

APPENDIX B

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SECTION 27 00 00 - COMMUNICATIONS

PART 1 GENERAL

1.01 OVERVIEW

- A. Division 27 – Communications governs the infrastructure for the low-voltage information transport systems, which include voice and data and their pathways.
- B. The Scope of Work covered by this document is to furnish and install single mode fiber to all ESD facilities as outlined in these specifications and accompanying drawings.
- C. Description of Work:
- D. Furnish and install materials for the fiber optic infrastructure systems as specified herein and as shown on the Drawings. Upon completion, the systems shall be functioning in compliance with performance requirements specified.
- E. The fiber optic cabling specified and shown on the Drawings is for complete, performance based, workable systems. Deviations from the systems shown due to a particular manufacturer's requirements shall be made only with the written approval of ESD, and at no additional cost to ESD.
- F. Owner's Representative/Technical Contact:
Debbie Erickson
Edmonds School District
E-Mail: ericksond659@edmonds.wednet.edu
Office Phone: 425-431-7264, Cell Phone: 425-918-2180
- G. System shall include the following:
 - 1. All fiber optic cabling
 - 2. Pathways for the fiber optic cabling
 - 3. Right-of-way and pole attachment permitting and lease for perpetual use by ESD
 - 4. All permits and inspections to satisfy AHJ(s)
 - 5. All traffic control and coordination with Washington Department of Transportation and local city and county law and traffic enforcement entities
 - 6. Grounding and Bonding System (GBS) as required
 - 7. Firestopping as required

1.02 SECTION INCLUDES

- A. Related Documents and Codes, and Standards
- B. Related Sections
- C. Abbreviations, Acronyms and Definitions
- D. Project Drawings
- E. Quality Assurance
- F. Warranty
- G. Substitutions
- H. Submittal Requirements
- I. Additional Requirements
- J. Delivery and Storage
- K. Permits and Inspections
- L. Additional Costs

1.03 RELATED DOCUMENTS AND CODES

- A. Comply with the referenced codes and standards and with the Contract Documents. Where conflicts occur, the more stringent shall apply.

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- B. The latest versions, including addenda, as enforced by the local authority having jurisdiction of the following codes, associations, acts and agencies:

Federal Communications Commission (FCC)

1. National Fire Protection Association (NFPA), specifically:
 - a. *NFPA 70, National Electrical Code® (NEC®)*
 - b. *NFPA 72, National Fire Alarm Code®*
 - c. *NFPA 76, Recommended Practice for the Fire Protection of Telecommunications Facilities*
 - d. *NFPA 101, Life Safety Code®*
 - e. *NFPA 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces*
 - f. *NFPA 780, Standard for the Installation of Lightning Protection Systems*
 - g. *NFPA 5000™, Building Construction and Safety Code*
 2. National Electrical Safety Code (NESC)
 3. Occupational Safety and Health Administration (OSHA)
- C. The latest versions, including addenda, of the following standards:
1. American National Standards Institute (ANSI)
 2. National Electrical Manufacturers Association (NEMA)
 3. Telecommunications Industries Association (TIA), specifically:
 - h. TIA TSB-125, Guidelines for Maintaining Optical Fiber Polarity through Reverse-Pair Positioning
 - i. TIA TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
 - j. TIA-526-7, Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
 - k. ANSI/TIA-568-0-D - Generic Telecommunications Cabling for Customer Premises
 - l. ANSI/TIA-568.1-D,-2015 Commercial Building Telecommunications Infrastructure Standard
 - m. ANSI/TIA-569-D-2015, Telecommunications Pathways and Spaces
 - n. ANSI/TIA-598-C, Optical Fiber Cable Color Coding
 - o. ANSI/TIA-604.2-A, FOCIS 2—Fiber Optic Connector Intermateability Standard
 - p. ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructures
 - q. ANSI/TIA/607-C, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
 - r. ANSI/TIA-758-A, Customer-owned Outside Plant Telecommunications Infrastructure Standard
 - s. ANSI/NECA/BICSI 568-2006, Standard for Installing Telecommunications Systems
 4. Other Reference Materials
 - a. *ANSI/NECA/BICSI-568-2006, Standard, Installing Commercial Building Telecommunications Cabling*
 - b. *BICSI Outside Plant Design Reference Manual (COOSP)*
 - c. *BICSI Electronic Safety and Security Reference Manual (ESSDRM)*

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- d. *BICSI Information Transport Systems Installation Methods Manual (ITSIM)*
- e. *BICSI Network Design Reference Manual (NDRM)*
- f. *BICSI Telecommunications Distribution Methods Manual (TDMM)*
- g. *BICSI Wireless Design Reference Manual (WDRM)*
- h. Institute of Electrical and Electronic Engineers (IEEE)
- i. National Electrical Manufacturers Association (NEMA)
- j. Underwriters Laboratories (UL®) Cable Certification and Follow up Program
- k. American Standards Association (ASA)

1.04 RELATED SECTIONS

- A. Section 27 05 13 – Communications Services
- B. Section 27 05 26 – Grounding and Bonding for Communications Systems
- C. Section 27 05 28 – Pathways for Communications Systems
- D. Section 27 05 28.29 - Hangers and Supports for Communications Systems
- E. Section 27 05 28.33 - Conduits and Backboxes for Communications Systems
- F. Section 27 05 28.39 - Surface Raceways for Communications Systems
- G. Section 27 05 43 - Underground Ducts and Raceways for Communications Systems
- H. Section 27 05 53 – Identification for Communication Systems
- I. Section 27 08 00 – Commissioning of Communications
- J. Section 27 11 00 – Communications Equipment Room Fittings
- K. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
- L. Section 27 17 00 – Testing, Identification and Administration of Fiber

1.05 ABBREVIATIONS and ACRONYMS

AFF	Above Finished Floor
AWG	American Wire Gauge
BICSI	Building Industry Consulting Services International
Gbps	Gigabits per second
Mbps	Megabits per second
MDF	Main Distribution Frame, consisting of carrier entrance rooms and head-end
OSHA	Occupational Safety and Health Act
RUS	Rural Utilities Service
SCS	Structured Cabling System
SFF	Small Form Factor
TE	Telecommunications Enclosure
TIA	Telecommunications Industry Association
TR	Telecommunications Room
UL®	Underwriters Laboratory
WAN	Wide Area Network

1.06 DEFINITIONS

Conduit - A raceway of circular cross-section.

Conveniently Accessible - being capable of being reached from floor or use of 8' step ladder without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work

Entrance Facility (EF) – Termination point of service provider cables that have entered the building and location of service demarcation point and interconnection point to the network.

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Entrance Room – A space in which the joining of campus and building telecommunications backbone facilities takes place

Equipment Room – An environmentally controlled centralized space for telecommunications equipment that usually houses a main or intermediate crossconnect, as well as video surveillance and security equipment

Lead Telecommunications Installer – the project manager for the Contractor for all telecommunications work in the construction documents (Power & Signal Drawings and specification Section 27), who shall be on-site at all times while Division 27 work is being performed. This individual shall attend all construction project meetings.

Listed Communications Cable – A cable listed by the Underwriters Laboratory (UL®) and accepted by the local authority having jurisdiction as having met appropriate designated standards or has been tested and found suitable for installation in specific spaces. Refer to NEC® Section 800 for listing types and additional requirements.

MDF – Main Distribution Frame, also known as the Main Equipment Room.

Owner – Edmonds School District

Owner's Representative – An entity assigned to represent ESD in all matters pertaining to this project. Used synonymously with "Owner".

Plenum -A space within the building designed for the movement of environmental air; i.e., a space above a suspended ceiling or below an access floor.

Plenum-rated – listed by the Underwriters Laboratory as being suitable for installation into a plenum space. Communications cabling routed through plenum-rated space shall be plenum-rated and identified as Type CMP

Point of Entrance (Building Entrance) - The point within a building at which the Outside Plant (OSP) communications wire or cable emerges from an external wall, from a concrete floor slab, or from a rigid metal conduit (Type RMC) or an intermediate metal conduit (Type IMC) connected by a grounding conductor to an electrode in accordance with the NEC®.

Raceway - Any channel designed for holding wires or cables; i.e. conduit, electrical metal tubing, busways, wireways, ventilated flexible cableway.

Subcontractor, Telecommunications – entity responsible for all telecommunications work in the construction documents (Power & Signal Drawings and specification sections 27 0000 through 27 5313)

Telecommunications – in general, telecommunications refers to infrastructure/equipment needed for the voice, data, and video communications and transport systems.

Telecommunications Room - An environmentally enclosed architectural space designed to contain telecommunications equipment, cable terminations, or crossconnect cabling. The Main Equipment Room may also be known as the MDF, and may be co-located with the building's Entrance Room and Equipment Room. Telecommunications Rooms will also house equipment for additional systems, such as security, cable television, and audio/video.

1.07 QUALITY ASSURANCE

A. Contractor Qualifications

1. Company Requirements

- a. The Contractor shall have total responsibility for the coordination and installation of the work shown and described in the drawings and Specifications.
- b. Fiber optic systems specified shall be assembled and installed under the direction of a qualified Contractor. Qualification requirements shall include submittal to ESD of the following:
 - 1) List of previous projects of this scope and nature, including names and sizes of projects, description of work, times of completion, and names of contact persons for reference.

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- 2) Installers shall certify that they are manufacturer-authorized or trained for work to be performed.
- B. When articles, materials, operations or methods related to execution of communications work are noted, specified, or described in the specifications or are indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances and related items necessary and appropriate for a complete and proper installation and operation. The Contractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified.

- The work shall be installed, in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on drawings and on shop drawings approved by ESD.
- C. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility; they do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Contractor.
 - D. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

1.08 WARRANTY

- A. Warranty Requirements: Comply with additional requirements in contract general requirements and extended warranties required in other specification sections. Refer to all other Division 27 sections for specific additional warranty requirements that exceed or are in addition to those of this section.
- B. Contractor warranty: Provide all services, materials and equipment necessary for successful operation of entire system for a period of one year after system acceptance. Scope of warranty includes all equipment, devices, cable, accessories, installation, and configuration required to maintain a complete and operable system. This shall apply to all items except those specifically excluded, or items wherein a longer period of service and warranty is specified or indicated. All warranties shall be effective for one year, minimum, from date Certificate of Final Acceptance is issued. Use of systems provided under this section for temporary services and facilities shall not constitute final acceptance of work nor beneficial use by ESD and shall not institute warranty period.
- C. The warranty shall cover repair or replacement of defective materials, equipment, workmanship, and installation that may be incurred during this period. Warranty work is to be done promptly and to ESD's satisfaction. In addition, warranty shall cover correction of damage caused in making necessary repairs and replacements under warranty.
- D. Project Warranty
 1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defect, and are to be guaranteed to be free from defect.
 2. When a defect or problem is observed within the first year after substantial completion, ESD will notify the governing subcontractor through the proper channels. The appropriate Subcontractor then has 48 hours to fix the defect or furnish and install a replacement part/system, all at no cost to the project or ESD.

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- E. Advanced System Warranty for Fiber Systems
 - 1. Beyond the initial one year project warranty, the fiber optic cabling systems shall be warranted for a minimum of 20 years by a national and reputable connectivity or cabling manufacturer.
 - a. This warranty shall cover any material defect, as well as the performance of the cabling system.
 - b. This warranty shall cover both material and labor for the full length of the warranty period.
 - 2. The Contract shall be certified by this manufacturer.
- F. Owner's rights: This section shall not be interpreted to limit Owner's rights under applicable codes and under this Contract.

1.09 SUBSTITUTIONS

- A. Substitution requests: Substitution requests will be considered only if submitted to Owner's Representative not less than 7 working days prior to project bid date. Acceptance or rejection of proposed substitution is at Owner's Representatives sole discretion. No exceptions. Requests for substitutions shall be considered not approved unless approval is issued in writing by Owner's Representative.
- B. Rejection: For equipment, cabling, wiring, materials, and all other products indicated or specified as no substitutions or no alternates, ESD does not expect nor desire requests for substitutions and alternate products other than those specified. ESD reserves right for ESD's Representative to reject proposed substitution requests and submissions of alternates without review or justification.

1.10 SUBMITTALS

- A. General Requirements
 - 1. ESD is to review all submittals related to Division 27 work. This includes, but is not limited to, relevant:
 - a. Pre-bid questions
 - b. Contractor and personnel qualifications with bid
 - c. Voluntary alternates and unit pricings with bid
 - d. Pre-construction product submittals and shop Drawings
 - e. Change order requests, requests for information (RFIs), design change directives (DCDs), and any other changes as directed by the architect/engineer.
 - 2. Allow a minimum of one week (five working days) for ESD to review.
 - 3. The following submittals are due at the Pre-Bid deadline for questions:
 - a. Requests for product substitution shall be in accordance with this document.
 - b. All products seeking approval either as "approved equivalent" or otherwise, shall be submitted as a product substitution request prior to bid. Failure to submit product substitution request in a timely manner (before pre-bid questions are due) may preclude product from being utilized on the project. Requests made with bid or post-bid will not be considered without a significant cost savings realized to ESD.
 - c. The burden of proof is on the contractor to provide documentation that equivalent product meets the specifications and project requirements. Include in substitution request:
 - 1) Product being replaced
 - 2) Reason for product substitution
 - 3) Full manufacturer specification sheet clearly indicating that all requirements in project documents have been met

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- d. Failure to meet these requirements will result in the product substitution request being returned without review.
 - e. All product substitution requests are to be reviewed and approved by ESD. Not all requests will be approved, and all decisions are final, without recourse.
 - B. The following submittals are due with the Bid:
 - 1. Proof of Contractor and personnel qualifications
 - a. Provide a typed list with the following information:
 - 1) Company name of Contractor
 - b. List of previous projects (minimum of 3) of this scope and nature, including:
 - 1) Project name and date of completion
 - 2) Project size)
 - 3) Name and contact information
 - 2. Voluntary alternatives (that realize substantial cost savings)
- C. The following submittals are due at the Pre-Construction Phase (to be delivered to ESD):
 - 1. General Requirements:
 - a. Follow submission guidelines as outlined in this section.
 - b. Ensure a cover page with Project Title, Telecommunication Subcontractor Company, and point of contact is included for all physical submittals.
 - c. Updated Personnel Qualifications
 - 2. Product Information, divided by Specification Section and in order as listed in specification. Identify the start of each specification section.
 - a. Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.
 - 1) Submitted cutsheets without specific product identified will result in the whole submittal being returned without review.
 - 2) No product substitutions will be considered post bid without a significant cost savings to the project to be realized by ESD – a minimum of \$1000, either in material or labor savings. For any product substitution requests post-bid, Contractor shall submit an RFI through the proper channels with the requested documentation from the Pre-bid requirements above. Also, include realized cost savings. The project team may issue a change order (or its equivalent) for the product change at their discretion.
 - b. Refer to individual sections for additional requirements.
 - c. Communications pathways – internal to buildings:
 - 1) Hangers and Supports – indicate proposed routing of all cabling supported by J-hooks.
 - 2) Firestopping – indicate manufacturer, product/assembly, and UL system for all firestop penetrations required for communications cabling.
- D. The following submittals are due during Construction (project closeout), in accordance with the requirements of this Section:
 - 1. 3 weeks prior to Substantial Completion:
 - a. Record Drawings

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- 1) Modify reviewed and accepted AutoCAD® shop Drawings to include revisions based upon completion of work.
- 2) Provide (1) printed set of record Drawings to scale (not less than 1/8" = 1'-0").
- 3) This set is to include system function diagrams and details not on original construction documents.
- b. Test Results, in accordance with Sections 27 08 00 and 27 17 00.
- c. With the exception of the (1) printed set of record Drawings, submit these files electronically either on disk (CD or DVD) or USB Flash Drive, with project name and number clearly indicated.
2. Within two weeks after Substantial Completion:
 - a. Warranty Certificates for the Advanced Telecommunications System Warranty for the copper and fiber systems with point of contact for any warranty claims.

1.11 ADDITIONAL REQUIREMENTS

- A. Integration: Responsibility for overall telecommunications system integration and coordination of work among subcontractors, and suppliers shall rest with Contractor named in this contract. Work covered by this division of specifications shall be coordinated with related work indicated on drawings or specified elsewhere under project specifications. All work related to telecommunications system and required for complete and operational systems as detailed in these specifications or the accompanying drawings shall be performed under direct supervision of telecommunications system installer in a manner approved by product manufacturer.
- B. General compliance requirements: Provide a complete and operable system in compliance with project drawings, specifications, referenced standards, applicable building codes, and Authority Having Jurisdiction (AHJ) requirements. Scope of this contract includes planning, design, materials, equipment, labor, configuration, programming, testing, startup and commissioning services, and documentation costs for complete and operable system that meets all requirements indicated on drawings or contained in specifications. Comply with all contract documents, specifications, drawings, manufacturer's instructions, and ESD and AHJ requirements. In case of conflict among applicable documents or standards, contractor shall notify ESD's representative in writing of apparent conflict, and then comply with most stringent requirements unless otherwise directed in writing from ESD's representative.

1.12 DELIVERY STORAGE AND HANDLING

- A. General: ESD will, at Contractor's request, provide appropriate space on site for Contractor trailer or job box; however, Contractor shall be responsible for the deliveries, storing and handling of all materials relative to the systems, including materials supplied by others that are part of the installation contract. Material shall be stored and protected according to manufacturer's instructions. Contractor shall be responsible for the security of all material during installation. For all material provided by contractor, or delivered to contractor on site, contractor assumes full responsibility and liability for any material shortages, damage or loss due to storage and handling methods.

1.13 PERMITS AND INSPECTIONS

- A. General: All telecommunications systems shall meet or exceed the latest requirements of all national, state, county, municipal, and other authorities exercising jurisdiction over the telecommunications systems and the Project.
- B. Contractor shall obtain and pay for all licenses, permits, and inspection fees required by local agencies and/or other agencies having jurisdiction (AHJ). Copies of all permits shall be delivered electronically to ESD.

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- C. Contractor agrees to furnish any additional labor or material required to comply with all local and other agencies having jurisdiction at no additional cost.
- D. Contractor shall obtain certificates of inspection and approval from all authorities having jurisdiction, and forward copies of same to ESD prior to request for Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations.
- E. All required permits and inspection certificates shall be made available at the completion of the telecommunications system installation and commissioning.
- F. Any portion of the telecommunications work which is not subject to the requirements of an electric code published by a specific AHJ shall be governed by the National Electrical Code and other applicable sections of the National Fire Code, as published by the National Fire Protection Association (NFPA).
- G. Installation procedures, methods and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Administration (OSHA).
- H. All work shall comply with the TIA Standards listed in this document.

1.14 EXAMINATION

- A. General: Prior to submitting a proposal, Contractor shall examine sites, review drawings and specifications, and determine exact extent of work required. Contractor shall include in their proposals all materials, labor, and equipment required to complete required work indicated. Work that is necessary to obtain complete and usable Project as specified herein shall be included in Contractor's proposal, even if not indicated or specified.
- B. Bidders' questions: Should bidders have questions as to intent of drawings and specifications, quality of materials to be used, and work to be performed, questions shall be submitted in writing to ESD in manner dictated by ESD. All answers and clarifications to drawings and specifications will be issued in writing.
- C. Extra payment will not be allowed for claims for due to unfamiliarity with work to be performed by other trades, existing conditions at job site, local or state laws and codes, and alterations due to field conditions.

1.15 ADDITIONAL COSTS

- A. General: Project acceptance inspections, final completion inspections, substantial completion inspections, and acceptance testing/demonstrations shall be conducted after verification of system operation and completeness by Contractor.
- B. Inspections and testing: For Project acceptance inspections, final completion inspections, substantial completion inspections, and/or testing/demonstrations that require more than one site visit by ESD to verify Project compliance for same material or equipment, ESD reserves right to obtain compensation from Contractor to defray cost of additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions. ESD will notify Contractor of hourly rates and travel expenses for additional site visits, and will issue an invoice to Contractor for additional site visits. Payment of additional site visit costs by Contractor is required within 30 days of invoicing. ESD reserves right to deduct additional costs defined herein that are indicated on past due invoices from Project amount due Contractor.
- C. Exclusions: Contractor shall not be eligible for extensions of Project schedule or additional charges resulting from additional site visits that result from Project construction or testing deficiencies/incompleteness, incorrect information, or non-compliance with Project provisions.

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PART 2 PRODUCTS

2.01 GENERAL

- A. Materials and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.
- B. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer and part number.
- C. All products and materials shall be new and unused prior to their installation as part of this project. Refurbished items are not allowed.

PART 3 EXECUTION

3.01 GENERAL

- A. Prior to the start of work, the Contractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where Division 27 work may properly commence. Start of work indicates acceptance of conditions.
- B. Coordinate location of equipment and conduit with ESD prior to execution.
 - 1. Holes through concrete and masonry structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building.
 - 2. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by ESD as required by limited working space.
 - 3. Holes shall be located so as not to affect structural sections such as ribs or beams.
 - 4. Holes shall be laid out in advance. The ESD shall be advised prior to drilling through structural sections, for determination of proper layout.
 - 5. Structural Penetrations: Where conduits, wireways and other raceways pass through fire partitions, fire walls or walls and floors, provide an effective barrier against the spread of fire, smoke and gases.
 - 6. Strict precautions must be taken to manage any dust debris from hole drilling, Inspections will be performed by district staff if necessary.
- C. Follow all manufacturers' instructions and install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.
 - 1. In the event of discrepancy, immediately notify ESD through the proper channels. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.
- D. Protection of Systems and Equipment
 - 1. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.
 - 2. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.
 - 3. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum-cleaned both inside (as appropriate) and outside before testing, operating or painting.
- E. As determined by ESD, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of ESD shall be final.

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- F. Painted surfaces shall be protected with removable heavy kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.
- G. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by manufacturer.
- H. Access to Equipment
 - 1. Equipment shall be installed as per the detail on the drawings.
 - 2. Working spaces shall be not less than specified in the National Electrical Code® for voltages specified.
 - 3. Where ESD determines that the Contractor has installed equipment not “conveniently accessible” for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by ESD, at no additional cost to ESD.
- I. Cleaning
 - 1. During construction, and prior to ESD acceptance of the building, remove from the premises and dispose of packing material and debris caused by communications work.
 - 2. Remove dust and debris from interiors and exteriors of telecommunications equipment (including electrical rough-in). Clean accessible current carrying elements prior to being energized.
- J. Completion
 - 1. General:
 - 2. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean,
 - 3. Results Expected:
 - a. Systems shall be complete and operational.
 - b. Cleaning work shall be complete.
 - 4. Testing and Verification – General Requirements
 - a. Refer to individual sections for additional testing and verification requirements.
 - b. The Contractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.
 - c. Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications.
 - d. Verification by Test and Demonstration: The Contractor shall verify by formal demonstrations or tests that the requirements of this Specification have been met. The Contractor shall demonstrate that the communications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test".
 - e. System Operation Tests Conducted Upon Completion of Work: Upon completion of the Telecommunications Subcontractor's Work, subject the system to functional and operational tests. When required corrections determined by initial test results have been completed, fully retest the system. ESD shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the Contractor has satisfactorily performed the final tests specified herein.

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- f. The acceptance testing and final inspection shall be accomplished in the presence of ESD. At least 10 days prior to scheduled system completion, the Contractor shall submit, for approval by ESD, a test plan to completely test the telecommunications system. The Contractor shall include in test plan, for acceptance by ESD, a complete and detailed final acceptance test check-off list ("punch list"). The list shall be a complete representation of specified functions and conditions.

END OF SECTION

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SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL SECTION

1.01 SUMMARY

- A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.

1.02 SECTION INCLUDES

- A. Summary
- B. General Requirements
- C. Environmental Considerations
- D. Site Specific Requirements

1.03 RELATED SECTIONS

- A. Section 27 05 13 – Communications Services
- B. Section 27 05 26 – Grounding and Bonding for Communications Systems
- C. Section 27 05 28 – Pathways for Communications Systems
- D. Section 27 05 28.29 - Hangers and Supports for Communications Systems
- E. Section 27 05 28.33 - Conduits and Backboxes for Communications Systems
- F. Section 27 05 28.39 - Surface Raceways for Communications Systems
- G. Section 27 05 43 - Underground Ducts And Raceways For Communications Systems
- H. Section 27 05 53 – Identification for Communication Systems
- I. Section 27 08 00 – Commissioning of Communications
- J. Section 27 11 00 – Communications Equipment Room Fittings
- K. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
- L. Section 27 17 00 – testing, Identification and Administration of Fiber

1.05 GENERAL REQUIREMENTS

- A. Edmonds School District is providing new single mode fiber optic cable and infrastructure to support District-wide communications. This contract will be responsible for all aspects of cabling and supporting infrastructure required for functional systems, specifically:
 - 1. Pathways as per Section 27 05 28 and as called out on Drawings.
 - 2. Outside plant conduit and vault system and related components as called out in Section 27 05 43, site narrative(s) or as noted on Drawings
 - 3. Installation of fiber backbone between the demarcation points within each of ESD's facilities as identified in these specifications and as depicted on Drawings. Testing of fiber cabling systems in accordance with ANSI/TIA-568 and as outlined in Section 27 08 00.
 - 4. Creation of as-built documentation, both electronically and printed, as specified in these documents.
- B. All work outlined in these documents and on the accompanying Drawings must be completed prior to the substantial completion date called out in this bid package, specifically:
 - 1. All construction from utility right-of-way to the point of demarcation.
 - 2. All raceway (including requisite surface mounted raceway), conduits, and junction boxes required for telecommunications pathways.
 - 3. Installation and testing of all fiber optic cabling to allow District to install active electronics and bring complete systems live.
 - 4. Test results and as-build documentation as per Section 27 05 13.

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1.06 SUMMARY

- A. The intent of the Division 27 Specifications and the accompanying Drawings is to provide a complete and workable system as shown, specified and required by applicable codes and the Authority Having Jurisdiction (AHJ). Include all work as specified in Division 27 and shown on the accompanying Drawings, including appurtenances, to provide a complete and functional system.
- B. The Division 27 Specifications and accompanying Drawings are complementary and what is called for in one shall be as binding as if called for in both. Items shown on the Drawings are not necessarily included in or called out in the Specifications and vice versa. Specifications shall supersede Drawings in the case of a conflict.
- C. Imperative language is frequently used in the Division 27 Specifications. Except as otherwise noted, such requirements are to be performed by the Contractor or a Sub-contractor directly responsible to the Prime Contractor performing the Division 27 work.
- D. The Drawings accompanying Division 27 (T series) are diagrammatic. They do not show every component of a complete telecommunications premises distribution system which may be required to accommodate unique building construction features or materials installed by other trades. The Drawings are to be followed as closely as practical while making necessary adjustments in the placement of cable to facilitate the overall construction of the building without additional cost to the Owner. The right is reserved to make any reasonable changes in Telecommunications Outlet locations prior to roughing-in.

1.07 ENVIRONMENTAL CONSIDERATION

- A. Except as noted for purposes of recycling, all construction related debris; packaging and waste materials will be removed from the job site each day and disposed of by the Contractor.

1.08 DEVICE LOCATIONS

- A. Demarcation locations as per the accompanying Drawings.

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END OF SECTION

SECTION 27 05 13 - COMMUNICATIONS SERVICES

PART 1 - GENERAL REQUIREMENT

1.01 SECTION INCLUDES

- A. Basic Communication Requirements
- B. Administrative Requirements
 - 1. Contract Documents, Quality Assurance, and Manufacturer's Warranty
 - 2. Technical Qualifications
 - 3. Certificates and Reference Standards
 - 4. Laws and Regulations, Permits
 - 5. Submittal and Substitution Information
 - 6. Environmental Requirements
 - 7. Progress Drawings and Schedules

1.02 RELATED SECTIONS

- A. Section 27 0000 - Communications
- B. Section 27 0005 – Common Work Results for Communications
- C. Section 27 0526 – Grounding and Bonding for Communications Systems
- D. Section 27 0528 – Pathways for Communications Systems
- E. Section 27 0528.29 - Hangers and Supports for Communications Systems
- F. Section 27 0528.39 - Surface Raceways for Communications Systems
- G. Section 27 0553 – Identification for Communication Systems
- H. Section 27 0800 – Commissioning of Communications
- I. Section 27 1100 – Communications Equipment Room Fittings
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 17 00 – testing, Identification and Administration of Fiber

1.03 BASIC COMMUNICATION REQUIREMENTS

- A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture.
- B. The Contractor shall field-investigate all District facilities to ascertain the exact physical conditions at the point of demarcation (typically in the main Equipment Room [MDF]) to become familiar with the physical environment of the building.
- C. The Contractor shall provide, install, and test the entire fiber optic cable infrastructure as described under this contract.
- D. The Contractor shall call attention to the Owner any error, conflict, or discrepancy in Plans and/or Specifications. Do not proceed with any questionable items of work until a resolution or clarification has been made. Supplemental Plans and Specifications may be supplied as required and shall become part of the Contract Documents.

1.04 CONTRACT DOCUMENTS

- A. The contract documents, such as drawings, schedules and specifications are used to describe the required work.
- B. The work to be performed under the contract documents includes furnishing all labor, materials, equipment and services necessary, whether listed in the specifications or not, to construct and install the complete communications infrastructure as shown on contract drawings and specifications.

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- C. The drawings and schedules depict, in general, application-dependent data while the narrative/specifications, in general, define broader requirements, such as overall quality.
- D. The Contractor shall follow all specifications herein. In case of conflict between drawings and specifications, the latter shall prevail unless authorized in writing by the Owner.
- F. Supplementary Details and Plans may be supplied as required. They shall be issued as addendum and shall become a part of the Contract Documents.

1.05 QUALITY ASSURANCE

- A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.
- B. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where “approved equal” is stated or a substitution is requested, equipment shall be equivalent in every way to that of the equipment specified. All substitutions are subject to the control and approval of the owner or the owner representative.
- C. Strictly adhere to all Telecommunications Industry Association (TIA) and BICSI recommended installation practices and manufacturer’s guidelines when installing communications components.

1.06 TECHNICAL QUALIFICATIONS

- A. A minimum of three references demonstrating Contractor’s past installation experience in similar projects. The Contractor must supply a one year warranty upon completion of the job.
- B. All Journeymen are to possess a current Washington License.
- C. All Apprentices are to be actively enrolled in a Washington State approved electrical apprenticeship program.
- D. All Equipment shall be installed and tested on-site by a technician(s) who, by virtue of an acceptable training course or documented experience, is qualified to perform these procedures. Acceptable training may include successful completion of training courses, documented on-the-job experience or successful completion of applicable technical courses in a recognized trade school.
- E. Verification of the above requirements must be submitted in writing with bid.

1.07 REFERENCE STANDARDS

- A. This section references the latest revisions of the following documents. In case of conflict between the requirements of this section and those of the listed documents, the more stringent shall prevail.

<u>Reference</u>	<u>Title</u>
ANSI/TIA-568x	<i>Building Telecommunications Wiring Standards</i>
ANSI/TIA-569	<i>Commercial Building Standard for Telecommunications Pathways and Spaces</i>
EIA RS-310-C	<i>Racks, Panels, and Associated Equipment</i>
UL 94	<i>Tests for Flammability of Plastic Materials and Parts in Devices and Appliances</i>
ANSI/ICEA S-80-576-1988	<i>Communications Wire and Cable for Wiring of Premises</i>
ANSI-TIA-607-C	<i>Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises</i>
UL1863	<i>Standard for Communication Circuit</i>

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1.08 LAWS AND REGULATIONS

- A. This section references the latest revisions of the following documents. In case of conflict between the requirements of this section and those listed documents, the requirements of the listed documents shall prevail.

<u>Reference</u>	<u>Title</u>
NFPA-70	National Electric Code® (NEC®) plus all Washington State Electrical Code plus local County and City Amendments
IBC	International Building Code
IFC	International Fire Code, 2015 Edition
UL®	Underwriters Laboratories Inc.

1.09 UNDERWRITERS LABORATORIES LISTING

- A. Unless otherwise specified, electrical equipment and material shall be listed and labeled by Underwriters Laboratories (UL®) for the purpose for which it is used. This requirement may be waived only if a UL® listing is not available for this type of product. Telecommunications cables are acceptable if UL® recognized.

1.10 PERMITS, LICENSES AND TAXES

- A. Contractor shall obtain and pay for permits, inspections, licenses and taxes applicable to this work. Copies of all permits and inspections are to be prominently displayed at each site. Copies of all inspection reports are to be presented to Owner upon closeout of project.
- B. Contractor is required to adhere to standard specification as detailed by the latest version of. District will absorb the costs for railroad and DOT permits (if so required) as a direct pass through with no contractor markup.
- C. Before any construction may occur, the contractor shall have plans which have been signed and approved by AHJ, all required permits obtained, and all required bonds posted. A pre-construction conference shall be held prior to the start of construction.
- D. All work and materials falling within the WSDOT Right-of-Way (potentially State Highway 99) shall be in accordance with the “*Standard Specifications for Road, Bridge, and Municipal Construction*”
<http://www.wsdot.wa.gov/publications/manuals/m41-10.htm>
- E. A copy of the approved plans must be on the job site whenever construction is in progress.
- F. If mailboxes need to be moved or rearranged, the contractor shall coordinate with the U.S. Postal Service for the new location of the mailbox structure.
- G. Any roadway signage or stripping removed or temporarily moved by the contractor shall be restored so as to meet the current WSDOT standards unless shown otherwise.
- H. It is the responsibility of the contractor to provide adequate temporary traffic control to ensure traffic safety during construction activities. Therefore, the contractor shall submit a traffic control plan to the public works department at least 48 hours prior to starting any work in the right-of-way.
- I. All traffic control devices shall conform to the “Manual on Uniform Traffic Control Devices” (MUTCD) or as modified by the traffic engineer so authorized by the Authority Having Jurisdiction (AHJ). All work requiring lane closures must be pre-approved. Fire, pedestrian, and vehicular access shall be maintained at all times, except when contractor has permission to close and access. Pedestrian access must be maintained in accordance with ADA requirements during any sidewalk closure.

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- J. Allowable work hours will be daylight hours only. No work days will be allowed Saturday, Sunday or holidays unless authorized by Edmonds School District, State of Washington, County or City.

1.11 OTHER CONSTRUCTION REQUIREMENTS AND RESTRICTIONS

- A. Trucks shall remain on paved surfaces and the construction at all times. All excavated material shall be disposed at an approved and permitted disposal site. Stockpiling on site will not be permitted.
- B. Any existing public or private property and improvements damaged during construction shall be replaced at no additional cost prior to final inspection.
- C. Contractor must provide steel plating to cover open trenches in order to maintain traffic and vehicle access.

1.12 SUBMITTALS

- A. **General:** Owner must approve all submittals before the start of fabrication (or shipment, for stock items) of any equipment requiring submittals.
- B. **Drawings**
 - 1. The Contractor shall submit shop drawings for any modification or new product installation not previously identified in bid documents.
 - 2. The drawing must be submitted not less than five (5) days (weekends and national holidays excluded) before the scheduled work begins.
 - 3. The Contractor shall proceed with the installation only after approval from the Owner.
- C. **Materials List:** The Contractor shall submit a list of all materials for the proposed work.
- D. **Firestopping:** The Contractor shall comply with all requirements of Authority Having Jurisdiction
- E. **Sound Deadening Materials:** The Contractor shall submit a list of acoustic separation products and procedures. The submittal shall include the manufacturer's technical data for each product including product description, specifications (including labeling or listing by an agency acceptable to the Owner), and storage requirements.
- F. **Material Safety Data Sheets:** Supply Material Safety Data Sheets (MSDS) to Owner for all material accompanied by such.
- G. **Test Plans**
 - 1. The Contractor shall submit a plan for the testing the installed network.
 - 2. The test plan shall include test equipment to be used, procedure and report structure.
- H. **Certificates**
 - 1. Construction Permits
 - 2. The Contractor shall post a copy of the all permits at the respective site and email or fax a copy to the Owner.
 - 3. The Contractor shall provide copy of approved permits to the Owner certifying that the work has been inspected and that the work conforms to the requirements of the Authority Having Jurisdiction.

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1.13 REQUESTS FOR SUBSTITUTION

- A. Substitution of items shown in the contract documents must be requested in writing.
- B. Approval shall be by written addendum or change order. Substitutions made without prior written approval will be reversed and all costs related to reversal will be the responsibility of the Contractor.
- C. Contractor shall be responsible for any design changes and costs related to substitution approval.
- D. The functions and features specified are vital to the operation of these facilities; therefore the acceptance of alternate manufacturers does not release Contractor from strict compliance with the requirements of the specification.

1.14 ENVIRONMENTAL SAFETY REQUIREMENTS

- A. Parking spaces for installer's trucks shall be provided by ESD at each site; however, spaces are very limited and must be coordinated with the designated district project manager. In no case will handicap access be compromised at any time.
- B. Job site trailer, if required, shall be coordinated with ESD prior to placement. Secured storage is the responsibility of the Contractor.
- C. Construction of dewatering (groundwater) systems shall be in accordance with the WSDOT standard specifications. During excavation, at bore pits and trenches, excavations shall be kept free of water. The contractor shall control surface run-off so as to prevent entry or collection of water in excavations. The static water level within the excavation shall be drawn down a minimum of 1 foot below the bottom of the excavation so as to maintain the undisturbed state of the foundation soils and allow acceptable placement of any bedding or backfill to the required density.
- D. The contractor shall furnish, install, and operate all necessary equipment to keep excavations free from water during construction. Dewatering systems shall be contractor designed and operated so as to prevent any removal or flowing of native soils. Disposal of the water shall not cause injury to public or private property or nuisance to the public and shall be approved by WSDOT. Discharge to the WSDOT storm drain system shall meet state ecology turbidity requirements. Sufficient pumping and power equipment in good working condition shall be available at all times.
- E. All bore pits shall be compacted to 95 percent density in roadways, roadway shoulders, roadway prism and driveways and 85 percent density in unpaved areas. Excavation, trenching and shoring for all utility work shall be in accordance with Washington State and Federal Occupational Safety and Health Administration requirements.
- F. The contractor's trench safety system shall be a protective system designed and maintained by a competent person and shall meet accepted engineering requirements or practices. This trench safety system may require the use of a support system in locations not designated in the contract as requiring a support system.
- G. The contractor shall be responsible for providing adequate safeguards, safety devices, protective equipment, confined space protections, flaggers, and any other needed actions to protect the life, health, and safety of the public and to protect property in connection with the performance of work covered by the contract. Any work within the traveled right-of-way that may interrupt normal traffic flow shall require a traffic control plan approved by the County or City public works. All sections of the WSDOT Standard Specifications, Traffic Control, and the Manual of Uniform Traffic Control Devices (MUTCD) shall apply.

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1.15 PROGRESS DRAWINGS AND SCHEDULES

- A. All drawings shall be revised as necessary during the course of the work.
- B. The Contractor shall maintain one neatly and legibly marked (redlined) set of full-size Drawings accurately depicting as-built locations, changes, and repairs made during the work.
 - 1. Marking of the Drawings shall be kept current.
 - 2. Drawings shall be delivered to the Owner prior to final progress payments.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.
- B. Quantities are to be determined by Contractor unless specified.
- C. Products shall be UL[®] listed for the purpose they are to be used.

2.02 PRE-APPROVED PRODUCT SETS

- A. The following product sets are pre-approved for this project. Except as noted, all others will require a substitution request to be completed and approved as per these documents. ESD will not consider product sets that have not been pre-approved or accepted as per the substitution request process.
 - 1. Fiber optic cable and connection/termination products shall be manufactured by one of the following:
 - a. Optical Cable Corporation
 - b. Corning
 - c. CommScope
 - d. Or approved alternate
 - 2. All ancillary components, attachment hardware, support structures shall be at the contractor's discretion; however, District will have final approval of material list submittal.

2.03 FIRESTOPPING

- A. Products may be in the form of caulk, putty, strip, sheet, or devices that shall be specifically designed to fill holes, spaces, and voids at communications penetrations.
- B. Firestopping materials shall also provide adhesion to substrates and maintain fire and smoke seal under normal expected movements of substrates, conduits and cables.
- C. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this section shall be performed by installer of fireproofing and paid for by section responsible for damage and shall not constitute grounds for an extra to Owner.

2.04 ACOUSTIC SEPARATION

- A. Acceptable products for 2" through 4" penetrations are as follows
 - 1. STI EasyPath™
 - 2. Or approved substitution
- B. Acceptable products for less than 2" penetrations are as follows
 - 1. Resilient latex caulk and re-enterable putty manufactured by 3M™, Specified Technologies or Hilti.
 - 2. Or approved substitution

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PART 3 - EXECUTION

3.01 GENERAL

- A. Manufacturer's installation instructions and requirements shall be strictly adhered to in the telecommunications equipment installation, fabrication and testing process.
- B. Where conflicts arise between the requirements of this Specification and the manufacturer's installation instructions, the Owner shall be consulted for resolution.
- C. All fiber optic cabling shall be installed according to manufacturers' installation guidelines, and according to related ANSI/TIA-568-C standards.
- D. All installed cables shall be kept free from nicking, abrading, or cutting during storage and during the installation process.
- E. Cable shall be installed into conduits after conduit installation is complete and appropriate bushings or couplers have been installed. Manufacturers' recommendations for maximum pulling tensions and minimum bend radii for all cables must not be exceeded.
- F. Care shall be exercised in wiring to avoid damage to wiring and equipment.
- G. All support equipment shall be firmly held in place. Fastenings, supports, and hangers shall be adequate to support their loads.
- H. Open areas requiring suspension for cables will employ properly rated support mechanisms and devices to accommodate future addition of cable.
- I. The installation must conform to OSHA standards and comply with state and local safety codes.
- J. Installation shall be neat, well organized, and professional.
- K. Any discrepancies, conflicts or issues must be brought to the attention of the Owner before installation or as soon as possible thereafter.
- L. The Contractor shall clean up any work area exposed to traffic at the end of each day. At the end of the project all material removed or left over, and/or not being used shall be removed from the project site unless other arrangements have been made. A final clean up shall be made before final payment is made.
- M. All wall and floor penetrations shall be fire stopped at or before substantial completion.

3.02 BURIED FIBER OPTIC CABLE

- A. All buried cables or wires, and accessory materials used in the construction of the Project must be handled with care. Each reel of buried cable or wire must be inspected for damage. All damage must be repaired to the satisfaction of the Owner and in accordance with the methods or other instructions described herein. If reel wrap is present, the reel wrap must remain intact on the reel until the cable or wire is ready to be placed.
- B. The construction equipment must be subject to the approval of the Owner and the AHJ(s) over highway and road rights-of-way.
- C. The design of the plowshare must be such that the buried fiber cable, conduit or wire passing through the plow must not bind. The plowshare must have a removable gate for the purpose of inspection, and a hinged fairlead, which must be equipped with smooth, freewheeling rollers or low friction surfaces to prevent damage to the cable, conduit or wire. The equipment shall be capable of extending the plow a minimum of 6 inches below the specified depths under all terrain conditions.

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- D. Care is to be exercised during the plowing operation, to feed the cable, conduit or wire into the ground through the plow loosely and at no tension. Equipment and construction methods must be such as to assure compliance with this requirement. The Contractor must furnish competent supervision at all times at the site of plowing operations to assure compliance with this requirement.
- E. If, during the plowing operation, the plow should strike a buried object or rock that stops the equipment which necessitates removal of the plow from the ground, the plow must be removed from the ground carefully, and if practicable without backing the plow, to avoid damage to the cable, conduit or wire. Should it be necessary to back the plow to remove it from the ground, the cable or wire must be uncovered a sufficient distance back for inspection by the Contractor's project engineer to determine whether the cable or wire has been damaged.
- F. Every instance of damaged cable, conduit or wire observed at any time whether prior to installation, occurring during construction, or discovered by test or observation subsequent to installation in plant, must be immediately called to the attention of the Contractor's project engineer. The method of repair or correction of such damage must be in accordance with the written instructions of the Contractor's project engineer. The Contractor must promptly repair such damage or make such corrections in accordance with such written instructions of the Contractor's project engineer. Minor damage to the outer jacket of the cable or wire observed prior to or occurring during construction must be repaired in accordance with RUS Splicing Standard Bulletin 1753F-401(PC-2).
- G. Major damage to cable or wire observed prior to or during construction must be corrected by enclosing the damaged section of cable or wire in (1) a buried plant housing located as specified by the Contractor's project engineer or (2) a buried splice closure if approved by the Contractor's project engineer, which are buried to the same depth as that required for the cable or wire. If the shield has been broken or the conductor insulation damaged, the cable or wire must be restored to the equivalent of new condition. This may require cutting out the damaged section of cable or wire if required by the Contractor's project engineer.
- H. Major damage to cable, conduit or wire discovered after placement either through test or observation must be repaired as approved by the Contractor's project engineer. This may require cutting out the damaged section and replacing it with a short section of new cable, conduit or wire with splices made in (1) buried plant housing or (2) buried splice closures, if approved by the Contractor's project engineer, which are buried to the same depth as that required for the cable or wire. It may also require the replacement of an entire section between housings already installed.
- I. Warning Tape shall be required for all buried cable installation process except when directional boring operation are used and shall be as follows:
 - 1. Extra Stretch terra tape
 - 2. Minimum of six inches (6") wide
 - 3. Orange in color with black lettering which reads "Caution Buried Fiber Optic Cable Below"
 - 4. Placed in the Trench a minimum of twelve inches (12") above all conduit/fiber.
- J. The Contractor's Project Engineer should periodically inspect the cable, conduit or wire as well as the installation equipment and procedures during installation to guard against damage to the cable, conduit or wire when it is being placed in the ground, and to see that proper depth is maintained.

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- K. The Contractor must promptly repair any damage to fences, lawns, shrubbery, drives and any other property damaged during construction.
- L. A rock excavating unit (BM71) must be applied where a plow train cannot maintain specified depth under the buried cable, conduit or wire unit (including ripping). To assist in determining the ability of any plowing equipment to place the cable/conduit at a specified depth, the table below must be used only to compare the capability of this equipment with standard minimum drawbar pull ratings.

Depth (inches)	Minimum Drawbar Pull (pounds)
24	55,000
30	75,000
36	95,000
48	135,000
60	175,000

- M. The equipment and construction methods used by the Contractor must be such as to cause minimum displacement of the soil. The slot made in the soil by the cable plow must be immediately closed.
- N. Damage to banks, ditches, driveways and roads caused by the equipment must be immediately repaired to the satisfaction of the AHJ(s) over highway and road rights-of-way where involved.
- O. Where cables, conduit or wires are buried near the edge of pavements, the Contractor must take particular care to avoid damaging the pavement. If such damage does occur repairs must be made immediately to meet the requirements of state or local authorities having jurisdiction over the pavement involved.
- P. The stub pole or stake portion of stake mounted housings must be installed in accordance with the manufacturer's instruction sheets in a manner not to damage the cable or wire placed in the trench.
- Q. To avoid possible damage to buried cable or wire from exposure to traffic, livestock and other hazards, trenching of laterals, trenching around culverts, construction of aerial inserts and similar operations must be completed as soon as practicable behind the plowing operation.
- R. Trenches must be promptly backfilled with earth and tamped at 6" lifts so that the earth is restored to original grade to assure no hazard to vehicular, animal or pedestrian traffic. No trenches will be left open overnight.
- S. When placing cable, conduit or wire in a trench in rock, the cable or wire must be cushioned by a fill of sand or selected soil at least 2" thick on the floor of the trench. The backfill for at least 4" above the cable or wire must be free from stones, rock or other hard or sharp materials, which might damage the cable. Alternate methods are permissible subject to approval of the AHJ.

3.03 BURIED CABLE DEPTH

- A. Unless otherwise specified by the Contractor's project engineer above the depth of buried cable or wire placed, measured from the top of the cable or wire to the surface of ground or rock must be as listed below:
1. Minimum depth in soil (Mainline) - 36 inch
 2. Minimum depth at ditch crossings 36 inch
 3. Minimum depth in rock 24 inch (152 mm) Rock to surface.
- Note: WSDOT requires contractor to place at a depth of 48" and 60" below culverts, for portions on WSDOT right-of-way. If such occurs in solid rock in, 24' is permitted with a concrete cap over the conduit.

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- B. In the case of a layer of soil over rock, either the minimum depth in rock, measured to the surface of the rock, or the minimum depth in soil, measured to the surface of the soil, may be used at the Contractor's Project Engineer's option.

- C. When rock excavating is required, width and depth requirements of the trench must be:

<u>Trench Width</u>	<u>Trench Depth</u>
10" (or greater)	24"

Either the minimum depth in rock must be achieved or some other method may be employed by the Contractor to provide adequate protection to the cable or wire as agreed to by the AHJ, e.g. concrete cap.

3.04 BURIED CABLE SPLICES

- A. Buried fiber optic cables or wires may be spliced directly but such must be accomplished in a re-enterable splice case that is accessible from above ground such as a pedestal or fiber hand hole. Splicing must be performed in a manner that leaves a minimum of 10' of coiled slack fiber for future access.

3.05 AERIAL FIBER OPTIC CABLE

- A. This contract shall be responsible for the identification of all poles required for aerial routing. Contractor shall complete all pole permit applications required for use and forward approved forms to District for payment processing.
- B. The contractor shall supply all the labor and material associated with installation of slack storage devices for aerial cable. The contractor shall use the Preformed FIBERLIGN® CLAS (Center-Lock Aerial Slack) storage system for All Dielectric Self Supporting (ADSS) cables and lashed messenger cable.
- C. Class A galvanized steel utility grade strand or Extra High Strength (EHS) galvanized steel strand shall be used
- D. All construction and installation work shall be done in a thorough and workmanlike manner in accordance with the specifications and drawings and shall be subject to acceptance by the Owner.
- E. All aerial cables, and accessory materials used in the construction of the Project shall be handled with care. Each reel of aerial cable shall be inspected for damage. Any damage shall be repaired to the satisfaction of the Owner. If reel wrap is present, the reel wrap shall remain intact on the reel until the cable is ready to be placed.
- F. The latest revision of the National Electrical Safety Code (NESC) and the National Electrical Code (NEC®) shall be followed in every case except where local regulations are more stringent, in which case local regulations shall govern.
- G. All bolts employed for the mounting of hardware items on poles shall be long enough to fully engage the nut (including locknut, where applicable) but shall not extend more than 2" beyond the nut after the nut is tightened. The ends of bolts shall not be cut.
- H. Where physical obstructions make it necessary to pull cable along the line from a stationary reel, cable stringing blocks shall be used to support the cable during all placing and tensioning operations. Ladders, cable cars and other equipment shall not be placed on or against the cable.
- I. During installation, maximum pulling tension and minimum bending radius of the aerial fiber optic cable shall not exceed the cable manufacturer's recommendations.
- J. Initial stringing tension, maximum permissible span length, and sagging shall be in accordance with the cable manufacturer's recommendations.
- K. The support messenger of fiber optic cable shall be grounded in a manner that satisfies the AHJ.

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- L. Cable guards shall be applied over the cable at points of potential abrasion such as at supports, and in locations where tree trimming is not permitted.
- M. During the placing operation, precautions shall be taken to prevent slippage of the cable sheath or jacket over the core. Splicing of the optical fibers shall be performed in accordance with RUS Splicing Standard Bulletin 1753F-401 (PC-2). Splicing of the support member shall be performed in accordance with the method specified by the manufacturer.
- N. The cable shall be installed within a reasonable time after the strand is installed and tensioned. If a delay in installing cable in excess of 24 hours is encountered, temporary dampers shall be installed on the strand.
- O. When tensioning strand the cable suspension clamps shall be loose enough to allow free movement of the strand.
- P. Suspension strand shall be placed in accordance with the manufacturer's instructions and shall be tensioned in accordance with same.
- Q. The suspension strand shall be placed on the roadside of the pole line.
- R. In tangent construction, the lip of the suspension strand clamp shall point toward the pole. At angles in the line, the suspension strand clamp lip shall point away from the load.
- S. In level construction the suspension strand clamp shall be placed in such a manner that it shall hold the strand below the through-bolt. At points where there is an up-pull on the strand, the clamp shall be so placed that it shall support the strand above the through-bolt.
- T. When a thimble-eye bolt is used both to mount the suspension strand clamp and to make the guy attachment, the size of the suspension strand clamp shall be governed by the size of the thimble- eye bolt required for the guy.
- U. Tensioning the strand shall be in accordance with air temperature as per manufacturer's instructions.
- V. The suspension strand shall be made electrically continuous throughout its entire length.
- W. Suspension strands shall be bonded to other bare cable suspension strands, and guys on the same pole and grounded by connection to ground leads. The lashing wire shall be terminated at each pole and the cable shall be supported and protected at the suspension clamp. Where the strand is to be grounded to a multi-grounded neutral on a pole which does not carry a vertical pole ground wire, a #6 AWG bare copper wire shall be left coiled and taped to permit it to be extended up the pole and connected to the multi-ground neutral by a representative of the servicing power company. This contract shall coordinate such bonding and grounding activities,
- X. Cable shall be lashed with lashing wire to the suspension strand by means of a suitable lashing machine. The pitch of the lashing wire may be from 10" – 15" but must be constant for any section of cable of the same size and gauge. For cables of ¾" or larger in diameter, the lashing wire shall be placed with a tension of 35 to 40 lbs. Cables having a diameter less than ¾" shall be lashed with a lashing wire tension of 18 to 25 lbs

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- Y. During the placing operation, precautions shall be taken to prevent slippage of the cable sheath or jacket over the core. The cable shall be snug against the suspension strand throughout the span. It shall be supported in a position directly below the strand insofar as possible, except where spiraling has been specified. Where more than one cable is placed on a strand, the cables shall be symmetrically arranged so that the cables are snug against the suspension strand and against each other. At lashing wire terminating points, the tension placed in the lashing wire by the lashing machine shall be maintained. No slack in the lashing wire shall be permitted to run into the span. Splicing of lashing wire is not allowed.
- Z. Where suspension strand attachments such as suspension strand cross-over, suspension strand pull-offs, etc., are encountered in the span, a positive separation shall be provided between the suspension strand attachment and the cable, and the cable shall be supported and protected in accordance with the manufacturer's instructions. Spiraling of the cable shall be performed within 48 hours of the tensioning operation.

3.06 SPLICING OF AERIAL FIBER

- A. All closures shall be *PLP Coyote*® closure, or equivalent, consisting of an aerial splice closure and the closure manufacturer's provided encapsulating material if required. It also includes all necessary hardware items to support the cable adjacent to the closure and to terminate the lashing wire. The fiber organizer trays shall be supplied as part of the Splice Case Closure.
- B. Cable closures shall be installed in accordance with the manufacturer's instructions. Splicing shall be performed in accordance with RUS Splicing Standard Bulletin 1753F-401 (PC-2).
- C. Splice closures shall be individually inspected during installation for proper encapsulation and/or flash tested when applicable.
- D. An optical time domain reflectometer (OTDR) shall be used for testing splices. The OTDR shall be stationed at the launch point for testing individual splices as they are made and for end-to-end signature tests for the fiber optic link. An optical power meter shall be used for end-to-end cable acceptance tests.
- E. The OTDR tests will be as per Section 27 08 00 for 100% of the cable strands including continuity test to ensure entire span is being tested. Continuity test will be completed by exposing inside end during test and then capping strand end to create a reflective event.
- F. The following specifications and expectations are to be met or exceeded:
 - 1. All Feeder fibers shall be tested loss and strand attenuation, both 1310nm and 1550nm light frequencies shall be tested.
 - 2. Launch cables will be used to give better resolution to events at the near end and far end terminations.
 - 3. Each strand shall be tested in bi-directional end to end.
- G. An electronic copy of the test results that summarizes the splice loss and fiber strand attenuation for each span, as well as an of each OTDR trace for all spans shall be provided to the Owner. In the event proprietary software is required to read the traces, a copy of the contractor software shall be provided with the test results said software.
 - 1. Average span splice loss to be .15db or better. The maximum splice loss per individual strand will be .20 db.
 - 2. Raw fiber adapters will be used to test any un-terminated Feeder Fibers.

3.07 USE OF PREMISES

- A. **General:** Use of premises shall be restricted as directed below:

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1. **Cleaning and rubbish removal:** Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. When working in a facility, put premises in neat and clean condition to provide acceptable appearance and operation of equipment, to satisfaction of District.
2. **Rubbish Removal:** Provide for the removal from the site of all spoils, debris, boxes, packaging, crates, and trash generated from the work.
3. **Storage:** Store materials maintaining an orderly, clean appearance. If stored on site in open or unprotected areas, all equipment and material shall be kept off ground by means of pallets or racks, and covered with tarpaulins.

3.08 PREPARATION

- A. Before installation of cabling and/or equipment in telecommunications spaces, the Contractor shall field-investigate each facility and ascertain if the physical conditions within the facility shall permit commencement of the Contractor's work.
- B. Any discrepancies, questions, or concerns noted at that time should be brought to the immediate attention of the Owner.

3.09 DOCUMENTATION

- A. Test Reports
 1. The Contractor shall compile test results into the forms that contain all applicable test data. Hard copy output indicating successful testing of every location is not required.
 2. A solid state USB memory device containing all test data and the appropriate application to display such in a Windows-based environment shall be provided.

3.10 AS BUILTS

- A. Contractor will provide schematic/line AutoCAD® drawings electronically. These drawings shall be the as built documentation with the following being provided by the Contractor as a separate AutoCAD® layer:
 1. Cable routing
 2. Cable ID.

END OF SECTION

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SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENT

1.01 SUMMARY

- A. This section includes the grounding and bonding requirements for the metallic components located in the Telecommunications Rooms.

1.02 SCOPE

- A. Provide all labor, materials, tools, and equipment required for the bonding and grounding of all metallic components associated with the installation of fiber optic termination equipment in the telecommunications rooms.
- B. Included in this section are the minimum composition requirements and installation methods for the following:
 - 1. Busbars
 - 2. Bonding accessories

1.03 QUALITY ASSURANCE

- A. See Section 27 05 13
- B. All grounding and bonding cables shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- C. Grounding shall meet applicable ANSI/TIA-607-C, NEC Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground bar with #6 AWG cable. All termination equipment shall be grounded according to the specifications of the manufacturer.
- D. Impedance shall not exceed 5 Ω between any two metallic points within a Telecommunications Room.

PART 2 - PRODUCTS

2.01 GROUND BUS BAR – TELECOMMUNICATIONS ROOM

- A. Telecommunications Grounding Busbar (TGB) shall be constructed of .25" thick solid copper bar.
- B. The busbar shall be 2" high and 12" long and shall have 9 attachment points (one row) for two-hole grounding lugs.
- C. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI/TIA/607-C and shall accept lugs with 5/8" and 1" hole centers.
- D. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4" standoff from the wall.
- E. The busbar shall be UL® Listed as grounding and bonding equipment.

2.02 CABLE RUNWAY BONDING STRAPS

- A. Continuous #6 AWG with two hole compression lugs, Chatsworth 40164-001 or approved alternate.
- B. #6 AWG from bench stock is acceptable with machine compression or exothermically applied lugs.

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2.03 BONDING ACCESSORIES

- A. Two Mounting Hole Ground Terminal Block
 1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
 2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
 3. The conductors shall be held in place by two stainless steel set screws.
 4. Ground terminal block shall have two .25" holes spaced on 5/8" centers to allow secure two-bolt attachment to the rack or cabinet.
 5. Ground terminal block shall be UL® Listed as a wire connector.
- B. Compression Lugs
 1. Compression lugs shall be manufactured from electroplated tinned copper.
 2. Compression lugs shall have two holes spaced on 5/8" or 1" centers, as stated below, to allow secure two bolt connections to busbars.
 3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0, as stated below.
 4. Compression lugs shall be UL® Listed as wire connectors.
- C. **Antioxidant Joint Compound:** Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.
- D. C-Type, Compression Taps
 1. Compression taps shall be manufactured from copper alloy.
 2. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
 3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0, as stated below.
 4. Compression taps shall be UL® Listed.

PART 3 - EXECUTION

3.01 GENERAL

- A. The following applies only to telecommunications spaces where a recognized grounding busbar is not already in place. In the event the telecommunications room is already properly equipped with a telecommunications busbar, this contract shall only be responsible for insuring that all components placed in the telecommunications rack are properly bonded to the grounding system.
- B. A copper bonding and grounding system shall be installed which places a properly sized (as per Table 250-122 of National Electrical Code) copper cable in the immediate vicinity of the telecommunications backboard. Contractor shall be responsible for placement of the above referenced ground busbars and terminal(s) as well as their connection to the building system grounding cable using an exothermic-welded type connector or appropriate compression applied connector to satisfy the Authority Having Jurisdiction.
- C. Bonding and grounding shall meet applicable ANSI/TIA-607-C, NEC® Articles 250 and 800 requirements and practices except where other authorities or codes may impose a more stringent requirement or practice. All racks and cable trays shall be bonded to a ground busbar with #6 AWG cable. All termination equipment shall be bonded to a known source of building system ground according to the specifications of the manufacturer.

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3.02 TELECOMMUNICATIONS BONDING AND GROUNDING SYSTEM USING STRUCTURAL METAL (The following two paragraphs are as per directives in ANSI/TIA-607-C)

- A. When structural metal is bonded to the building's grounding electrode system it may be used in place of a TBB or a GE. Before utilizing structural metal in place of a TBB or a GE, building plans (including as-builts as applicable) and specifications shall be reviewed to ensure the structural metal is electrically continuous or can be made so. Additionally, the two-point continuity test described in ANSI/TIA-607-C should be performed from floor-to-floor on the structural metal, thereby ensuring electrical continuity through the entire structure. Concrete reinforcing steel shall not be used as a TBB or a GE.
- B. **Connections to the TMGB/TGB:** The bonding conductor from the structural metal to the TMGB or TGB shall be sized according to table 1 of ANSI/TIA-607-C. Bonds to structural metal shall be made by listed exothermic welding, listed compression or listed mechanical connectors and shall be accessible. Bonds to the TMGB or TGB shall be made as specified in ANSI/TIA-607-C. Components to be connected to the TMGB or TGB shall be as specified in ANSI/TIA-607-C.

3.02 PREPARATION

- A. Preparation of surfaces: Clean contacting surfaces of ground connections to bright metal before connecting
- B. When making bolted connection to aluminum or galvanized structures, apply a corrosion-inhibitor such as Penetrox A to contact surfaces between connector, and surface of structure.

3.03 INSTALLATION

- A. **Outdoor Grounding and Bonding Connections:** All outdoor grounding and bonding (earthing) connections shall be accomplished using exothermic welding.
- B. Wall-Mount Busbars
 - 1. Attach busbars to the wall with appropriate hardware according to the manufacturer's installation instructions.
 - 2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
 - 3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
 - 4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.
- C. Rack-Mount Busbars and Ground Bars
 - 1. When a rack or cabinet supports active equipment or any type of shielded cable or cable termination device requiring a ground connection, add a rack-mount horizontal or vertical busbar or ground bar to the rack or cabinet. The rack-mount busbar or ground bar provides multiple bonding points on the rack for rack and rack-mount equipment.
 - 2. Attach rack-mount busbars and ground bars to racks or cabinets according to the manufacturer's installation instructions.
 - 3. Bond the rack-mount busbar or ground bar to the room's TMGB or TGB with appropriately sized hardware and conductor.

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- D. Ground Terminal Block
 - 1. Every rack and cabinet shall be bonded to the TMGB or TGB.
 - 2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
 - 3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.
- E. Cable Runway Bonding Straps
 - 1. Bond equipment to a vertical rack-mount busbar using bonding jumper according to the manufacturer's recommendations.
 - 2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar to help prevent corrosion at the bond.

3.03 INSTALLATION

- A. All metallic components that make up the equipment racks and ladder rack shall be bonded together in a manner that provides continuous continuity between the components. Attention must be given to the removal of paint or powder coating to present bare metal where bonding straps are fastened to the metallic component.

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS
PART 1 - GENERAL REQUIREMENT

1.01 GENERAL

- A. Drawings and general provision of the Contract, including General and other Conditions and other General Requirements sections, apply to the work specified in this section.
- B. This section and all related sections shall be performed by a qualified Contractor as outlined in the specifications.

1.02 DESCRIPTION OF WORK

- A. This Section pertains only to pathways in interior spaces. All exterior pathway and construction requirements are detailed in Section 27 05 43.
- B. This contract shall be responsible for all hangers and support mechanisms required to properly support all fiber optic cables installed as a part of this project in a manner that completely satisfies the local Authority Having Jurisdiction.
- C. This contract shall be responsible for all pathways as called out on Drawings, specifically:
 - 1. Various conduits, sleeves or supporting mechanisms required to transition the fiber optic cable from outside the facility to the point of demarcation within the building. Any necessary penetrations shall accommodate a minimum of a Trade Size 1 EMT conduit.
 - 2. Surface mounted raceway, as per Section 27 0528.39 and as shown on "T" series Drawings
- D. The Contractor shall coordinate with ESD (if applicable) prior to final placement of telecommunications pathways. Placement shall be such that pathway will be accessible for future additions requiring placement of telecommunications cable.
- E. The Contractor shall provide all labor, equipment and supplies to furnish and install the communications pathway, hangers and supports.
- F. Installation shall include the actual physical installation of the hardware and/or support structure, firestopping, testing and documentation.

1.03 RELATED SECTIONS

- A. Section 27 05 28.29 - Hangers and Supports for Communications Systems
- B. Section 27 05 28.33 - Conduits and Backboxes for Communications Systems
- C. Section 27 05 28.39 - Surface Raceways for Communications Systems
- D. Section 27 05 43 – Underground Ducts and Raceways for Communications

1.04 REFERENCES

- A. *ANSI/NFPA 70/250 - National Electric Code – Ground and Bonding*
- B. *ANSI/NFPA 70/318 – National Electric Code – Cable Trays*
- C. *ANSI/NFPA 70/645 – National Electric Code – Information Technology Equipment*
- D. *ANSI/NFPA 70/770 – National Electric Code – Optical Fiber Cables and Raceways*
- E. *ASTM A 510 - Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel*
- F. *ASTM B 633 - Specifications for Electrodepositing Coatings of Zinc on Iron and Steel, Sections SC2 and SC3*
- G. *ASTM A653 - Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process*
- H. *ASTM A123 - Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel*
- I. *ANSI/TIA/568-D.0-x Series - Commercial Building Telecommunications Cabling Standard.*

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- J. *ANSI/TIA/ 569-B Commercial Building Standard for Telecommunications Pathways and Spaces*
- K. *NEMA VE 2-2006 Cable Tray Installation Guidelines*
- L. *NEMA VE-1/CSA C22.2 No 126 1-02 Metal Cable Tray Systems*
- M. *UL® E209183*
- N. *ANSI C80.1 Rigid Steel Conduit - Zinc Coated*
- O. *ANSI C80.4 Fittings for Rigid Metal Conduit*
- P. *BICSI Electronic Safety and Security Reference Manual (ESSDRM)*
- Q. *BICSI Information Transport Systems Installation Methods Manual (ITSIM)*
- R. *BICSI Network Design Reference Manual (NDRM)*
- S. *BICSI Telecommunications Distribution Methods Manual (TDMM)*
- T. *BICSI Wireless Design Reference Manual (WDRM)*

1.05 QUALITY ASSURANCE

- A. All fiber optic cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Strictly adhere to all Building Industry Consulting Service International (BICSI) and Telecommunications Industry Association (TIA) recommended installation practices when installing fiber optic cabling.
- C. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.

1.06 SUBMITTALS

- A. The following information shall be provided:
 - 1. Manufacturer's literature and catalog cuts indicating:
 - a) Physical dimensions, including dimensions (if appropriate)
 - b) Materials of construction

PART 2 - PRODUCTS

2.01 GENERAL

- A. All materials and equipment installed under this contract shall be new, unused, free of defects, and of current manufacture. Equipment and material shall carry Underwriters Laboratory certification if required by local, state or national codes. Products are to be from the acceptable manufacturer listed below or an approved alternate. In no case will field fabrication or "shop built" cable support products be acceptable.

2.02 NON-CONTINUOUS CABLE SUPPORT SYSTEMS (J-HOOKS)

- A. Shall be constructed of galvanized steel, stainless steel, or hot dipped zinc.
- B. Fastener is to be installed using dedicated wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments. Product is to be UL® Listed for the application.

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1. Non-Continuous Cable Supports
 - a) Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL® Listed.
 - b) Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 - c) Non-continuous cable supports sized 1 - 5/16" and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.
 - d) Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 - e) Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.
 - f) Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CM™ Double J-Hook CAT100CM; CAT-CM™ U-hook series CAT200CMLN, CAT300CMLN; and CAT-CM™ retainer CATRT200CM, CATRT300CM or approved equal
 - g) Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CM™ Double J-Hook CAT100CM; CAT-CM™ U-hook series CAT200CMLN, CAT300CMLN; and CAT-CM™ retainer CATRT200CM, CATRT300CM or approved equal.
2. Adjustable non-continuous cable support sling
 - a) Constructed from steel and woven laminate; sling length can be adjusted to hold up to 425 4-pair UTP; rated for indoor use in non-corrosive environments. Rated to support optical fiber cable; UL® Listed.
 - b) Adjustable non-continuous cable support sling shall have a static load limit of 100 lbs.
 - c) Adjustable non-continuous cable support sling shall be suitable for use in air handling spaces.
 - d) If required, assemble to manufacturer recommended specialty fasteners including beam clips, flange clips, C and Z purlin clips.
 - e) Acceptable products: ERICO CADDY CableCat™ CAT425; or approved equal.
3. Multi-tiered non-continuous cable support assemblies
 - a) Multi-tiered non-continuous cable support assemblies shall be used where separate cabling compartments are required. Assemblies may be factory assembled or assembled from pre-packaged kits. Assemblies shall consist of a steel angled hanger bracket holding up to six non-continuous cable supports, rated for indoor use in non-corrosive environments; UL® Listed.
 - b) If required, the multi-tier support bracket may be assembled to manufacturer recommended specialty fasteners including beam clamps, flange clips, C and Z purlin clips.

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- c) The multi-tiered support bracket shall consist of ERICO CADDY CATHBA and CableCat™ J-Hooks with screws; or approved equal.
- 4. Non-continuous cable support assemblies from tee bar
 - a) Tee bar support bracket with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL® Listed.
 - b) Acceptable products: ERICO CADDY CAT12TS, CAT21528, CAT32528; or approved equal.
- 5. Non-continuous cable support assemblies from drop wire/ceiling
 - a) Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL® Listed.
 - b) Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.
- 6. Non-continuous cable support assemblies from beam, flange
 - a) Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; UL® Listed.
 - b) Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.
- 7. Non-continuous cable support assemblies from C & Z Purlin
 - a) Fastener to C or Z purlin with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL® Listed.
 - b) Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY Purlin hangers; or approved equal.
- 8. Non-continuous cable support assemblies from wall, concrete, or joist
 - a) Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, UL® Listed.
 - b) Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal.
- 9. Non-continuous cable support assemblies from threaded rod
 - a) Fastener to threaded rod with one non-continuous cable support, factory or jobsite assembled, rated for indoor use in non-corrosive environments, UL® Listed.
 - b) The multi-tiered support bracket shall have a static load limit of 300 lbs.
 - c) U-hooks and Double J-hook shall attach directly to threaded rod using standard nuts.
 - d) Acceptable products: ERICO CableCat™ J-hook, CAT12, CAT21, CAT32, CAT64 with CADDY CATHBA series; CAT-CM™ Double J-hook CAT100CM, CAT-CM™ Direct mount U-hook CAT200CMLN, CAT300CMLN; or AFAB series; or approved equal.

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10. Cantilever-Mounted cable supports
 - a) U-hook shall be able to be assembled to a wide variety of wall mount brackets.
 - b) Spacing of individual U-hooks as needed, max of 4' to 5' apart.
 - c) U-hooks may have the optional attachment of a cable roller for ease in pulling cables.
 - d) Acceptable products: ERICO CAT-CM™ U-hooks
CAT200CMLN, CAT300CMLN: CAT-CM roller assemblies
CATRL200CM, CATRL300CM; CATWMCM bracket; or
approved equal.

2.03 SURFACE MOUNTED RACEWAY

- A. Surface Mounted Raceway (SMR) shall be provided as per Section 27 0528.39 with all fittings including but not limited to mounting clips and straps, couplings, flat, bend limiting internal and external elbows, cover clips, bushings, device boxes and other incidental and miscellaneous hardware required for a complete SMR system.

2.04 ADJUSTABLE CABLE SUPPORT SYSTEM

- A. Cable support system shall be a factory produced assembly and sized to accommodate 100 percent expansion, i.e., rated to hold double the number of initially installed cables.
- B. Acceptable product is: CADDY® CABLECAT Adjustable Cable Support

2.05 ROD MOUNTED CABLE SUPPORT SYSTEMS

- A. Acceptable product is: CADDY® CAT-CM Cable Support System

2.06 FIRESTOPPING SYSTEMS FOR TELECOM RACEWAYS

- A. Acceptable products for 2" through 4" penetrations are as follows
 1. STI EasyPath™
 2. Resilient elastomeric caulk and re-enterable putty manufactured by 3M™, Specified Technologies or Hilti.
- B. Acceptable products for less than 2" penetrations are as follows
 1. Resilient elastomeric caulk and re-enterable putty manufactured by 3M, Specified Technologies or Hilti.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install per manufacturer's instruction per weight loading.
- B. All conduits shall be installed stacked and attached to walls unless conditions exist which prohibit this type of installation. When this condition exists, mount conduits side-by-side supported with 3/8" rod attached to building structure utilizing UniStrut® channel to form a trapeze. Double nut the top and bottom at the UniStrut®. Utilize conduit clamp to secure conduits to UniStrut®.
- C. Install in accordance with directions given in Section 27 0528.39
- D. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- E. Do not exceed load ratings specified by manufacturer.
- F. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- G. SMR shall be securely supported using mechanical fasteners at intervals not exceeding 10 feet or in accordance with manufacturer's installation instructions.
- H. Metal components shall be bonded and grounded in accordance with applicable code and ANSI/TIA-607-C.

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- I. J-hooks are to be supported by dedicated wires or rods installed by this contract. In no case will ceiling grid wires be used to support J-hooks. J-hooks will be attached to ceiling grid wires (where applicable) to satisfy seismic bracing requirements and to prevent swinging.
- J. Adjustable cable support systems are to be securely attached to building structure and loaded as per manufacturer's instruction.
- K. Fire Rated wall and floor penetrations shall be fire-stopped in accordance with the manufacturer's instructions using the product set referenced in 2.06 above.

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 05 28.29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS
PART 1 - GENERAL REQUIREMENT

1.01 SUMMARY

- A. Section includes discrete J-Hooks, slings and related accessories for supporting low voltage cable bundles above accessible.
- B. This Section pertains only to pathways in interior spaces. All exterior pathway and construction requirements are detailed in Section 27 05 43

1.02 REFERENCES

- A. The latest versions (including addenda) American National Standards Institute (ANSI) / Telecommunications Industry Association (TIA)
 - 1. ANSI/TIA-568-D.0-x Commercial Building Telecommunications Cabling Standard
 - 2. TIA -569-C Standard for Telecommunications Pathways and Spaces for Commercial Building
 - 3. ANSI/NFPA 70 National Electrical Code
- B. Underwriters Laboratories, Inc. (UL®)
 - 1. UL® 2043 Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces
 - 2. UL® 2239 Conduit, Tubing and Cable Support Hardware

1.03 SUBMITTALS

- A. Provide submittal information in accordance with Section 27 0500 - Common Work Results for Communications and supplementary requirements described in this specification.
- B. Product Data: Submit product data on all cable support devices and accessories. Indicate materials, finishes, load ratings, dimensions, listings, approvals and attachment methods.
- C. Closeout Submittals
 - 1. As-built Drawings: Provide as-built drawings of main pathways in AutoCAD® format as per Section 27 05 13.

1.04 QUALITY ASSURANCE

- A. Low voltage system cable supports and accessories shall be listed to Underwriters Laboratories, Inc. Standard 2239.
- B. Low voltage system cable supports and accessories shall have the manufacturers name and part number stamped on the part for identification.
- C.

PART 2 - PRODUCTS

2.01 WIDE BASE CABLE SUPPORTS

- A. J hooks - minimum size is 1" diameter loop. Provide larger size or multiple hooks where required. A minimum of 1" wide with flared edges where cables enter and leave support.
- B. Accessories: Provide applicable accessories to independently support "J" hooks from structure. This includes extender bracket for mounting multiple J hooks on a single support, fasteners and clamps for connecting to wall, beams, rods, dedicated support wires and "C" and "Z" Purlins as required for specific construction.
- C. Cable Retainers: Provide cable retainers at each "J" hook
- D. Finish
 - 1. Dry Locations, Above Lay-in Ceiling, Below Raised Floor - galvanized
 - 2. Wet and Damp Locations: stainless steel

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

- E. Manufacturer
 - 1. ERICO Caddy CableCat™ series
 - 2. Chatsworth RapidTrak™ series

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All low voltage systems cables shall be supported. Provide supports along entire Pathway.
- B. Space supports a maximum of 48 inches apart and at each change of direction of the cables. In areas covered by dropped ceiling, tiles shall be left open to allow inspection by Owner.
- C. Hang cable supports from $\frac{3}{8}$ " all thread rods, dedicated #8 galvanized ceiling drop wire or wall brackets connected directly to structure. Do not support from the ceiling grid or ceiling wire system.
- D. Where main pathways are indicated on the Drawings, contractor shall follow the indicated pathways as closely as possible according to field conditions. Pathways for smaller cable counts shall be designed and documented on the as-built drawings by the contractor.
- E. Install support wires, brackets or rods to route cables parallel and perpendicular to building lines.
- F. Provide multiple hooks or slings at each hanger location as required by cable count.
- G. Install low voltage cable support system above accessible ceilings only.
- H. Elevation of Cable Supports: Contractor shall coordinate the allocation of ceiling space and the mounting elevations to allow maintenance and accessibility for future modifications. Telecommunications cable supports shall be as close to the ceiling as possible while allowing ceiling tiles to be removed. Supports shall be located to avoid interference with maintenance access to other equipment.
- I. Cable installation and supports shall comply with applicable provisions of ANSI/TIA-569-C and NFPA 70.

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 05 28.33 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS
PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes boxes and conduits related to transition of outside plant fiber optic cable from the exterior of a facility to the point of demarcation within the building.

1.02 RELATED DOCUMENTS

- A. Related Sections
 - 1. Section 26 05 33 - Raceways and Boxes for Electrical Systems
 - 2. Section 27 05 28.29 - Hangers and Supports for Communications Systems
 - 3. Section 27 05 28.39 - Surface Raceways for Communications Systems
 - 4. Section 27 13 23 - Communications Optical Fiber Backbone Cabling
- B. Other References
 - 1. ANSI/TIA-569-D - Commercial Building Standard for Telecommunications Pathways and Spaces
 - 2. ANSI/TIA-607-C – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

1.03 DESCRIPTION

- A. Provide raceway systems for the installation of the telecommunications cables.
- C. This Section shall include all raceways, outlet boxes; plaster rings and all appurtenances required for the conduits and raceways.
- D. Size conduits and raceways as indicated. Where no size is indicated, conduit will be a minimum of Trade Size 1.

PART 2 - PRODUCTS

2.01 RACEWAYS

- A. Minimum conduit size for telecommunications outlets shall be Trade Size 1 EMT

2.02 PULL STRING

- A. Shall be nylon having not less than 200-pound tensile strength.

PART 3 - EXECUTION

3.01 RACEWAYS

- A. No length of run shall exceed 100 feet and shall not contain more than two 90-degree bends or the equivalent without a code size pull box. Provide pull boxes where necessary to comply with these requirements. Locate pull boxes in straight runs only, not as a replacement for an elbow.
- B. Conduits with an internal diameter of two inches or less shall have a bend radius at least 6 times the internal conduit diameter. Conduits greater than two inches shall have a bend radius at least 10 times the internal conduit diameter.
- C. Provide an insulated bushing on all conduits terminated in a cabinet and/ or pull boxes.
- D. Terminate conduits stubbed out above accessible ceiling space so that the conduit is parallel with the ceiling and provide an insulating bushing.

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

3.02 PULL BOXES

- A. Pull boxes may be used in locations where high-count fiber enters and a lesser fiber count exits.
- B. In the event a pull box is used on the exterior of a facility it shall be rated NEMA-4 and be equipped with locking screws.
- C. Pull boxes shall be sized per the following table:

PULL BOX SIZING (inches)

Conduit <u>Trade Size</u>	<u>Width</u>	<u>Length</u>	<u>Depth</u>	Width increase for <u>additional conduit</u>
1	4	16	3	2
1-1/4	6	20	3	3
1-1/2	8	27	4	4
2	8	36	4	5
2-1/2	10	42	5	6
3	12	48	5	6
3-1/2	12	54	6	6
4	15	60	8	8

3.03 PULL STRINGS

- A. Nylon type pull strings shall be included in all raceways over 10 feet long. Leave not less than 12 inches of slack at each end of the pull wire.

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 05 28.39 - SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS
PART 1 - GENERAL REQUIREMENT

1.01 SECTION INCLUDES

- A. Surface mounted raceway (SMR).

1.02 RELATED SECTIONS

- A. Section 26 05 33 - Raceways and Boxes for Electrical Systems
- B. Section 27 05 28 – Pathways for Communications Systems
- C. Section 27 05 28.29 - Hangers and Supports for Communications Systems
- D. Section 27 05 28.33 - Conduits and Backboxes for Communications Systems

1.03 SUBMITTALS

- A. Submit under provisions of Section 27 0513
- B. Samples: If other than specified product is bid, Contractor must submit a 24-inch length of proposed product. Show finished detail with boxes, faceplate, connectors, angles and transitions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms regularly engaged in manufacturer of raceway systems, boxes and fittings of the types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years. Provide fittings and boxes produced by a manufacturer listed in this section.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver raceways and distribution systems in factory labeled packages.
- B. Store and handle in strict compliance with manufacturer's written instructions and recommendations
- C. Protect from damage due to weather, excessive temperature, and construction operations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Provide surface mount raceway distribution components as manufactured by Panduit, or approved alternate.
- B. All fittings and transitions pieces are to be of the same manufacturer; however, low voltage receptacles may be from a different manufacturer so long as the product is designed to be an integral part of the completed system
- C. SMR shall be a low profile product and may be nonmetallic if product satisfies the Authority Having Jurisdiction.

2.02 SURFACE MOUNTED RACEWAYS AND FITTINGS

- A. General:
 - 1. System: Surface raceway systems shall consist of bases, covers, appropriate fittings, mounting brackets, workstation boxes / enclosures and device mounting brackets and fasteners necessary for a complete installation.
 - 2. Surface mounted raceways shall be a rectangular design with removable covers or solid construction, constructed of shatter-proof thermoplastic (or similar) raceway, utilizing elbows, couplings, and connectors of the same material.

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3. Mounting Brackets: Surface mounted raceway shall be secured to wall using properly rated anchors or mounting brackets. Brackets shall provide un-obscured inspection of fastening bolts at point of wall penetration. In no case whatsoever will surface mounted raceways be attached with drywall screws.
4. Fittings: Fittings shall include flat, internal and external elbows, tees, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Provide full capacity corner elbows and fittings to maintain a controlled 2-inch cable bend radius, meeting the specification for Fiber Optic cabling and exceeding the ANSI/TIA/569-C requirements for communications pathways.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions under which raceways, boxes, distribution systems, accessories, and fittings are to be installed and substrate that will support raceways. Notify the Owner in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Strictly comply with manufacturer's installation instructions and recommendations and approved installation practices. Care should be taken to prevent "over tightening" of fastening devices.
- B. The SMR shall be surface mounted on the wall using properly rated anchors or brackets. All fastening hardware shall be zinc plated or stainless steel. The top edge of the SMR shall be horizontally level below the suspended ceiling line or the true ceiling line, whichever is lower, shall be installed to permit visually inspection to verify the physical integrity of the raceway for its entire run, shall not block doorways or access to emergency exits, shall not inhibit the operation of windows, and shall not run across windows.
 1. Support: SMR shall be supported by properly rated anchors or mounting brackets at intervals not to exceed 5 feet or in accordance with manufacturer's installation sheets.
 2. Accessories: Provide accessories as required for a complete installation.

3.03 FINAL FINISH

- A. All surfaces are to be left completely smooth and finished. No cut edges are to be exposed. In the event a metallic product is used, all rough edges are to be dressed and covered with appropriate fittings that prevent any access whatsoever with sharp edges.

3.04 CLEANING AND PROTECTION

- A. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
- B. Protect raceways and boxes until acceptance.

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS
PART 1 — GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Specification Sections, apply to the work of this Section.

1.02 SUMMARY

- A. Provide all materials and labor for the installation of a pathway system for outside plant communications circuits. Work in this section includes excavation and trenching, conduit (raceway) construction, cutting and patching, concrete, and handhole construction, and landscaping.

1.03 RELATED SECTIONS

- A. Section 27 05 13 – Communications Services
- B. Section 27 05 26 – Grounding and Bonding for Communications Systems
- C. Section 27 05 28 – Pathways for Communications Systems
- D. Section 27 05 53 – Identification for Communication Systems
- E. Section 27 08 00 – Commissioning of Communications
- F. Section 27 13 23 – Communications Optical Fiber Backbone Cabling

1.03 REFERENCES

- A. The following standards contain provisions which, through reference in this text, constitute provisions of this Specification. Incorporate by reference the applicable portions. All standards are subject to revision, and parties to agreements based on this Specification are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. ANSI, NFPA, and TIA maintain registers of currently valid national standards published by them.
 - 1. General:
 - a. National Electrical Code (*NEC*®)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 - 2. Communications:
 - a. *ANSI/TIA - 758: Customer-owned Outside Plant Telecommunications Cabling Standard*
 - b. *ANSI/TIA - 568: Commercial Building Telecommunications Cabling Standard*
 - c. *ANSI/TIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces*
 - d. *ANSI/TIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings*
 - e. *ANSI/TIA-607-C: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*
 - f. *ISO/IEC IS 11801: Generic Cabling for Customer Premises*
 - 3. Concrete:
 - a. Reinforcement:
 - 1) *ACI 301: Structural Concrete for Buildings*
 - 2) *ACI SP-66: American Concrete Institute - Detailing Manual*
 - 3) *ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement*
 - 4) *ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel*

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- 5) *ANSI/AWS D12.1: Reinforcing Steel Welding Code*
- 6) *ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement*
- 7) *AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction*
- b. Pre-Cast:
 - 1) *ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections*
 - 2) *ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures*
 - 3) *ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures*
 - 4) *ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures*
 - 5) *ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures*
 - 6) *ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)*
- 4. Trenching and Backfill:
 - a. *ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort*

1.04 DEFINITIONS

Aggregate: Mineral materials such as sand or stone used in making concrete

Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased duct banks and direct-buried conduits.

Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased duct banks, direct-buried conduit, maintenance holes and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased duct banks, conduits, maintenance holes or handholes.

Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased duct bank, conduits, maintenance holes or handholes. Bedding is placed on top of the base and beneath the backfill.

Fill: The collective term for base, bedding, and backfill.

Handhole (HH): A structure similar to a small maintenance hole through which cable can be pulled, but not large enough for a person to fully enter to perform work.

RNC: Rigid Non-Metallic Conduit (PVC)

PSC: PVC Coated Rigid Steel Conduit.

RGC: Rigid Galvanized Steel Conduit

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

1.05 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Outside Plant pathway system as hereinafter specified and/or shown on the Contract Documents. The Pathway system shall support an ANSI/TIA and ISO/IEC compliant communications telecommunications infrastructure as specified in 27 05 00.
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA and ISO/IEC compliant pathway system.

1.06 SUBMITTAL INFORMATION

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.
 - 1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
 - 2. For those items noted as allowing “or equal,” and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other descriptive information, along with a written description detailing the reason for the substitution.
 - 3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
- B. Closeout Submittals: Provide submittal information for review as follows:
 - 1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
 - 2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
 - a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
 - b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
 - c. Keep Record Drawings current throughout the course of construction. (“Current” is defined as not more than one week behind actual construction).
 - d. Show identifiers for major infrastructure components on Record Drawings.

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

1.07 CONTRACTOR WARRANTY:

- A. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.
- B. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
- C. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 — PRODUCTS

2.01 GENERAL

- A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.02 BASE, BEDDING AND BACKFILL

- A. Use of on-site soils for base, bedding, and backfill is not acceptable.
- B. Base: Readily compactable and meet the following gradation requirements.
 - 1. For Handholes (provide gravel):

Sieve Size	Percent Passing
1" Square	100
¼" Square	25 - 80
U.S. No. 200	15 max
Sand Equivalent	30 min

- 2. For Trenches (provide sand):

Sieve Size	Percent Passing
U.S. No. 10	35 - 100
U.S. No. 20	20 - 80
U.S. No. 40	10 - 55
U.S. No. 100	0 - 10
U.S. No. 200	0 - 3

- C. Bedding: Same as Base - For Trenches, above.

- D. Backfill:

- 1. For Handholes - Same as Base - For Maintenance Holes and Handholes, above
 - 2. For Trenches

Sieve Size	Percent Passing
½" Square	100
¼" Square	65 - 100
U.S. No. 10	40 - 100
U.S. No. 50	3 - 50
U.S. No. 100	0 - 4
U.S. No. 200	- 3

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2.03 CONDUIT AND DUCT BANKS

- A. Conduit
 - 1. Rigid Non-Metallic Conduit (RNC):
 - a. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement
 - b. Fittings: NEMA TC3 and TC9, matched to conduit and material.
 - 2. Rigid Galvanized Steel Conduit (RGC):
 - a. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
 - b. Couplings: Unsplit, NPT threaded with galvanizing equal to (and compatible with) conduit. Running thread or set screw threaded fittings (except for three piece and watertight split couplings) are not acceptable.
 - c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.
 - 3. PVC Coated Rigid Steel Conduit (PSC):
 - a. NEMA RN 1 rigid steel conduit coated with rigid polyvinyl chloride (PVC).
 - b. Fittings: NEMA RN 1.
 - 4. Fittings:
 - a. Sweeps: Factory manufactured with a single arc of not less than a 15 foot radius.
 - b. End Caps (Plugs): Pre-manufactured and water-tight. Tape is not an acceptable end cap or cover.
 - 5. Pull Ropes: ¼ inch polypropylene with a minimum tensile strength of 200 pounds.
- B. Duct banks:
 - 1. Conduit Spacers/Supports: High-density plastic interlocking spacers/supports. Spacers shall be:
 - 2. Underground Devices Inc.: WUNPEECE®
 - 3. Warning Tape: 6" wide metallic warning tape, orange in color.
 - 4. Grounding/Bonding: #2 bare copper ground as required by Authority Having Jurisdiction (AHJ)

2.04 UNDERGROUND SPACES

- A. Handholes: Precast, conform to ASTM C478 and other ASTM standards and specifications as listed in REFERENCES above. Complete with concrete floors, lockable covers, pulling eyes, and 12" diameter closed sumps.
 - 1. Sizes and Types:
 - a) Utility Vault Company: 264-TA - 2'-0" W x 6'-0" L x 4'-0" H (exterior dimensions). Complete with 264P galvanized diamond plate doors equipped with locking bolt.
 - b) Utility Vault Company: 444-LA - 4'-0" W x 4'-0" L x 4'-0" H (exterior dimensions). Complete with Cover Section 44-332P, Base Section 444-BL, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) galvanized pulling iron per corner (four (4) total). Manufactured with conduit knockouts: 4" TERM-A-DUCT '90.

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

- c) Utility Vault Company: 504-LA - 4'-8" W x 4'-8" L x 4'-0" H (exterior dimensions). Complete with Cover Section 55-332P, Base Section 504-BL, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) galvanized pulling iron per corner (four (4) total). Manufactured with conduit knockouts: 4" TERM-A-DUCT '90.
 - d) Utility Vault Company: 25-TA - 2'-3" W x 5'-2.5" L x 2'-7.5" H (exterior dimensions). Complete with Cover Section 38/25-T, Base Section 25-T, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) pulling insert per end (two (2) total).
 - 2. Covers: Rectangular diamond plate covers, equipped with a self-latching stainless steel slam lock, recessed lift inserts, lock down bolts, shall be labeled with 1/8" high letters stating "COMMUNICATIONS". Shall conform to AASHTO H20 loading if located in a roadway and to AASHTO H10 loading otherwise.
 - 3. Racking and Hardware: Galvanized
- B. Grounding:
 - 1. 3/4" x 10' copper clad steel ground rods
 - 2. #4/0 pigtail for connection to interior ground conductors.

2.05 FIRESTOPPING MATERIAL:

- A. Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions. Manufactured by:
 - 1. Specified Tech. Inc. or approved alternate

2.06 LABELS:

- A. As recommended in ANSI/TIA-606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
 - 1. Hand-carried label maker:
 - a. Brady: ID Pro Plus (or approved equal).
 - 2. Labels:
 - a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)

2.08 LANDSCAPING:

- A. Topsoil: Imported from off construction site.

PART 3 — EXECUTION

3.01 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA and WISHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC® except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in PART 1 - - REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.

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- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- F. Remove surplus material and debris from the job site and dispose of legally.

3.02 EXCAVATING, TRENCHING AND FILL

- A. Excavation:
 - 1. Do not excavate when the outside temperature is less than 35° F or when there is standing water or snow on the subgrade.
 - 2. Where crossing of concrete or asphalt is required, saw cut and remove surface material prior to excavating. Remove concrete in complete sections from control joint to control joint regardless of the width of the excavation. Restore concrete and asphalt surfaces following excavation to match existing depth, strength, color, and type of material.
 - 3. If an adjacent structure may be compromised or damaged by excavation work, underpin the structure as required. If the structural integrity is in question, obtain an evaluation and recommendation from a registered structural Designer employed by the Contractor prior to proceeding with the work.
 - 4. Maintain adequate separation between the excavation and adjacent underground utilities. Locate excavations such that duct banks, maintenance holes, and handholes have a minimum separation of twelve (12) inches between the duct bank and/or MH/HH and the nearest underground utility after installation. For gas lines a minimum separation of eighteen (18) inches is required. For water a minimum separation of thirty-six (36) inches is required. Contact the Designer prior to proceeding if minimum separation distances cannot be achieved.
 - 5. Protect excavations at the end of the work shift. Cover with steel sheets and barricade prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
 - 6. Install, operate and maintain pump or dewatering equipment as necessary to prevent water from accumulating in the excavation.
 - 7. Excavation Depth/Width
 - a. For HH: Excavate to a sufficient depth to cover the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum six (6) to twelve (12) inches of base. Excavate to a sufficient width to provide a minimum of six (6) inches clearance around each side of the MH/HH.
 - b. For trenches: Excavate to a sufficient depth to provide a minimum of twenty-four (24) inches cover over the conduit or duct bank formation and to allow for the proper alignment of conduits into the MH/HH. Excavate to a sufficient width to provide a minimum of six (6) inches to each side of the duct bank formation.
 - 8. Over-excavate, fill, and compact any soft spots in the subgrade.
 - 9. Run trench excavation true and as straight as possible. Clear trenches of stones and soft spots.
 - 10. Slope trench grade to fall 3 inches per 100 feet in general and ¼" per foot where possible.

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- a. Slope trench toward lower HH or from high points toward HH at both ends.
 - b. Slope trench away from building entrances.
- B. Fill:
 - 1. Drain and/or pump groundwater and surface water from the recipient area prior to the placement of fill.
 - 2. Do not place frozen fill.
 - 3. Base:
 - a. Scarify and moisture-condition the subgrade bed to receive fill prior to placing materials.
 - b. Moisture-condition base material to within three (3) percent of optimum moisture content and place in loose, horizontal layers.
 - c. Level the subgrade bed using sand for trenches and gravel for MH/HH as necessary to form an even base.
 - 4. Bedding: Do not exceed 4" depth of bedding lifts/layers before compacting
 - 5. Backfill: Do not exceed 6" depth of backfill lifts/layers before compacting.
 - 6. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).
 - a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
 - b. Backfill: Compact material up to two (2) feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from two (2) feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.
- C. Waste Disposal: Remove excavation materials and other construction debris from the site in a timely manner and dispose of legally.

3.03 CONDUITS AND DUCT BANKS

- A. Conduits:
 - 1. Outdoor underground: Provide either
 - a. RNC Schedule 40 (Type 1).
 - b. RGC with half lapped wrap of Scotchrap No. 51 plastic tape or a coat of Kopper's Bitumastic No. 505 (minimum 20 mil thickness).
 - 2. Outdoor exposed: Provide RGC.
 - 3. Transitions: Transition to PSC at stub up locations. Transition to PSC for building entrances a minimum of 10 feet before reaching building foundation. Transitioning back to RNC after passing 5 feet inside the building foundation is acceptable.
 - 4. Sweeps:
 - a. Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.
 - b. Where the conduit sweep radius is less than 40 feet, sweeps shall be factory-manufactured bends with a minimum of 48 inch radius. Bending conduit in the field using manual or mechanical methods is not acceptable.
 - c. Do not exceed 90 degrees for an individual sweep.

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- d. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field-manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.
- e. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.
- f. Two 90-degree sweeps separated by less than 10 feet is not permissible.
- g. Construct sweeps for conduits within a common duct bank parallel, measured from the same center-point.
- h. Do not install LB's, condulets, or 90 degree electrical elbows.
- 5. Fittings:
 - a. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight (see below).
 - b. End Caps (Plugs): Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the work day and on conduits at night. Leave end caps in place upon final completion of the work.
 - c. End Bells: Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls. Do not use TERM-A-DUCT.
- 6. Sealing: Apply a watertight, conductive thread compound (for PSC) or solvent-type cement (for RNC) to make conduit connections waterproof and rustproof. Seal and grout conduit terminations in maintenance holes and handholes to ensure that voids in the joints are filled. Seal conduit terminations in buildings until used for cable.
- 7. Cleaning: After installation, and within five days prior to releasing conduit for cabling installation, clean each conduit with a wire brush and swab. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.
- 8. Test Mandrels: Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.
- 9. Conduit Entrances:
 - a. HH: Conduit entrances at opposite ends of a maintenance hole or handhole shall be at the same level and in the same position with respect to the side walls. Ensure that each conduit leaving a HH in any position enters the next HH in the same relative position.
 - b. Buildings: Terminate conduits 4-inches above the finished floor.

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10. Length: Unless otherwise shown on the Drawings, do not exceed 600 feet of duct bank between pulling points. Contact the Designer prior to proceeding if a duct bank section will exceed 600 feet.
 11. Pull Ropes: Install in each conduit immediately after the conduit has been cleaned and mandreled. Leave a minimum of 10 feet looped and tied off at each end of the conduit.
 12. Protection: Insure that after installation the conduit coatings and finishes are without damage. Repair as follows:
 - a. PVC Coated Rigid Steel Conduit: Patch nicks and scrapes in PVC coating after installing conduits.
 - b. Rigid Non-metallic Conduit: Repair damage with matching touchup coating recommended by the manufacturer.
- B. Duct banks:
1. Unless otherwise noted on the Contract Documents or required for sweep radius, construct duct banks without concrete encasement.
 2. Conduit Spacers/Supports: Place supports on eight (8) foot centers if encased in concrete and five (5) foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least six (6) inches vertically.
 3. Warning Tape: Install metallic warning tape half the distance between the top of the duct bank and finished grade.
 4. Grounding/Bonding: Install ground wire along length of duct bank. Bond to grounding electrodes of MH/HH and to building service grounds.
 5. Slope duct bank grade to fall 4 inches per 100 feet in general and ¼" per foot where possible.
 - a. Slope duct bank toward lower MH/HH or from high points toward MH/HH at both ends.
 - b. Slope duct bank away from building entrances.

3.05 UNDERGROUND SPACES

- A. Provide handholes in the sizes and locations shown on the Drawings.
- B. Precast maintenance holes and handholes shall be free from damaged joint surfaces, cracks, or other damage that would permit infiltration. Repair of defects is not acceptable. MH/HH and incidental and miscellaneous equipment (such as cable racking brackets and supports) shall be supplied by a single manufacturer.
- C. Install HH according to manufacturer's instructions.
- D. Setting and Placement: Remove water from excavation and properly install bedding material prior to setting the HH. Clean HH section seal surfaces so that they are free from dirt or other material.
 1. Set HH in place by lowering into the excavation, ensuring that the section is level, plumb, and firmly positioned, and ensuring that the section gasket/seal is properly installed and watertight prior to setting the next section.
 2. Carefully set the HH to ensure that the rim or lid elevation is set one inch above finished grade. For vaults located in paved areas, taper pavement up to the HH rim.
- E. Knockouts: Open conduit entry knockouts with care preserving the TERM-A-DUCT sidewalls. Glue conduits entering the vault to the opened TERM-A-DUCTs with PVC cement. Preserve intact the conduit entry knockouts that are not intended for current use.

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- F. Grouting: Apply grout in a manner to insure filling of voids in the joints being sealed. Apply grouting to conduit entrances, risers, and covers in addition to any other voids.
- G. Cleaning: Clean and dry the HH after construction activity is complete and prior to releasing the HH to the Owner for the Owner's use.

3.06 LANDSCAPING

- A. Topsoil: Provide imported topsoil for excavations in grass and/or landscaped areas. Provide loosely compacted topsoil to a depth of 4" or depth of excavation for excavations less than 12". Restore existing grades where disturbed. Rake and smooth topsoil following proper placement. Installation shall be approved by the Owner prior to placing sod. Place topsoil per APWA Paragraph 8-01.3(2).
- B. Provide sod for grass areas disturbed by construction activity and replace shrubbery and trees damaged, removed or disturbed by construction activity. The use of seed/hydro-seed shall be approved by the Owner and the Designer prior to installation.

END OF SECTION

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FIBER OPTIC CABLE INFRASTRUCTURE UPGRADE
EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 05 53 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS
PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete labeling of the telecommunications infrastructure.

1.02 SCOPE

- A. This section includes all telecommunications cables and the associated infrastructure in the telecommunications rooms and telecommunications cabinets.

1.03 SUMMARY

- A. Administration of the telecommunications infrastructure includes documentation of cables, termination hardware, patching and cross-connection facilities, conduits, other cable pathways, Telecommunications Rooms, and other telecommunications spaces. All facilities shall apply and maintain a system for documenting and administering the telecommunications infrastructure.
- B. The Owner desires to implement and maintain a District wide labeling scheme for the planned fiber optic network
- C. Industry Labeling Standards and Conventions shall be used unless otherwise stated in the bid documents or by the Owner's Representative.
- D. Installer shall maintain accurate, up-to-date construction drawings. At a minimum, the construction drawings shall show pathway locations and routing, configuration of telecommunications spaces including backboard and equipment rack configurations, and details including identifier assignments.
- E. Installer shall provide a complete and accurate set of as-built drawings. The as-built drawings shall record the identifiers for major infrastructure components including; the pathways, spaces, and wiring portions of the infrastructure which may each may have separate drawings if warranted by the complexity of the installation, or the scale of the drawings.

1.04 QUALITY ASSURANCE

- A. All labels shall be installed in a neat and workmanlike manner. All methods of labeling that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner.
- B. Labels shall be of the quality and manufacture indicated. The labels and labeling equipment specified are based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- C. Strictly adhere to all Telecommunications Industry Association (TIA) and BICSI recommended installation practices when installing communications/data labeling.
- D. Material and work specified herein shall comply with the applicable requirements of the current adopted revision of the following:
 - 1. ANSI/TIA-606 Administration Standards.
 - 2. ANSI/TIA-569 Pathway and Spaces
 - 3. ANSI/TIA-568 Telecommunications Cabling Standard
 - 4. BICSI Telecommunications Distribution Methods Manual
 - 5. UL 969 - UL Standard for Safety for Marking and Labeling Systems

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

1.05 SUBMITTALS

- A. **Provide product data for the following:** Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

1.06 COORDINATION

- B. Coordinate installation of labels with other trades.
- C. Storage and Handling: Avoid breakage, denting and scoring finishes. Damaged products will not be installed. Store materials in original cartons and in a clean dry space; protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. Panduit
- B. Brady Corporation
- C. Equivalent
- F. Brother/P-Touch

2.02 LABEL TAGS – CABLE AND FACEPLATES

- A. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
- B. Shall be preprinted or computer printed type. Hand written labels are not acceptable.
- C. Where insert type labels are used provide clear plastic cover over label.
- D. Outside plant labels shall be totally waterproof even when submerged.
- E. Equipment Room fiber backbone cable labels:
1. Panduit Part#LS7-75NL-1 or Brady#WML-1231-292
 2. P-Touch label tape of the same spec.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General
1. The size, color, and contrast of all labels should be selected to ensure that the identifiers are easily read. Labels should be visible during the installation of and normal maintenance of the infrastructure.
 2. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.
 3. All labels shall be printed or generated by a mechanical device.
 4. All fiber optic cables shall be labeled at each end. The nomenclature for labeling is:
 - a. Origination End – Cable ID with Circuit ID
 - b. Destination End - Cable ID and with Circuit ID, "From <Facility>"to <Facility-2>", where "Facility" is the originating location.
- B. Fiber Patch Panels
1. Patch panels shall be labeled identical to the cables
 - i. Circuit ID is to be labeled on the fiber panel strands placard as well as the front cover of the panel door.

END OF SECTION

EDMONDS SCHOOL DISTRICT – RFP26-03GF
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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 08 00 - COMMISSIONING OF COMMUNICATIONS
PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- E. Provide complete end-to-end testing of all installed copper and fiber optic cabling.

1.02 TESTING, IDENTIFICATION AND ADMINISTRATION

- A. All cables and termination points will be tested and labeled per specifications.
- B. Testing is required for this project for all fiber optic testing as detailed below.
- C. All test results shall be forwarded to the Owner for certification. Any results observed to be outside stated performance parameters shall be used by the Contractor for immediate correction.

1.03 POST INSTALLATION SERVICES

- A. The Contractor shall provide on-site service as part of the warranty in the event of the failure of any installed components.
- B. The contractor will provide support and warranty for installed cabling.
 - 1. The Contractor will be the first contact point and will interface between the manufacturer and Owner for warranty issues.
 - 2. The Contractor will provide the owner with contact information of the manufacturer for warranty coverage prior to cable acceptance.

1.04 QUALITY ASSURANCE

- A. See Section 27 05 13

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

- A. The Contractor shall provide all tools and instruments used to test the installed telecommunications signal cabling.
- B. Test instruments used by the Contractor shall be suitable for the purpose at hand and shall be of industry-recognized manufacturer. Recommended is Fluke OptiFiber® Pro OTDR.
- C. Tools leased by the Contractor are acceptable, provided the operator of the test instrument(s) has a sufficient degree of operational awareness to use the rented instrument(s) correctly and obtain test data that is both accurate and relevant.

2.02 WARRANTY

- A. All fiber optic cable and connectors installed as part of a manufacturer's certified system shall carry warranty for a minimum of 20 years.
- B. The manufacturer shall provide certification attesting to on-site service as part of the warranty in the event of the failure of any installed balanced twisted pair cables, fiber-optic cables, telecommunications room terminations, telecommunications outlet terminations, or cross-connect cables.
- C. Such service shall be free of charge to the Owner and shall commence from the date of project acceptance and terminate not earlier than the twentieth anniversary of that date as a minimum.

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
PART 3 - EXECUTION

3.01 GENERAL TESTING REQUIREMENTS

- A. Fiber shall meet or exceed the wavelength specific optical characteristics
1. Attenuation, Loose Tube Cable

1310 nm	0.34 dB/km
1385 nm	0.31 dB/km
1550 nm	0.22 dB/km
 2. Attenuation, Tight Buffer Cable

1310 nm	0.50 dB/km
1385 nm	0.50 dB/km
1550 nm	0.50 dB/km
 3. Mode Field Diameter

1310 nm	9.2 + 0.3 μ m
1385 nm	9.6 + 0.6 μ m
1550 nm	10.4 + 0.6 μ m
 4. Group Refractive Index

1310 nm	1.467
1385 nm	1.468
1550 nm	1.468
 5. Dispersion

1310 nm	3.5 ps/(nm-km) from 1285 to 1330 nm
1550 nm	18 ps/(nm-km)
- B. Additional Requirements
1. Attenuation @ 1385 nm 0.32 dB/km
 2. Point Defects 0.10 dB
 3. Cutoff Wavelength < 1260
 4. Zero Dispersion Wavelength 1302 - 1322 nm
 5. Zero Dispersion Slope 0.090 ps/(km-nm-nm)
 6. Polarization Mode Dispersion Link Design Value < 0.06 ps/sqrt(km)
- C. Contractor shall provide results from OTDR testing of fiber optic cable to attest to:
1. Length of each fiber segment
 2. Proper polarity
 3. End-to-end performance of the installed fiber.
- D. Contractor shall provide the Owner as part of the as-built documentation the factory test results indicating the actual length and the measured end-to-end loss.

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 11 00 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS
PART 1 - GENERAL REQUIREMENT

1.01 WORK INCLUDED

- A. This Section covers fittings and equipment within already existing telecommunications spaces.
- B. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

1.02 SCOPE OF WORK

- A. This section includes the minimum requirements for the equipment and cable installations in telecommunications equipment rooms.
- B. Included in this section are the minimum composition requirements and installation methods for the following:
 - 1. Communication Racks and Rack Cable Management

1.03 RELATED SECTIONS

- A. Section 27 00 00 – Communications
- B. Section 27 00 05 – Common Work Results for Communications
- C. Section 27 05 13 – Communications Services
- D. Section 27 05 26 – Grounding and Bonding for Communications Systems
- E. Section 27 05 28 – Pathways for Communications Systems
- F. Section 27 05 28.29 - Hangers and Supports for Communications Systems
- G. Section 27 05 28.33 - Conduits and Backboxes for Communications Systems
- H. Section 27 05 28.39 - Surface Raceways for Communications Systems
- I. Section 27 05 53 – Identification for Communication Systems
- J. Section 27 08 00 – Commissioning of Communications
- K. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
- L. Section 27 17 00 – Testing, Identification and Administration of Fiber

1.04 CONSTRUCTION REQUIREMENTS

- A. This contract is responsible for the build out of the telecommunications spaces to include ladder racking and all required support structure to allow transition of the fiber optic cable from the pathway into the telecommunications equipment racks.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The use of a manufacturer's name and model or catalog number herein is for the purpose of establishing the product set, which the Contractor is to supply and install.
- B. Quantities are to be determined by Contractor unless specified.

2.02 PRE-APPROVED PRODUCT SETS

- A. The following product sets only are approved for this project.
 - 1. Racks, cabinets, enclosures, frames and associated fastening devices
 - a. Chatsworth Products Incorporated (CPI)
 - b. Eaton
 - 2. Miscellaneous fasteners may be pulled from Contractors bench stock.

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS

PART 3 - EXECUTION

3.01 GENERAL

- A. Manufacturer's installation instructions and requirements shall be strictly adhered to in the telecommunications equipment installation, fabrication and testing process.
- B. Where conflicts arise between the requirements of this Specification and the manufacturer's installation instructions, the Owner's Representative shall be consulted for resolution.
- C. Equipment shall be firmly held in place. Fastenings, supports, and hangers shall be adequate to support their loads. Fasteners are to be a minimum of Grade 5 and constructed of stainless steel or zinc plated steel. In no case will drywall screws be accepted as permanent fasteners.
- D. The installation must conform to OSHA standards and comply with state and local safety codes.
- E. Installation shall be neat, well organized, and professional.
- F. The Contractor shall clean up the work area at the end of each day. At the end of the project all material removed or left over, and/or not being used shall be removed from the project site unless other arrangements have been made. A final clean up shall be made before final payment is made.
- G. All wall and penetrations shall be fire stopped at or before substantial completion.

3.02 PREPARATION

- A. Before commencing work, the Contractor shall field-investigate each facility and ascertain if the physical and electrical conditions within the facility shall permit commencement of the Contractor's work.
- B. Any discrepancies, questions, or concerns noted at that time should be brought to the immediate attention of ESD.

3.03 COMPONENT INSTALLATION

- A. All equipment is to be bonded as per Section 27 05 26

END OF SECTION

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EXHIBIT B – CONSTRUCTION SPECIFICATIONS
SECTION 27 13 23 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING
PART 1 GENERAL REQUIREMENT

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.02 SCOPE

- A. This section includes all single mode fiber optic cable and termination requirements.

1.03 QUALITY ASSURANCE

- A. See Section 27 05 13
- B. All cable shall be installed in a neat and workmanlike manner.

PART 2 PRODUCTS

2.01 FIBER OPTIC CABLE

- A. Fiber shall be an enhanced zero water peak full spectrum single mode fiber optic cable with usable wavelength range from 1260nm to 1625nm. Jacket rating shall be suitable for applications where placed.
- B. Acceptable fiber is that manufactured by:
 - 1. Optical Cable Corporation
 - 2. CommScope
 - 3. Corning
- C. Others will require substitution request.

2.02 FIBER OPTIC TERMINATION

- A. All fiber connectors shall be only duplex LC. APC connectors are not permitted. Bulkheads shall be dark blue in color, having 6 or 12 duplex connectors per mounting panel (bulk head adapter).
- B. Insertion loss of mated pair at 1310 nm to be less than 0.5 dB at acceptance for every duplex connector.
- C. Fitted with strain relief boots to ensure durable and robust connections
- D. Durability better than 500 matings, with a maximum increase in insertion loss of not more than 0.2 dB.
- E. Fitted with a tight polymer cap over the connector to prevent ingress of dirt and dust, until the connector is fitted to a coupler.
- F. Acceptable fiber connector, patch panel components, and splice tray enclosures are those manufactured by:
 - 1. Optical Cable Corporation
 - 2. CommScope
 - 3. Corning

2.03 FIBER OPTIC PATCH PANEL ENCLOSURES

- A. Rack mounted fiber optic enclosures shall be designed to manage and organize fiber optic cable to and from the equipment or cabling plant. Enclosures shall protect fiber optic connections for patching or splicing requirements. Enclosures shall accommodate up to 72 fibers (with duplex connectors) per rack space and shall be constructed of steel material. Enclosures shall have removable front and rear covers and top and bottom pass through holes.

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2.04 FIBER OPTIC PATCH CORDS

- A. Duplex fiber optic patch cords shall be provided as a part of this project. Quantities shall be sufficient to energize all edge devices. Patch cords shall be provided with connectors matching your installation, i.e., Duplex LC.
- B. Duplex single mode LC to LC fiber optic patch cords shall be supplied as follows:

Length	Quantity
1 meter	2 per edge device
2 meter	2 per edge device
3 meter	2 per school

PART 3 EXECUTION

3.01 GENERAL

- A. Cable ties must be finger tight. The cable tie must not distort the outer jacket.
- B. The bend radius shall be no less than 10 times the outside cable jacket.
- C. Only Velcro®-type tie wraps shall be used to bundle cables on the back of the equipment racks and in the cable trays located in the Telecommunication and Equipment Rooms.

3.02 PREPARATION

- A. Conduits - all conduits shall be inspected for bushings prior to cable installation.

3.03 INSTALLATION – FIBER

- A. Install per manufacturer's instructions.
- B. Fiber slack shall be neatly coiled within the fiber splice tray or enclosure.
- C. Where the fiber comes into the fiber LIU from the ladder tray, no drip loop shall be used. It shall come directly from the ladder tray and into the LIU entry grommet.
- D. A service coil of no less than 10' shall be coiled and secured to the plywood backboard in the MDF just after the Point of Entry (POE).
- E. Service coils in the ladder tray are not permitted.
- F. A label tag shall be affixed at the POE service loop and at the fiber entry point to the LIU.
- G. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
- H. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
- I. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
- J. Label fiber patch panels as per Section 27 05 53

END OF SECTION

SECTION 27 17 00 - TESTING, IDENTIFICATION AND ADMINISTRATION OF FIBER CABLING

PART 1 - GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, materials, tools, and field-test instruments required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. Contractor shall survey the work areas and coordinate cabling testing with ESD
- C. Contractor shall notify ESD of any additional tests that are deemed necessary to guarantee a fully functional system. Contractor shall carry out and record any additional measurement results at no additional charge.

1.02 SCOPE

- A. This Section includes the minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
- B. This Section includes minimum requirements for:
 - 1. Fiber optic test instruments
 - 2. Fiber optic testing
 - 3. Identification
 - a. Labels and labeling
 - 4. Administration
 - b. Test results documentation
 - c. As-built drawings
- C. Testing shall be carried out in accordance with this document. This includes measuring the attenuation of the installed cable plant, verifying the length and polarity, and verifying the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR).
- D. All fiber end-faces, including test jumpers and ports under test should be clean and free of damage in accordance with IEC-61300-3-35 using a fiber microscope with digital analysis.
- E. Testing shall be performed on each cabling link (connector to connector).
- F. Testing shall be performed on each cabling channel (equipment to equipment).
 - 1. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- G. All tests shall be documented, including fiber end-face inspection in accordance with IEC-61300-3-35, length and attenuation measurements and OTDR traces and/or event tables for single mode links and channels.

1.03 QUALITY ASSURANCE

- A. All testing procedures and test instruments shall comply with applicable requirements of:
 - 1. *ANSI Z136.2, ANS For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources*
 - 2. *ANSI/EIA/TIA-455-50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements*
 - 3. *ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.*
 - 4. *ANSI/TIA/EIA-455-60A, Measurement of Fiber or Cable Length Using an OTDR.*
 - 5. *ANSI/TIA/EIA-455-61A, Measurement of Fiber or Cable Attenuation Using an OTDR.*
 - 6. *ANSI/TIA/EIA-526-7-A, Optical Power Loss Measurements of Installed Single-mode Fiber Cable Plant.*

7. *ANSI/TIA-568-0-D, Generic Telecommunications Cabling for Customer Premises.*
 8. *ANSI/TIA-568-3-C, Optical Fiber Cabling Components Standard.*
 9. *ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, (including the requirements specified by the customer, unless the customer specifies their own labeling requirements.)*
- B. Trained technicians who have successfully attended an appropriate training program, which includes testing with an optical loss test sets (OLTS), an OTDR and a fiber microscope with objective analysis 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:
1. Manufacturer of the fiber optic cable and/or the fiber optic connectors.
 2. Manufacturer of the test equipment used for the field certification.
 3. Training organizations (e.g., BICSI, ACP [Association of Cabling Professionals™])
- C. ESD shall be invited to witness and may opt to review field-testing.
1. ESD shall be notified of the start date of the testing phase five (5) business days before testing commences. ESD representative will select a random sample of 5% of the installed links and such links shall be tested. The results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the Contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to ESD.

1.04 SUBMITTALS

- A. Manufacturers cut sheets for fiber optic field-test instruments including, OLTS; power meter and source and optical time domain reflectometer (OTDR).
- B. A schedule (list) of all optical fibers to be tested.
- C. Sample test reports.

1.05 ACCEPTANCE OF TEST RESULTS

- A. Unless otherwise specified, each link and channel shall be in compliance with the following test limits:
 1. Optical loss testing
 - a. Single mode links and channels attenuation limit shall be calculated by the following formulas as specified in ANSI/TIA-568.3.
 - 1) Link or Channel Attenuation Allowance (dB) = Cabled Fiber Attenuation Allowance (dB) + Connections Attenuation Allowance (dB) + Fiber Splices Attenuation Allowance (dB)

Where:

 - 1) Cabled Fiber Attenuation Allowance (dB) = Maximum Cabled Fiber Attenuation Coefficient (dB/km) x Length (km)
 - 2) Connections Attenuation Allowance (dB) = Number of Connections x Connection Loss Allowance (dB/connection)

Note: The number of connections includes the connections on the ends of the link.

Fiber Splices Attenuation Allowance (dB) = Number of Splices x Fiber Splice Loss Allowance (dB/splice) Connection Loss Allowance = 0.75 dB

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

Fiber Splice Loss Allowance = 0.3 dB

2. OTDR testing

- a. Reflective events (connections) shall not exceed 0.75 dB
- b. Non-reflective events (splices) shall not exceed 0.3 dB
- c. Slope shall not exceed the attenuation coefficient (dB/km) as listed in the table below

Type of Optical Fiber	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

3. Objective analysis of fiber connector end-faces

- a. The analysis shall be performed using a repeatable and consistent algorithmic process that provides a “pass” or “fail” result based on the acceptance requirements outlined in IEC 61300-3-35, section 5.4 and shown in the tables below.

1) For single-mode fiber (UPC – return loss >45dB)

Zone Name	Scratches	Defects
A: Core (0-25µm)	None	None
B: Cladding (25-120 µm)	No limit ≤3 µm None >3 µm	No limit < 2 µm 5 from 2–5 µm None > 5µm
C: Adhesive (120-130 µm)	No limit	No limit
D: Contact (130-250 µm)	No limit	None ≥ 10 µm

- B. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link or channel that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected link or channel meets performance requirements. The final and passing result of the tests for all links and channels shall be provided in the test results documentation in accordance with Part 3.
- C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

PART 2 - PRODUCTS

2.01 OPTICAL FIBER CABLE TESTERS

- A. The field-test instrument shall be within the calibration period recommended by the manufacturer.
 1. Single-mode optical fiber light source
 - a. Provide dual laser light sources with central wavelengths of 1310 nm (±20 nm) and 1550 nm (±20 nm).
 - b. Output power of –9 dBm minimum.
 - c. Acceptable manufacturers
 - 1) Fluke
 - 2) VIAVI Solutions
 2. Optical Power Meter
 - a. Provide 850 nm, 1300/1310 nm, and 1550 nm wavelength test capability.
 - b. Sensitivity of -34 dBm minimum

- c. Power measurement uncertainty of ± 0.2 dB
 - d. Store reference power measurement.
 - e. Save at least 2000 results in internal memory.
 - f. USB interface for transfer of test results
 - g. Acceptable manufacturers
 - 1) Fluke
 - 2) VIAVI Solutions
- 3. Length measurement
 - a. It is preferable to use an OLTS that is capable of measuring the optical length of the fiber using time-of-flight techniques.
- B. Optical Time Domain Reflectometer (OTDR)
 - 1. Shall have a 5-inch TFT color touch screen
 - 2. Shall have rechargeable Li-Polymer battery for 8 hours of normal operation.
 - 3. Weight with battery and module of not more than 4.0 lb (1.81kg) and no larger than 6.9x5.4x3.2 in (175 x 138 x 80mm)
 - 4. Internal non-volatile memory and USB interface with at least 128 MB capacity for results storage.
 - 5. Remote controllable via RJ45 Ethernet interface
 - 6. Network and at least two USB ports to transfer data to a PC, perform upgrades, etc.
 - 7. Integration of fiber microscope with objective analysis.
 - 8. Single-mode OTDR
 - a. Wavelengths of 1310 nm (± 20 nm) and 1550 nm (± 20 nm).
 - b. Event dead zones of 0.9 m maximum at 1310 nm and 1550 nm.
 - c. Attenuation dead zones of 4 m maximum at 1310 nm and 1550 nm.
 - d. Distance range not less than 60km.
 - e. Dynamic range of 37dB on 1310 nm and 35dB on 1550 nm wavelength
 - 9. Acceptable manufacturers
 - a. Fluke
 - b. VIAVI Solutions
- C. Fiber Microscope with objective analysis
 - 1. Dual (Low and high) magnification inspection and analysis.
 - 2. Must provide automated pass/fail analysis of the end-face quality in accordance with IEC 61300-3-35 as indicated in TIA-526-14-C and TIA-526-7-A
 - 3. Must provide ability to analyze both sides of the fiber connection (patch cord and bulkhead)
 - 4. Must provide ability to save analysis results and generate report documentation
 - 5. USB 2.0 interface to PC or test device
 - 6. Vertical field of view (V FoV) 250 μ m at low magnification and 120 μ m at high magnification
 - 7. Acceptable manufacturers
 - a. Fluke
 - b. VIAVI Solutions
- D. Integrated OLTS, OTDR and fiber microscope
 - 1. Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.
 - 2. Acceptable manufacturers
 - a. Fluke
 - b. VIAVI Solutions

2.02 IDENTIFICATION

- A. Labels
 - 1. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
 - 2. Shall be preprinted using a mechanical means of printing (e.g., laser printer).
 - 3. Where used for cable marking, provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other color than white, preferably orange or yellow – so that the labels are easily distinguishable.
 - 4. Where insert type labels are used provide clear plastic cover over label.
 - 5. Provide plastic warning tape 6 inches wide continuously printed and bright colored 18" above all direct buried services, underground conduits and duct-banks.
 - 6. Acceptable Manufacturers:
 - a. Panduit
 - b. W.H. Brady
 - c. Brother / P-Touch

2.03 ADMINISTRATION

- A. Administration of the documentation shall include test results of each fiber link and channel.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records.

PART 3 - EXECUTION

3.01 GENERAL

- A. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- B. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

3.02 OPTICAL FIBER CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated. Fiber connector end-face testing from the fiber microscope with digital analysis shall be recorded upon completion of each test so that administrative documentation (reports) may be generated.
- C. OLTS and OTDR testing shall be performed on each cabling segment (connector to connector).
- D. OLTS and OTDR testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
- E. Testing of the cabling shall be performed using test reference cords (TRCs) with reference grade connectors. The test cords for OLTS testing shall be between 2 m and 5 m in length. The test cords for OTDR testing shall be at least 20m for the launch cable and at least 20 m for the receive cable.
- F. Optical loss testing

1. Single-mode links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA-526-7-A. The One-Cord Reference Method (Annex A) shall be used to reference the power meter.
 2. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- G. Length Measurement
1. The length of each fiber shall be recorded.
 2. It is preferable that the optical length be measured using an OLTS or OTDR.
- H. Polarity Testing
1. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with ANSI/TIA-568-.3. The polarity of the paired duplex fibers shall be verified using an OLTS.
- I. OTDR Testing
1. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 - a. Single-mode: 1310 nm and 1550 nm
 2. A launch cable shall be installed between the OTDR and the first link connection.
 3. A receive cable shall be installed after the last link connection.
- J. Objective analysis of fiber connector end-faces
1. All end-faces shall be inspected and analyzed in accordance with IEC 61300-3-35, section 5.3 and summarized below.
 - a. Inspect and analyze fiber connector end-face
 - 1) If end-face meets acceptance criteria (passes), record result
 - 2) If end-face does not meet acceptance criteria (fails), clean end-face and re-inspect
 - b. Ensure all fiber end-faces meet the acceptance criteria and have their results recorded

3.03 IDENTIFICATION

- A. Labeling
1. Labeling shall conform to the requirements specified within ANSI/TIA-606-B or to the requirements specified by the Owner or the Owner's representative.

3.04 ADMINISTRATION

A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., “as saved in the field-test instrument”.
2. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner’s representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as-built information.
3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM or USB prior to Owner acceptance of the building. This can include the software tools required to view, inspect, and print any selection of the test reports.
4. Circuit IDs reported by the test instrument should match the specified label ID.
5. The detailed test results documentation data is to be provided in an electronic database for each tested optical fiber and shall contain the following information
 - a. The identification of the customer site as specified by the end-user
 - b. The name of the test limit selected to execute the stored test results
 - c. The name of the personnel performing the test
 - d. The date and time the test results were saved in the memory of the tester
 - e. The manufacturer, model and serial number of the field-test instrument
 - f. The version of the test software and the version of the test limit database held within the test instrument
 - g. The fiber identification number
 - h. The length for each optical fiber
Optionally the index of refraction used for length calculation when using a length capable OLTS
 - i. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
 - j. Test results to include OTDR link and channel traces and/or event tables at the appropriate wavelength(s).
 - k. The length for each optical fiber as calculated by the OTDR.
 - l. Digital analysis result of fiber end-face inspection with high and low magnification images. Measurement regions (zones) shall be overlaid on the images along with any allowable scratches and defects.
 - m. The overall Pass/Fail evaluation of the link-under-test for end face inspection, OLTS and OTDR measurements

B. Record copy and as-built drawings

1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on CD-ROM or USB. Record copy drawings at the end of the project shall be in AutoCAD® format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. AutoCAD® drawings are to incorporate test data imported from the test instruments.

2. The as-built drawings shall include, but are not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts and frame installation details. The as-builts shall include all field changes made up to construction completion:
 - a. Field directed changes to pull schedule.
 - b. Field directed changes to cross connect and patching schedule.
 - c. Horizontal cable routing changes.
 - d. Backbone cable routing or location changes.
 - e. Associated detail drawings.

END OF SECTION