoor distribution cable specified herein shall have an interlocking armor made of steel or aluminum. The interlocking armor for plenum cables shall have a PVC jacket.
 3. The color of the armor jacket shall match the jacket color of the optical fiber cable located inside of the armor. The armor for these cables shall be comparable to liquid tight flexible metal conduit if jacketed, or flexible metal conduit.
- D. Fiber Identification
1. The individual fibers shall be color-coded for identification. The optical fiber color-coding shall be in accordance with ANSITIA/EIA-598-B "Optical Fiber Cable Color Coding." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color-coded buffered fibers shall not adhere to one another.
 2. When buffered fibers are grouped into individual subunits, each subunit jacket shall be numbered for identification, with the exception of filler subunits where used. The number shall be repeated at regular intervals. The subunit jacket color

shall be orange for subunits containing multimode fibers, yellow for subunits containing singlemode fibers, and white for filler subunits.

3. The outer jacket for all dielectric cable shall be marked with the manufacturer name or UL file number, date of manufacture, fiber type, flame rating, listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket. The cable jacket color shall be orange for cables containing multimode fibers and yellow for cables containing singlemode fibers.
4. Cables with a PVC jacket over interlocking armor shall be marked with the manufacturer name, date of manufacture, fiber type, flame rating, listing symbol, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket. The cable jacket color shall match the color of the core optical fiber cable.

E. Cable Specifications

1. Temperature Range

- a. Non-Plenum Applications: The storage temperature range for the cable on the original shipping reel shall be -40 to +70°C. The installation/operating temperature range for riser cables shall be -20 to +70 °C. Testing shall be in accordance with FOTP-3.
- b. Plenum Applications: The storage temperature range for the cable on the original shipping reel shall be -40 to +70°C. The installation/operating temperature range for plenum cables shall be 0 to +70°C. Testing shall be in accordance with FOTP-3.

2. Compressive Load Resistance

- a. When tested in accordance with FOTP-41, Compressive Loading Resistance of Fiber Optic Cables, the cable shall withstand a minimum compressive load of 89 N/cm (50 lbf/in) applied uniformly over the length of the compression plate. While under compressive load, the fiber shall not experience an attenuation change greater than 0.4 dB at 1550 nm (singlemode) or greater than 0.6 dB at 1300 nm (multimode). After the compressive load is removed, the fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (singlemode) or greater than 0.4 dB at 1300 nm (multimode).

3. Cyclic Flexing

- a. When tested in accordance with FOTP-104, Fiber Optic Cable Cyclic Flexing Test, the cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycle per minute. The fiber shall not experience an attenuation change greater than 0.2 dB at 1550 nm (singlemode) or greater than 0.4 dB at 1300 nm (multimode).

4. High and Low Temperature Bend

- a. When tested in accordance with FOTP-37, Fiber Optic Cable Bend Test, Low and High Temperature, the cable shall withstand four full turns around a mandrel at test temperatures of 0 °C and +50 °C. The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (singlemode) or greater than 0.5 dB at 1300 nm (multimode).
5. Impact Resistance
 - a. When tested in accordance with FOTP-25, Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies, the cable shall withstand a minimum of 20 impact cycles for riser cables and 10 impact cycles for plenum cables. The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (singlemode) or greater than 0.4 dB at 1300 nm (multimode).
 6. Temperature Cycling
 - a. When tested in accordance with FOTP-3, Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components, the change in attenuation at extreme operational temperatures (0 to +50 °C) shall not exceed 0.3 dB/km at 1550 nm (singlemode) or 0.6 dB/km at 1300 nm (multimode). The change in attenuation is measured with respect to the baseline values measured at room temperature before temperature cycling.
 7. Twist-Bend
 - a. When tested in accordance with FOTP-91, Fiber Optic Cable Twist-Bend Test, a length of cable no greater than 2 meters shall withstand 10 cycles of mechanical twisting and bending around a mandrel 20 times the cable outer diameter. The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (singlemode) or 0.4 dB at 1300 nm (multimode).
- F. Multimode (50/125 μm)
1. The multimode fiber utilized in the optical fiber cable shall meet EIA/TIA-492AAAA-A-1997, Detail Specification for 50μm Core Diameter/125μm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers (OM4 type). Cable shall have the following specifications:
 - a. Core Diameter: 50 ± 3 μm
 - b. Core Non-Circularity: ≤5%
 - c. Cladding Diameter: 125± 2 μm
 - d. Cladding Non-Circularity: <2.0%
 - e. Core-to-Cladding Concentricity: ≤ 3 μm
 - f. Coating Diameter: 245 ± 2 mm
 - g. Refractive Index Profile: Graded index

- h. Numerical Aperture: 0.275 ± 0.015
 - i. Maximum Attenuation: less than 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm.
2. IEEE 802.3z Performance: The fiber shall support laser-based 10 Gigabit Ethernet (10GbE) operation for up to 500 meters.
 3. Attenuation at the Water Peak: The attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at 1300 nm by more than 1.0 dB/km.
 4. Macrobend Attenuation: The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.5 dB at 850 nm or 1300 nm.
- G. Singlemode
1. The singlemode fiber utilized in the optical fiber cable shall meet EIA/TIA-492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Singlemode Optical Fibers, and ITU recommendation G.652, Characteristics of Singlemode Optical Fiber Cable. The cable shall meet the following specifications:
 - a. Core Diameter (Characterized): $8.3 \mu\text{m}$
 - b. Cladding Diameter: $125 \pm 1.0 \mu\text{m}$
 - c. Core-to-Cladding Concentricity: $\leq 0.8 \mu\text{m}$
 - d. Cladding Non-Circularity: $\leq 1.0 \%$
 - e. Coating Diameter: $245 \pm 10 \mu\text{m}$
 2. Attenuation: The maximum attenuation shall be 0.5 dB/km at 1310 nm and 0.4 dB/km at 1550 nm.
 3. Attenuation Uniformity: There shall be no point discontinuity greater than 0.10 dB at either 1310 nm or 1550 nm.
 4. Attenuation at the Water Peak: The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.
 5. Cutoff Wavelength: The cabled fiber cutoff wavelength shall be ≤ 1260 nm.
 6. IEEE 802.3z Performance: The fiber shall support laser-based Gigabit Ethernet (GbE) operation in the 1000BASE-LX (1300 nm) operating window at 5000 m.
 7. Mode Field Diameter: The mode field diameter of the fiber shall be $9.30 \pm 0.50 \mu\text{m}$ at 1310 nm $10.50 \pm 1.0 \mu\text{m}$ at 1550 nm.
 8. 12 Macrobend Attenuation: The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.05 dB at 1310 nm and 0.10 dB at 1550 nm.
 9. Zero Dispersion Wavelength (λ_0): The zero dispersion wavelength of the fiber shall be $1301.5 \text{ nm} \leq \lambda_0 \leq 1321.5 \text{ nm}$.

10. Zero Dispersion Slope (So): The zero dispersion slope of the fiber shall be ≤ 0.092 ps/(nm•km).
 11. Maximum Dispersion: The maximum dispersion shall be ≤ 3.2 ps/(nm•km) from 1285 nm through 1330 nm and shall be ≤ 18 ps/(nm•km) at 1550 nm.
- H. The cable shall be Berk-Tek, Corning, General, Mohawk or other equivalent products that meet these specifications.

2.06 Fiber Optic Connector

- A. The optical connector shall be LC-type.
- B. The connector ferrule shall be ceramic or glass-in-ceramic. The optical fiber within the connector ferrule shall be secured with an adhesive. The attenuation per mated pair shall not exceed 0.35 dB (individual) and 0.2 dB (average). Connectors shall sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications.
- C. The connector shall meet the following performance criteria:

1. Cable Retention (FOTP-6)	0.2 dB
2. Durability (FOTP-21)	0.2 dB
3. Impact (FOTP-2)	0.2 dB
4. Thermal Shock (FOTP-3)	0.2 dB
5. Humidity (FOTP-5)	0.2 dB
- D. Connectors shall be Leviton field polished, 3M Hot Melt or other approved connector.

Part 3 - Execution

3.01 Testing

- A. Refer to Section 27 00 00 for additional requirements.
- B. Field Test Requirements for Fiber Optic Cabling System
 1. The fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, the Contractor shall provide cable manufacturer's test report for each reel of cable provided. These test reports shall include the manufacturer's on reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.
 2. Factory data shall be provided upon request, showing on-the-reel bandwidth performance results as tested at the factory.
 3. Every fiber optic backbone link in the installation shall be tested in accordance with the field test specifications defined by the Telecommunications Industry

Association (TIA) standard ANSI/TIA/EIA-568-C or by the appropriate network application standard(s), whichever is more demanding.

4. The test shall include the representative connector performance at the connecting hardware associated with the mating of patch cords. The test does not, however, include the performance of the connector at the interface with the test equipment.
5. 100% of the installed cabling links shall be tested and shall pass the requirements of the standards mentioned above and as further detailed in this document. Any failing link shall be diagnosed and corrected at no additional cost to the Owner. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with RFP.
6. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:
 - a. The manufacturer of the fiber optic cable and/or the fiber optic connectors
 - b. The manufacturer of the test equipment used for the field certification
 - c. Training organizations authorized by BICSI
7. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14-A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50B, Method A. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-C.1) with a Category 1 light source.
8. Field test instruments for singlemode fiber cabling shall meet the requirements of ANSI/EIA/TIA-526-7.
9. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
10. The fiber optic launch cables and adapters shall be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.
11. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests.
12. Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter.
13. A representative of the Owner shall be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing begins.

14. A representative of the Owner will select a random sample of 5% of the installed links. The results obtained shall be compared to the data provided by the installation Contractor. If more than 2% of the sample results differ in terms of the Pass/Fail determination, the installation Contractor, under supervision of the Owner representative, shall repeat 100% of the testing. The cost of retesting shall be borne by the installation Contractor.

C. Fiber Performance Test Parameters

1. The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA standard 568-B.
 - a. $\text{Link Attenuation} = \text{Cable_Attn} + \text{Connector_Attn} + \text{Splice_Attn}$
 - b. $\text{Cable_Attn (dB)} = \text{Attenuation_Coefficient (dB/km)} * \text{Length (Km)}$
 - c. The values for the Attenuation_Coefficient are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation_Coefficient (dB/km)
Multimode 50/125 μm	850	3.5
	1300	1.5
Singlemode (Inside plant)	1310	0.5
	1550	0.4
Singlemode (Outside plant)	1310	0.4
	1550	0.5

- d. $\text{Connector_Attn (dB)} = \text{number_of_connector_pairs} * \text{connector_loss (dB)}$
 - e. Maximum allowable mated connectors_loss = 0.50 dB
 - f. $\text{Splice_Attn (dB)} = \text{number of splices (S)} * \text{splice_loss (dB)}$
 - g. Maximum allowable splice_loss = 0.1 dB (when tested bidirectionally)
2. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices—i.e., it does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
3. Test equipment that measures the link length and automatically calculates the link loss based on the above formulas is preferred.
4. The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.
5. The backbone link (multimode/singlemode) shall be tested in two directions at both operating wavelengths to account for attenuation deltas associated with wavelength.

6. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A.
7. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.
8. Multimode backbone links are designed to be used with network applications that use laser light sources (underfilled launch conditions). However, the link attenuation equation has been based upon the use of a light source categorized as Category 1, Overfilled.
9. Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1. All singlemode links shall be certified with test tools using laser light sources at 1310 nm and 1550 nm.

3.02 Fiber Optic Cable Installation Requirements

- A. Cable slack shall be provided in each backbone fiber optic cable. This slack is exclusive of the length of fiber that is required to accommodate termination requirements and is intended to provide for cable repair and/or equipment relocation. The cable slack shall be stored in a fashion as to protect it from damage and be secured in the termination enclosure or a separate enclosure designed for this purpose. Multiple cables may share a common enclosure.
- B. A minimum of 15 feet of slack cable (each cable) shall be coiled and secured at each end.
- C. Exact cable termination locations shall be field verified with Owner.

End of Section

Section 27 15 00 – Communications Horizontal Cabling

Part 1 - General

1.01 Scope

- A. This section describes the products and execution requirements relating to telecommunications voice, data and video horizontal (station) cabling and termination components.
- B. Horizontal cabling is the cabling between the work area telecommunications outlet and the telecommunications room (TR). Horizontal cabling is often referred to as “station cabling”.
- C. The horizontal cabling system will consist of the following:
 - 1. Unshielded Twisted Pair (UTP) Cable
 - 2. Outlet Termination Modules (jacks)
 - 3. Outlet Termination Plates
 - 4. Horizontal Fiber Optic/Copper Composite Cabling
 - 5. Above Ceiling Cable Support Systems
 - 6. Horizontal Cable Testing Requirements
 - 7. Cable Pathway/Sleeve Requirements
 - 8. Coaxial Cable

1.02 Related Work

- A. Section 27 05 23 – Pathways for Technology Systems
- B. Section 27 00 00 – General Technology Requirements
- C. Section 27 10 00 – Communications Cabling General Requirements
- D. Section 27 10 05 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 13 00 – Communications Backbone Cabling
- G. Section 27 16 00 – Communications Connecting Cords
- H. Section 27 18 00 – Communications Labeling and Identification

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Category 6 Horizontal Copper Cables (standard data cables)

- A. All cables and equipment shall be furnished, tested, installed and wired by the Contractor.
- B. All horizontal data cables shall terminate on modular patch panels in the telecommunications rooms as specified on the Drawings.
- C. Standard data cable specification defines the requirements for commercially available high performance Category 6 cable.
- D. This cable shall be suitable for installation free-air, in building risers, in conduit, and/or in cable tray and shall carry CMP rating.
- E. Standard data cable design described herein shall exceed transmission performance of Category 6 cables.
- F. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code, and meet the specifications of NEMA (low loss), UL 444, and ICEA. Conductor shall also conform to the requirements for solid annealed copper wire in accordance with ASTM B 3.
- G. All cables, termination components, and support hardware shall be furnished, tested, installed, and wired by the Contractor.
- H. The jacket color for data cables shall be BLUE.
- I. IMPORTANT: Cable and termination components (jack, patch panel, wiring blocks) are specified to function as a system. The compatibility of the cable to be installed with the proposed termination components shall be recognized and documented by the termination component manufacturer.
- J. Category 6 Cables shall be:
 - 1. Berk-Tek - LANmark 1000
 - 2. General Cable – Genspeed 6000
 - 3. Or Hitachi – Supra 660

2.03 Category 6A Horizontal Copper Cables (WAP and Up-Links)

- A. Category 6A cables shall be used to support all Wireless Access Point (WAP) and all Uplink connections connecting MDF/IDF rooms. All cables and equipment shall be furnished, tested, installed and wired by the Contractor.
- B. All horizontal data cables shall terminate on modular patch panels in the telecommunications rooms as specified on the Drawings.
- C. WAP and Uplink cable specification defines the requirements for commercially available high performance Category 6A cable.
- D. This cable shall be suitable for installation free-air, in building risers, in conduit, and/or in cable tray and shall carry CMP rating.
- E. WAP and Uplink cable design described herein shall exceed transmission performance of Category 6A cables.
- F. Cables shall be Underwriters Laboratory (UL) listed, comply with Article 800 (Communications Circuits) of the National Electrical Code, and meet the specifications of NEMA (low loss), UL 444, and ICEA. Conductor shall also conform to the requirements for solid annealed copper wire in accordance with ASTM B 3.
- G. All cables, termination components, and support hardware shall be furnished, tested, installed, and wired by the Contractor.
- H. The jacket color for data cables shall be BLUE.
- I. **IMPORTANT:** Cable and termination components (jack, patch panel, wiring blocks) are specified to function as a system. The compatibility of the cable to be installed with the proposed termination components shall be recognized and documented by the termination component manufacturer.
- J. Category 6A Cables shall be:
 - 1. Berk-Tek – LANmark-SST
 - 2. General Cable – Genspeed 10 MTP Thin-Profile
 - 3. Or Hitachi – Supra 10G

2.04 Coaxial Cable (when applicable)

- A. RG-6 Quad Shield Coaxial Station Drop Cable
 - 1. RG-6 coaxial cable shall be used for video connectivity from the video system main trunk cable to the individual CATV or broadcast outlet. The cable shall be placed within the cable tray system and shall be UL Listed CMP Plenum rated.
 - 2. Center conductor shall be nominal 18AWG minimum, solid bare copper. The dielectric insulation shall be foam FEP. The outer conductor or shield shall be

aluminum foil and 95% coverage tinned copper braid. Outer jacket shall be CommFlex V with minimum 80 degree Celsius temperature rating and white in color.

3. Maximum attenuation of the cable @ 20degrees Celsius shall be 6.05dB/100feet @ 720MHz. Velocity of Propagation shall be 84% NOMINAL. Nominal impedance shall be $75\Omega \pm 2\Omega$.
4. Acceptable Product:
 - a. General Cable
 - b. Belden

2.05 Information Outlet

A. General

1. Station cables shall each be terminated at their designated workstation location in the connector types described in the subsections below. Included are modular jacks, faceplates, and surface mount raceway. The combined assembly is referred to as the Standard Information Outlet (SIO). These connector assemblies shall snap into a mounting frame.
2. SIOs shall be mounted (1) where existing boxes are in place, (2) on surface mount raceway typically in surface raceway with barrier, (3) on floor mount interface boxes, or (4) on power poles either currently owned or new.
3. The telecommunications outlet frame shall accommodate or incorporate the following:
 - a. A minimum of four (4) modular jacks, when installed on a wall-mounted assembly.
 - b. A maximum of 6 cables shall be in a single outlet box/faceplate. If more than 6 cable/jacks are needed at one location, contractor shall provide adjustment faceplates with not more than 6 jacks per faceplate.
 - c. A mechanism for adjusting the surface plate to a plumb position.
4. Multiple jacks are identified in close proximity on the Drawings. The Contractor shall determine the optimum compliant configuration based on the products proposed.
5. The same orientation and positioning of jacks and connectors shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each SIO type for review by the Consultant.

B. Modular Jack

1. Data jacks shall be non-keyed 8-pin modular jacks.

2. Termination components shall be designed to maintain the cable's pair twists as closely as possible to the point of mechanical termination.
 3. Jacks shall utilize a four-layer printed circuit board to control NEXT.
 4. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
 5. Modular jack contacts shall accept 2500 plug insertions.
 6. Modular jack contacts shall be formed flat for increased surface contact with mated plugs. These contacts shall be arranged on the PC board in two staggered arrays of four to maximize contact spacing and minimize crosstalk.
 7. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
 8. Contact Plating shall be a minimum of 50 micro inches of gold in the contact area over 50 micro-inch of nickel, compliant with FCC part 68.5.
 9. Jack termination shall be 110 IDC, integral to the jack housing, laid out in two arrays of four contacts.
 10. Jacks shall utilize a paired punch down sequence. Cable pairs shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
 11. Jacks shall utilize tin lead plated (60% tin/40%lead) phosphor bronze 110 insulation displacement contacts.
 12. Jacks shall terminate 22-26 AWG stranded or solid conductors.
 13. Jacks shall terminate insulated conductors with outside diameters up to .050".
 14. Jacks shall be compatible with single conductor 110 impact termination tools.
 15. Jacks shall be compatible with EIA/TIA 606 color code labeling and accept snap on icons for identification or designation of applications.
 16. Jacks shall be Gray in color.
 17. Jacks shall be marked as either T568A or T568B wiring.
 18. Category 6 jacks shall be manufactured by Leviton 61110-RG6.
 19. Category 6a jacks shall be manufactured by Leviton 6AUJK-RG6
- C. Outlet Faceplates
1. Faceplates shall be stainless steel and incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.
 2. Any unused jack positions shall be fitted with a removable blank inserted into the opening.

3. Modular jacks shall have capability to incorporate a dust cover that fits over and/or into the jack opening. The dust cover shall be designed to remain with the jack assembly when the jack is in use. No damage to the jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the jack pinning shall not be accepted.
4. Wall-mounted “voice only” outlets shall be installed where identified on the floor plan Drawings to accommodate wall-mounted telephone sets. The wall plate shall be of stainless steel construction, accommodate one (1) voice jack as defined below, mount on a standard single gang outlet box or bracket, and include mating lugs for wall phone mounting.
5. All standard information outlets and the associated jacks shall be of the same manufacturer throughout each/the building. An allowable exception, however, is the wall-mounted “voice only” outlet described above.
6. Faceplates shall be manufactured by modular jack manufacturer.

D. Surface Mount Interface Box

1. Low profile, surface mount boxes shall incorporate recessed designation strips at the top for identifying labels. Designation strips shall be fitted with clear plastic covers.
2. The box shall feature built-in cable management for both fiber and copper applications.
3. Any unused jack positions shall be fitted with a removable blank inserted into the opening.
4. Modular jacks shall have capability to incorporate spring-loaded shutter door for added protection from dust and other airborne contaminants. The dust cover shall be designed to remain with the jack assembly when the jack is in use.
5. The box shall have the capability to incorporate optional magnets that can be internally mounted.
6. Surface mount box shall be manufactured by modular jack manufacturer.

2.06 Additional Modules for Copper Cabling

A. Additional modules for copper shall include the following:

1. 50 and 75 Ohm BNC coax coupler modules, male-male
2. F-type coax coupler module, male-male threaded
3. RCA connector modules with black, red, yellow, and white inserts
4. Solder, pass-through and punch-down termination types
5. S-Video connectors modules - coupler and punch-down termination types

6. Blank module to reserve space for future additions
- B. The connectors shall be designed to allow snap-in installation into the outlet faceplates.

2.07 Cable Hook Systems

- A. In the areas where the cables are required to be run in a “free-air” plenum, a cable hook system shall be used.
- B. Cable hooks shall be capable of supporting a minimum of 30 lbs with a safety factor of 3.
- C. Spring steel cable hooks shall be capable of supporting a minimum of 100 lbs with a safety factor of 3 where extra strength is required.
- D. Follow manufacturer’s recommendations for allowable fill capacity for each size of cable hook.
- E. Installation and configuration shall conform to the requirements of the ANSI/EIA/TIA Standards 568A & 569, NFPA 70 (National Electrical Code), and applicable local codes.
- F. Cable hooks shall:
 1. Have a flat bottom and provide a minimum of 1 5/8" cable bearing surface.
 2. Have 90-degree radiused edges to prevent damage while installing cables.
 3. Be designed so the mounting hardware is recessed to prevent cable damage.
 4. Have a retainer that shall be removable and reusable.
 5. Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, and floor posts, to meet job conditions.
- G. Factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed.
- H. Cable hooks shall be:
 1. B-Line series BCH21, BCH32
 2. Cable trunks with less than 20 cables may be supported by Stiffy (Tomarco/CEAS Attachment Products).

Part 3 - Execution**3.01 Twisted Pair Test Equipment**

- A. Test equipment used under this contract shall be from a manufacturer who has a minimum of five years' experience in producing field test equipment. Manufacturers shall be ISO 9001 certified.
- B. All test tools of a given type shall be from the same manufacturer and have compatible electronic results output. Test adapter cable shall be approved by the manufacturer of the test equipment. Baseline accuracy of the test equipment shall exceed TIA Level III, as indicated by independent laboratory testing.
- C. Test equipment shall:
 - 1. Be capable of certifying Category 5E, 6 and 6A permanent links.
 - 2. Have a dynamic range of at least 100dB to minimized measurement uncertainty.
 - 3. Be capable of storing full frequency sweep data for all tests and printing color graphical reports for all swept measurements.
 - 4. Include S-band time domain diagnostics for NEXT and return loss.
 - 5. Be capable of running individual NEXT, return loss, etc., measurements in addition to AutoText.
 - 6. Include a library of cable types, stored by major manufacturer.
 - 7. Store at least 1000 Category 5e, 6 or 6A autotests in internal memory.
- D. The measurement reference plane of the test equipment shall start immediately at the output of the test equipment interface connector. There shall not be a time domain dead zone of any distance that excludes any part of the link from the measurements.
- E. The approved manufacturer of the test equipment is Fluke.

3.02 Cable Support

- A. J-hooks fabricated to contain data/voice and video cables may be used to support 25 or fewer cables in each hook. J-hooks are to be fastened to building steel with beam clamps, suspended from ceiling slab with threaded rod, or anchored to the wall. All J-hooks shall be hung straight and level. No other installation technique will be authorized unless pre-approved.
- B. Three tiered double-sided J-hook configurations shall contain a maximum of 25 cables per hook or 150 cables. Smaller configurations may be used as bundles decrease in size, maintaining no more than 25 cables per hook.
- C. Bundles surpassing 150 cables shall be supported by hangers, fabricated of 3/8" threaded rod and 24" Unistrut. Hangers shall also be installed where the installation

of a three-tiered J-hook system is not appropriate for the ceiling space, or where blocked by other trades' work.

- D. Cable bundles consisting of fewer than 20 cables may be supported by single J hooks or Stiffy (Tomarco/CEAS Attachment Products)
- E. All cable support in the cable path shall be installed every four and five feet (staggered).
- F. A sag shall be maintained between supports of 6", to reduce cable strain. Velcro is an appropriate method of securing cables, when properly used and not over tightened.
- G. Proper cable support is extremely important to the Owner, and care shall be taken by the Contractor to provide and install the appropriate supports. Supports found to be inadequate will be replaced.
- H. Cable bundles including voice/data cabling shall not have plastic cable ties.
- I. All cable trunks shall have radius controlled cable waterfalls where trunk drops from conduit, sleeve or tray from horizontal path to vertical path.

3.03 Station Cabling

- A. Information outlet cables with copper media (voice & data UTP and "TV" coax) shall be located as detailed on the Project Drawings.
- B. The Contractor shall utilize these documents in determining materials quantities and routing.
- C. Station cables shall be run to the information outlet from the MER/TR serving each area in conduit, free-air above drop ceiling, in cable tray, and/or in modular furniture.
- D. The maximum station cable drop length for UTP cables shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and shall include any slack required for the installation and termination. The Contractor shall install station cabling in a fashion to avoid unnecessarily long runs.
- E. Contractor shall verify cable lengths comply with published standards; prior to installation of any horizontal cabling, this Contractor shall verify cable paths and confirm no horizontal cable will exceed 295 total feet. If it is determined that the cable will exceed 295', this Contractor shall route the cabling to another MER/TR or determine shorter path so cables are under 295'. If this is not possible, the Contractor shall notify the Consultant prior to installation. Failure to do this step will not result in a change order from the Contractor.
- F. The minimum station cable drop length for UTP cables shall be no less than 45 feet. The Contractor shall install station cabling in a fashion to avoid runs less than 45

feet. If cable slack is required to accommodate the minimum length requirements, the Contractor is responsible for storing the slack in a fashion as to protect the cable from damage. The cable slack shall be secure above the ceiling tiles in a figure 8 form by means of J-hooks or D-rings anchored to the building structure. The cable slack shall be coiled to maintain from 100% to 200% of the cable recommended minimum bend radius. Multiple cables may share a common support.

- G. All cables shall be installed splice-free unless otherwise specified.
- H. During pulling operation, an adequate number of workers shall be present to allow cable observation at all points of duct entry and exit as well as the feed cable and operate pulling machinery.
- I. Avoid abrasion and other damage to cables during installation.
- J. All cable shall be free of tension at both ends. In cases where the cable shall bear some stress, Kellom grips may be used to spread the strain over a longer length of cable.
- K. Where installed free-air, installation shall consider the following:
 - 1. Cable shall run at right angles and be kept clear of other trades' work.
 - 2. Cables shall be supported according to code, using "J-hooks" anchored to ceiling concrete, walls, piping supports, or structural steel beams.
 - 3. Hooks shall be designed to maintain cable bend to larger than the minimum bend radius (typically 4 x cable diameter).
 - 4. Supports shall be spaced at a maximum 4-foot interval unless limited by building construction. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.
- L. Cable shall never be laid directly on the ceiling grid.
- M. Cables shall not be attached to existing cabling, plumbing, or steam piping, ductwork, ceiling supports, or electrical or communications conduit.
- N. Manufacturers' minimum bend radius specifications shall be observed in all instances. Use of plastic cable ties is not acceptable. Cable bundles shall be neatly dressed with use of Velcro type straps.
- O. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.
- P. A coil of one foot in each cable shall be placed in the ceiling at the last support (e.g., J-hook) before the cables enter a fishable wall, conduit, surface raceway, or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15 feet of slack shall be left in each station cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support

before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

- Q. To reduce or eliminate EMI, the following minimum separation distances from $\leq 480V$ power lines shall be adhered to:
 - 1. Twelve (12) inches from power lines of $<5\text{-kVa}$
 - 2. Eighteen (18) inches from high voltage lighting (including fluorescent)
 - 3. Thirty-nine (39) inches from power lines of 5-kVa or greater
 - 4. Thirty-nine (39) inches from transformers and motors
- R. All openings shall be sleeved and firestopped per prevailing code requirements upon completion of cable installation.

3.04 Information Outlet

- A. Information outlets shall be flush mounted on wall-mounted boxes, in floor-mounted boxes, on surface raceway, or on modular furniture.
- B. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Consultant. Nominal height (from finished floor to center line of outlet) in new installation shall be as follows:
 - 1. Standard Voice & Data Outlet (SIO) shall match adjacent electrical outlets.
 - 2. Wall-Mounted Telephone Outlet (Standard Voice only) shall meet ADA requirements.
- C. The Contractor shall coordinate the style of the telecommunication outlets to be installed in the floor mount boxes and surface mount raceways with the Owner.

3.05 Cable Termination

- A. At the telecommunication closet, all data and voice cables shall be positioned on termination hardware in sequence of the outlet ID, starting with the lowest number.
- B. Termination hardware (blocks and patch panels) positioning and layout will be reviewed and approved by the Consultant prior to construction. The review does not exempt the Contractor from meeting any of the requirements stated in this document.
- C. Cable Termination – Data/Voice UTP
 - 1. Data/voice patch panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.

2. Data patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.
3. At information outlets and data/voice patch panels, the installer shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination for data/voice cables. The cable jacket shall be removed only to the extent required to make the termination.

D. Cable Termination – Fiber Optic

1. All fibers shall be terminated using the specified connector type.
2. All terminated fibers at the telecommunications closets shall be mated to couplings mounted on patch panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.
3. All couplings shall be fitted with a dust cap.
4. Fibers from multiple locations may share a common enclosure, but they shall be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure, provided they are clearly identified as such. Fibers from different locations shall not share a common connector panel (e.g., “insert”).
5. Slack in each fiber shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30” high workbench positioned adjacent to the termination enclosure(s). A minimum of one meter (~39”) of slack shall be retained regardless of panel position relative to the potential work area.
6. Contractor shall install a plastic twist-on bushing on each end of interlocking armored fiber to protect cable from sharp edges of the armor.

3.06 Test Data – Copper Media

- A. The test result records saved by the tester shall be transferred into a Windows-based database utility that allows for the maintenance, inspection, and archiving of these test records. A guarantee shall be made that these results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test. Comma separated value (CSV) format is not acceptable.
- B. The database for the completed job – including twisted-pair copper cabling links, if applicable – shall be stored and delivered on CD-ROM. This CD-ROM shall include the software tools required to view, inspect, and print any selection of test reports.
- C. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information:

1. The identification of the link in accordance with the naming convention defined in the overall system documentation.
2. The overall Pass/Fail evaluation of the copper channel-under-test, including the NEXT worst-case margin (margin is defined as the difference between the measured value and the test limit value).
3. The overall Pass/Fail evaluation of the fiber link-under-test, including the Attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
4. The date and time the test results were saved in the memory of the tester.

3.07 Copper Station Cables

- A. Station cabling testing shall be from the jack at the outlet in the work area to the termination block on which the cables are terminated at the MDF or IDF.
- B. Testing shall be of the permanent link. Contractor shall warrant performance, however, based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.
- C. Testing shall be from the jack at the SIO to the patch panel on which the cables are terminated at the wiring hub.
- D. Horizontal “station” cables shall be free of shorts within the pairs and shall be verified for continuity, pair validity and polarity, and wire map (conductor position on the modular jack). Any defective, split, or mispositioned pairs shall be identified and corrected.
- E. Testing of the cabling systems rated at TIA Category 6/6a and above shall be performed to confirm proper functioning and performance.
- F. Testing of the transmission performance of station cables (Category 6/6a) shall include the following:
 1. Length
 2. Attenuation
 3. Pair to Pair NEXT
 4. ACR
 5. PSNEXT Loss
 6. Return Loss
 7. Pair to Pair ELFEXT Loss or ACRF
 8. PSEFEXT Loss or PS-ACRF

9. Propagation Delay

10. Delay Skew

11. Return Loss

G. The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.

H. Worst case performance at 20°C, based on a horizontal cable length of 90 meters and equipment cord length of 4 meters, shall be as follows:

1. CATEGORY 6 (Permanent LINK)

Frequency (MHz)	Insertion Loss (Maximum dB)	NEXT Loss Pair to Pair (dB)	PS-NEXT Loss (dB; Worst Case)	ELFEXT Loss Pair to Pair (dB)	PSELFEXT loss (dB)
1.0	1.9	65.0	62.0	64.2	61.2
4.0	3.5	64.1	61.8	52.1	49.1
8.0	5.0	59.4	57.0	46.1	43.1
10.0	5.5	57.8	55.5	44.2	41.2
16.0	7.0	54.6	52.2	40.1	37.1
20.0	7.8	53.1	50.7	38.2	35.2
25.0	8.8	51.5	49.1	36.2	33.2
31.25	9.8	50.0	47.5	34.3	31.3
62.5	14.1	45.1	42.7	28.3	25.3
100.0	18.0	41.8	39.3	24.2	21.2
200.0	26.1	36.9	34.3	18.2	15.2
250.0	29.5	35.3	32.7	16.2	13.2

2. CATEGORY 6A (Permanent LINK)

Frequency (MHz)	Insertion Loss (Maximum dB)	NEXT Loss Pair to Pair (dB)	PS-NEXT Loss (dB; Worst Case)	ACRF Pair to Pair (dB)	PS-ACRF (dB)
1.0	1.9	65.0	62.0	64.2	61.2
4.0	3.5	64.1	61.8	52.1	49.1
8.0	5.0	59.4	57.0	46.1	43.1
10.0	5.5	57.8	55.5	44.2	41.2
16.0	7.0	54.6	52.2	40.1	37.1
20.0	7.8	53.1	50.7	38.2	35.2
25.0	8.8	51.5	49.1	36.2	33.2
31.25	9.8	50.0	47.5	34.3	31.3
62.5	14.1	45.1	42.7	28.3	25.3
100.0	18.0	41.8	39.3	24.2	21.2
200.0	26.1	36.9	34.3	18.2	15.2
250.0	29.5	35.3	32.7	16.2	13.2
300.0	32.7	34.0	31.4	14.6	11.6
400.0	38.5	29.9	27.1	12.1	9.1
500.0	43.8	26.7	23.8	10.2	7.2

- I. In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation method. The Contractor shall make additional tests as the Consultant deems necessary at no additional expense to the Owner or Consultant.
- J. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1 MHz to highest relevant frequency, using a swept frequency interval that is consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combination and in both directions when required by the appropriate standards.
- K. Cables shall be tested to the maximum frequency defined by the standards covering that performance category. Transmission Performance Testing shall be performed using a test instrument designed for testing to the specified frequencies. Test records shall verify "PASS" on each cable and display the specified parameters—comparing test values with standards-based "templates" integral to the unit.
- 3.08 Coordination
- A. Structured cabling contractor shall provide up to two (2) 8-hour site visits for coordination with Owner's wireless installer.

End of Section

Section 27 16 00 – Communications Connecting Cords

Part 1 - General

1.01 Scope

- A. This section describes the products relating to high quality Category 6 voice and data patch cords.
- B. In this section the term patch cords refers to the cords that connect Owner provided data network electronics to the horizontal cable infrastructure.
- C. It is important that the horizontal cable system and the provided patch cords work as one complete system for guaranteed channel performance. Patch cords shall be manufactured by the same manufacturer as the jack and patch panels.
- D. The Contractor shall provide and deliver all cords as listed in this section. The Owner will be responsible for installation of cords.

1.02 Related Work

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 23 – Pathways for Technology Systems
- C. Section 27 10 00 – Communications Cabling General Requirements
- D. Section 27 10 05 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 13 00 – Communications Backbone Cabling
- G. Section 27 15 00 – Communications Horizontal Cabling
- H. Section 27 18 00 – Communications Labeling and Identification

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Category 6/6A Patch Cords

- A. The Owner has the right to determine the final length of the patch cords after the contract is awarded.

- B. All Category 6/6A UTP patch cords shall be round and consist of eight insulated 23 AWG, stranded copper conductors, arranged in four color-coded twisted pairs within a flame retardant jacket and be backwards compatible with lower performing categories. Modular patch cords shall utilize ISO termination method that is designed to reduce and control near-end cross talk (NEXT) and far end cross talk (FEXT) without compromising signal impedance.
- C. Both ends of the cord shall be equipped with modular 8-position (RJ45 style) plugs wired straight through with standards compliant wiring. All modular plugs shall exceed FCC CFR 47 part 68 subpart F and IEC 603.7 specifications, and have 50 micro inches of gold plating over nickel contacts. Cable shall be label-verifiable. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level. Category 6/6A cords shall have color-coded insert molded strain relief boot with a latch guard to protect against snagging. Additional color-coding shall be available by the use of snap-in icons.
- D. Patch cords shall be wired straight through. Pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring per ANSI/TIA/EIA-568-B. Patch cords shall be unkeyed.
- E. The manufacturer of the cords shall be the same as the manufacturer for UTP termination hardware (jacks & patch panels). Cords shall be highest quality Category 6/6A cords available by connectivity manufacturer.
- F. Coordinate with Owner to verify whether small OD patch cords are acceptable on a per project basis.
 - a. Blue – Cat 6 [Standard data]
 - i. 33% 7-foot
 - ii. 33% 10-foot
 - iii. 33% 15-foot
 - b. Green – Cat 6 [VoIP Phone]
 - i. 33% 7-foot
 - ii. 33% 10-foot
 - iii. 33% 15-foot
 - c. Cat 6A [Wireless APs]
 - i. One (1) 7-foot Yellow for each WAP
 - ii. One (1) 3-foot Blue for each WAP
 - d. Red – Cat 6 [Fire Alarm or Security Equipment]
 - i. Two (2) 10-foot for each cable installed
 - e. Orange – Cat 6A [Copper Backbone Uplinks]

- i. Four (4) 7-foot for each IDF
2. For outlets, furnish to the owner at the time of final inspection (1) Category 6 modular non-booted patch cord for each terminated horizontal data cable plus 25 percent, 50 percent of the total quantity shall be blue and the other 50 percent shall be black in the following proportions:
 - a. Blue – Cat 6
 - i. 50% 10-foot
 - ii. 50% 15-foot
 - b. Black
 - i. 50% 10-foot
 - ii. 50% 15-foot

Part 3 - Execution

3.01 Ordering and Delivery

- A. Prior to ordering patch cords the Contractor shall schedule meeting with Owner to verify patch cord lengths, colors and quantities.
- B. Contractor shall coordinate delivery of patch cords with Owner. Contractor shall have list of delivered cords and shall have Owner sign delivery sheet at time of delivery.

End of Section

Section 27 18 00 – Communications Labeling and Identification

Part 1 - General

1.01 Scope

- A. This section describes the products and execution requirements relating to labeling of telecommunications cabling, termination components, and related subsystems. Covered systems include the following:
 - 1. Equipment room backboards and equipment racks
 - 2. Station cable and terminating equipment
 - 3. Telecommunications grounds and related components

1.02 Related Work

- A. Section 27 00 00 – General Technology Requirements
- B. Section 27 05 23 – Pathways for Technology Systems
- C. Section 27 10 00 – Communications Cabling General Requirements
- D. Section 27 10 05 – Grounding and Bonding for Technology Systems
- E. Section 27 11 00 – Communications Equipment Rooms
- F. Section 27 13 00 – Communications Backbone Cabling
- G. Section 27 15 00 – Communications Horizontal Cabling
- H. Section 27 16 00 – Communications Connecting Cords

Part 2 - Products

2.01 Substitutions

- A. Unless noted otherwise, products in this section are intended as a basis of design and are open to substitutions per the product substitution procedures defined in Section 27 00 00.

2.02 Labels

- A. All labels shall be permanent and be machine generated (e.g., Brady or Panduit). No handwritten or non-permanent labels shall be allowed. Labels shall be Brady “I.D. Pro” or XC-Plus or equivalent. Labeling on backboards and/or equipment racks may be pre-cut adhesive type.
- B. Characters on all labels shall be black printed on a white background.

- C. Label size shall be appropriate to the cable size(s), outlet faceplate layout, patch panel design, or other related equipment sizes and layouts.
- D. All labels to be used on cables shall be self-laminating, white/transparent vinyl, and be wrapped around the cable sheath. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.
- E. Labels used to identify innerduct carrying fiber optic cable shall be labeled with a durable yellow polyethylene tag that reads "CAUTION Fiber Optic Cable" and includes blank spaces for adding (1) fiber count and (2) destination information. An example of a compliant product is VIP Products' "Caution Write-On Coverall Tag."

Part 3 - Execution

3.01 General

- A. Clean surfaces before attaching labels.
- B. Install all labels firmly. Labels attached to terminating equipment such as backboards, faceplates, 110 blocks, and patch panels shall be installed plumb and neatly on all equipment.

3.02 Labeling of Cabling and Termination Components

A. Backboard and Equipment Racks

1. Backboards and equipment racks shall be labeled by the Contractor identifying the telecommunication room. Additionally, equipment racks shall have an alpha character after the room number unique to that particular communications closet. For example, TR1-A would be the first rack in TR1.
2. Character height shall be 1-inch (minimum).

B. Cabling

1. Horizontal cables shall have a machine generated wrap around cable label within 4" of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standards. Character height shall be .25" (minimum).
2. Voice/data/video backbone cables shall have a machine generated wrap around cable label within 12" of each end of the cable. Label shall be clearly legible and meet TIA-EIA 606 standard. Character height shall be .5" (minimum).

3.03 Fiber Optic Backbone, Riser Cables, and Termination Components

- A. All fiber optic backbone and copper (inter-building, riser, and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g., equipment room or telecommunications room I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.

- B. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.04 Standard Information Outlet (SIO) Faceplates

- A. All faceplates shall be clearly labeled indicating the destination of the cable(s) (telecommunication room number), the data patch panel(s) letter designation, the data port number(s) on the data patch panel(s), and the voice cable number(s).
- B. Telecommunications outlets are to be labeled (1) on the cover of the assembly and (2) on each cable terminated at that location.
- C. Station cables shall be labeled within two inches of the cable end.

3.05 Data Patch Panels

- A. All data patch panels shall be clearly labeled indicating the telecommunication room number, the data patch panel letter designation, and the data port number on the data patch panel (ports 1 through 48). Each telecommunication room shall start with data patch panel 'A' and continue through the alphabet.
- B. A data port schedule for each telecommunication room shall be created in spreadsheet format (Excel) with the telecommunication room number, data patch panel letter designations, data port numbers, and room numbers identified in the spreadsheet. In addition, for each data patch panel port, a field shall be provided in the spreadsheet for the Owner to manage the cabling infrastructure by recording the device and any special notes pertaining to the room utilizing the data cable terminated to the port.
- C. Refer to Telecommunication "T" Series Project Drawings for standard information outlet faceplate and data & voice patch panel labeling scheme requirements. A sample of the data and voice port schedules is to be provided to the Owner, in the cable record book and in electronic format (Excel spreadsheet), with final documents provided on the Project Drawings.

3.06 Fiber Optic Cables and Termination Components

- A. All fiber optic cables, termination enclosures and connector panels, and splice closures shall be clearly labeled.
- B. In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.
- C. Each fiber optic termination panel shall be clearly labeled indicating (1) the destination(s) of the cable(s) and (2) fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

3.07 Ground System Labeling

- A. All grounds shall be labeled as close as practical to the point of termination (for ease of access to read the label). Labels shall be nonmetallic and include the following statement: "WARNING: If this connector or cable is loose or must be removed, please call the building telecommunications manger." Refer to ANSI/TIA/EIA 606 for additional labeling requirements.

End of Section