

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. 50/125-micrometer optical fiber cabling.
 - 3. Multi-pair copper cable
 - 4. Coaxial cable (radio frequency video).
 - 5. Cable connecting hardware, patch panels, and cross-connects.
 - 6. Telecommunications outlet/connectors.
 - 7. Passive Optical Splitters
 - 8. Cable management system.
 - 9. Cabling identification products.
 - 10. Backboards.
 - 11. Telecommunications equipment racks and cabinets.
 - 12. Telecommunications service entrance pathways.
 - 13. Grounding.
 - 14. Pathways.
 - 15. Telecommunications mounting elements.
 - 16. Multiuser telecommunications outlet assemblies.
- B. Related Sections:
 - 1. Division 27 05 26 "Grounding and Bonding for Communications Systems for voice and data cabling associated with system panels and devices.
 - 2. Division 27 05 28.36 "Cable Trays for Communications Systems" for voice and data cabling associated with system panels and devices.
- C. Bidding Requirements:
 - 1. Bidder shall submit complete detailed proposals with line item cost representation for components and associated installation labor. Lump sum bids will not be accepted.
 - 2. Bidders shall include as part of the bid response the following items:
 - a. Installation schedule with proposed manpower assignments.
 - b. Resumes for project manager and lead technician for this project.
 - c. BICSI RCDD certificate and registration number.
 - 3. Bidders shall review associated electrical, telecommunications infrastructure drawings to verify that necessary conduit and floor boxes will be provided by

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

others. Bidders shall understand and coordinate shared infrastructure locations for telecommunications outlets. The Owner will provide no additional infrastructure to support the telecommunications cabling systems Inside Plant (ISP) and Outside Plant (OSP). Any discrepancies with the identified infrastructure to support these systems should be questioned in the form of a request for information (RFI) during the bidding process. Be responsible for any additional infrastructure requirements after receipt of contract for this project. Unless specifically stated, no wiremold-style or surface mounted raceways shall be approved on this project.

4. Unspecified Equipment and Material: Any item of equipment or material not specifically addressed on the drawings or in this document and required to provide complete and functional Structured Cabling System shall be provided in a level of quality consistent with other specified items.

1.3 ABBREVIATIONS USED

#	Abbreviation	Description
1	10Gig	10-Gig Active Ethernet
2	10GPON	10-Gigabit Symmetrical Passive Optical Network
3	A/V	Audio Visual
4	AC	Alternating Current
5	ADN	Area Distribution Node
6	APC	Angled Physical Contact
7	BICSI	Building Industry Consulting Services International
8	DC	Direct Current
9	DTS	Department of Technology Services
10	EF	Entrance Facility
11	ER	Equipment Room
12	ETSD	Enterprise Telecommunications Division
13	EUB	End User Building
14	Gbe	Gigabit Ethernet
15	GPON	Gigabit Passive Optical Network
16	ID	Intermediate Distribution Frame
17	IDC	Insulation Displacement Connector
18	ISP	Inside Plant Wiring
19	ITu	International Telecommunications Union
20	JHA	Jurisdiction Having Authority
21	LAN	Local Area Network
22	MCN	Main Core Node
23	MDF	Main Distribution Frame
24	NS	Network Services
25	ODN	Optical Distribution Network
26	OLT	Optical Line Terminal
27	ONT	Optical Network Terminal
28	OSP	Outside Plant Wiring
29	PDS	Protective Distribution System
30	PDU	Power Distribution Unit (ONT Remote Powering)

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

31	PoE	Power over Ethernet, 15.4W
32	PoE+	Power over Ethernet Plus; 25.5W
33	POL	Passive Optical LAN (aka Passive Optical Network: PON)
34	RCDD	Registered Communications Distribution Designer
35	RU	Rack Unit
36	SFP	Small Form Pluggable
37	SMF	Single Mode Fiber
38	TDMM	BICSI Telecommunications Distribution Methods Manual
39	TR	Telecommunications Room
40	UPC	Ultra Physical Contact
41	WAO	Work Area Outlet

1.4 SYSTEM DESCRIPTION

- A. Provide a complete and functioning Structured Cabling System inclusive of all hardware, software and training to meet or exceed the performance features outlined in this document. The standard for all Structured Cabling Systems in Montgomery County is based on the deployment of Passive Optical LAN (POL) for Information and Communications Systems. How this standard is implemented depends upon the needs of the County including the cost tradeoff between an active or passive network. In many cases the County will decide to install a hybrid infrastructure composed of active, passive and wireless elements. This document presents standards for both active and passive technologies as if both were being installed together in a complementary manner. It is the responsibility of the Design Team to select the appropriate mix of technologies and to document how these will work together in the bid documents. Guidance in making these decisions will be provided by the Department of Technology Services in conjunction with the project stakeholders in the form of a Basis of Design (BOD) document. The BOD will be developed as a companion document to the Program of Requirements (POR) so that it may be included in the materials given to the architectural firm preparing the bid package.
- B. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 4. Optical splitters shall be installed as part of the optical fiber cabling permanent link and included in all permanent link test reports.
- C. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- D. The maximum allowable horizontal cable length for Category rated copper cabling is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.
- E. Backbone cabling system shall provide interconnections between communications ERs, MDFs, and EFs in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection and backbone to zone cross-connection points.

1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: The cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTAL REQUIREMENTS

- A. Comply with requirements of Section 01 33 00 - Submittal Procedures.
- B. Submittal data is to be submitted in a three ring binder, a continuous spiral binder, or plastic binding that allows the booklet to lie flat while open. Each booklet shall contain the below in the following order:
 - 1. Cover Sheet (including name of supplying contractor, project name, and project manager contact information)
 - 2. Detailed List of Materials
 - a. Include a catalog sheet per product of equipment listed in the Detailed Bill of Materials, in the exact order as the Detailed Bill of Materials. Each catalog sheet shall describe mechanical, electrical and functional equipment specifications. The catalog sheet must also include a image of the product. Photocopy duplications of the manufacturer's original equipment catalog sheets will be allowed as long as they provide adequate clarity of both the printed word and graphics/pictures. If more than one product is shown on the catalog sheet the intended product must be denoted by either an arrow or highlight.
 - 3. Authorized Distribution/Reseller Certificate
 - a. Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is an Authorized Distributor of the product being supplied.
 - 4. Prequalification Warrantee
 - a. Recently dated (within one year from submittal date) support letter from manufacturer stating that the supplying contractor is Authorized to obtain for the owner the Special Warranty for Cabling System and the Special Warranty for System Assurance.
 - 5. Prequalification Certificate
 - a. Copy of the installing technician(s) certificate of completion from the manufacturer's training school for the equipment being provided.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- C. Shop Drawings are to be submitted on project standard full size and bound. Each shop drawing set is to include the below in the following order:
 - 1. Title Sheet.
 - a. Containing, at a minimum, a list of all drawings in the set and a symbols legend defining each symbol used in the package.
 - 2. Riser Diagram.
 - a. Show the relationship of TR's, the pathway between them, and cable connectivity to be installed.
 - 3. Video/CATV System Engineering
 - a. Depict device location by room number and device type. Delineate cable types and cable pathway for both riser and horizontal distribution. Calculate db loss and outline levels for each splitter, tap, amplifier, and outlet.
 - 4. Telecommunications Room Details.
 - a. Plan Details of infrastructure and room fittings with clearances, Elevation Details of wall fields and rack details showing the relationship of rack mounted elements inclusive of Owner provided equipment (labeled as such).
 - 5. Typical Outlet Details.
 - a. Detail each typical outlet type to be installed. Include manufacturer specific plates, jacks, and an example of labeling. Note on the drawing the typical application of each outlet type, for example; standard office, computer lab, ceiling mounted wireless access location, etc.
 - 6. Floor Plans.
 - a. Show planned location for all elements and cable routing. Drawings should be at project standard scale clearly legible. Include outlet port numbers for each outlet.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer and manufactures certified installer, who shall be present at all times when Work of this Section is performed at Project site. One half of remainder of the crew shall be at a minimum Registered Technicians by manufacture as part of their Certified Installer Program.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Installing company shall be certified by manufactures in aspects of design, installation and testing of optical and Category 6 metallic premise distribution systems, be a manufactures Value Added Reseller (VAR) in good standing and have

a minimum of five (5) years' experience on similar Structured Cabling Systems (SCS). Have a Registered Communications Distribution Designer (RCDD) on staff.

- E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- F. Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, 2002 ANSI/TIA/EIA – 606
- G. Grounding: Comply with ANSI-J-STD-607-A.
- H. NFPA 70 – National Electric Code, 2005
- I. BICSI – TDMM, 13th Edition, 2014
- J. NEMA – VE-1 – Metal Cable Tray Systems, 2002
- K. NEMA – VE-2 – Metal Cable Tray Installation Guidelines, 2001

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install equipment frames and ladder racking until spaces are enclosed, secured and weather tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.9 COORDINATION

- A. Coordinate layout and installation of communications equipment with Owner's ETSD Network Services. Coordinate service entrance arrangement with local exchange carrier for public utilities and CATV providers. Coordinate service entrance arrangement with Program Manager for County's FiberNet Wide Area Network.
 - 1. Meet jointly with DTS/ETSD/Network Services, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- B. Coordinate layout and installation of telecommunications pathways and cabling with Owner's design team and DTS/ETSD/Network Services.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- C. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- D. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate

1.10 EXTRA POL MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Patch-Panel Units: The greater of one (1) or 10% of total quantity of each type.
 - 2. Zone Box Units: The greater of one (1) or 10% of total quantity of each type.
 - 3. Connecting Blocks: The greater of one (1) or 10% of total quantity of each type.
 - 4. Device Plates: The greatest of ten (10) or 2% of total quantity of each type.
 - 5. OLT PON Cards: 1 spare card per OLT chassis
 - 6. OLT Switch Fabric Cards: 1 spare card per 10 OLTs, or a single card for under 10 OLTs
 - 7. ONTs: the greatest of 15 or 2% of the total quantity of each ONT type.
 - 8. Optical Patch Cords: the greatest of ten (10) or 1% of the total quantity of each length.

1.11 WARRANTY

- A. Special Warranty for Cabling System: Manufactures warranty shall ensure against product defects; that approved cabling components exceed the specifications of TIA/EIA 568B, TIA/EIA 568B-5 and ISO/IEC IS 11801. The warranty shall apply to passive SCS components.
 - 1. Warranty Period: 25 year Cabling System from date of Substantial Completion.
- B. Special Warranty for Passive Optical LAN system: Manufactures warranty shall ensure against product defects and provide maintenance release software upgrades. Warranty shall include advanced order replacement of electronics OLT and ONT components and sub-components, and be provided with 24x7x365-24x7x52 technical assistance center access directly from the manufacturer. On-site support from the manufacturer shall be a 24-hour response time for deemed 'critical outages' impacting greater than 10% of the system install base or as necessary by the manufacturer.
 - 1. Warranty Period: one (1) year electronics warranty from date of substantial completion with options delivered for two (2), three (3) and five (5) year terms in the base bid.

2 PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified or as approved equal by the owner.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

2.2 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Cable Support: NRTL labeled. Cable support brackets in Telecommunications Rooms shall be designed to prevent degradation of cable performance and pinch points that could damage cable.
- C. Provide bend limiters, if not built into the cable support, to maintain cable type bend radius whenever cable exists pathways or makes transition between two pathways.
- D. Non-continuous cable supports shall be used in any area above the finished ceiling where cable tray is not available.
- E. Non-continuous cable (J-Hooks/Arlington Loops) supports
 1. Cable Support: NRTL labeled for support of Category rated and optical fiber cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 2. Non-continuous cable supports shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; cULus Listed.
 3. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 4. 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.
 5. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
 6. Non-continuous cable supports shall be ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, CAT21SS, CAT32SS, CAT64SS; CAT-CMTM Double J- Hook CAT100CM; CAT-CMTM U-hook series CAT200CMLN, CAT300CMLN; and CAT-CMTM retainer CATRT200CM, CATRT300CM or approved equal.
- F. Multi-tiered non-continuous cable support assemblies
 1. 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; cULus Listed.
 2. 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.
 3. The multi-tiered support bracket shall consist of ERICO CADDY CATHBA and CableCat™ J-Hooks with screws; or approved equal.
- G. Non-continuous cable support assemblies from drop wire/ceiling
 1. Fastener to wire/rod with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 2. Acceptable products: ERICO CADDY CAT124Z34, CAT126Z34, CAT214Z34, CAT216Z34, CAT324Z34 or CAT326Z34; or approved equal.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- H. Non-continuous cable support assemblies from beam, flange
 - 1. Fastener to beam or flange with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments; cULus Listed.
 - 2. Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64 with CADDY beam clamps and CADDY flange clips; or approved equal.
- I. Non-continuous cable support assemblies from wall, concrete, or joist
 - 1. Fastener to wall, concrete, or joist with one non-continuous cable support, factory or jobsite assembled; rated for indoor use in non-corrosive environments, cULus listed.
 - 2. Acceptable products: ERICO CableCat™ J-hook series CAT12, CAT21, CAT32, CAT64, with CADDY angle bracket; or approved equal

2.3 CONDUITS AND BOXES

- A. Conduit and Boxes: Comply with requirements in Division 16 Section "Raceways and Boxes." Flexible metal conduit shall not be used.
- B. No run of conduit shall exceed 100-feet or contain more than 180-degrees in bends and sweeps without an appropriately sized pull box being inserted.

2.4 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Mohawk; a division of Belden CDT.
 - 2. Superior Essex Inc.
 - 3. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
 - 4. Hubbell Premise wire
 - 5. General Cable Technologies Corporation.
 - 6. Molex
- B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
 - 1. 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.5 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, provided products by one of the following available manufacturers that may be incorporated into the Work includes, but are not limited to, the following:
 - 1. Belden

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

2. Tyco Electronics/AMP Netconnect
 3. Corning Optical Cables
 4. Molex
 5. Approved equal
- B. Description: Plenum Rated Simplex or 2-strand Singlemode, nonconductive, Optical Fiber cable.
1. Comply with ICEA S-87-640 for mechanical properties.
 2. Comply with TIA/EIA-568-B.3 for performance specifications.
 3. Comply with ICEA S-83-596 for mechanical properties.
 4. Comply with TIA/EIA-568-B.3 for performance specifications.
 5. Comply with TIA/EIA-492AAAA-B for detailed specifications.
 6. Comply with low-bend radius guidelines of between 5mm and 8mm
 7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - a. General Purpose, Nonconductive: Type OFN or OFNG[, or OFNR, OFNP].
 - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
 - d. General Purpose, Conductive: Type OFC or OFCG.
 - e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
 - f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.
 8. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 9. Minimum Modal Bandwidth: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
 10. Jacket:
 - a. Jacket Color: Yellow for Single Mode Fiber (SMF)

2.6 LOW-VOLTAGE REMOTE POL/ONT POWERING CABLE

- A. Manufacturers: Subject to compliance with requirements, provided products by one of the following available manufacturers that may be incorporated into the Work includes, but are not limited to, the following:
1. Belden
 2. Tyco Electronics/AMP Netconnect
 3. Panduit
 4. Leviton
 5. Molex
 6. Approved equal
- B. Description: Low voltage copper pair cabling for ONT remote powering covered with thermoplastic jacketing:
1. Be available in 16AWG, 18AWG, 20AWG and 22AWG pairs.
 2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.7 OPTICAL FIBER AND LOW-VOLTAGE REMOTE POL/ONT POWERING HYBRID CABLE

- A. Manufacturers: Subject to compliance with requirements, provided products by one of the following available manufacturers that may be incorporated into the Work includes, but are not limited to, the following:
 - 1. Belden
 - 2. Tyco Electronics/AMP Netconnect
 - 3. Corning Optical Cables
 - 4. OCC
 - 5. Approved equal
- B. Description: Low voltage copper pair cabling for POL/ONT remote powering covered with yellow thermoplastic jacketing and bundled with a simplex or duplex single mode optical fiber:
 - 1. Be available in 16AWG, 18AWG, 20AWG and 22AWG pairs.
 - 2. Be provided with either a single or duplex SM28e optical fiber cable
 - 3. Comply with ICEA S-87-640 for mechanical properties
 - 4. Comply with TIA/EIA-568-B.3 for performance specifications.
 - 5. Imprinted with fiber count, fiber type, copper pair information, and aggregate length at regular intervals not to exceed 40 inches.
 - 6. Comply with TIA/EIA-568-B.3 for performance specifications
 - 7. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Plenum Rated, Nonconductive: Type OFCP, complying with NFPA 262

2.8 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Hubbell Premise Wiring.
 - 2. Leviton Voice & Data Division.
 - 3. Belden
 - 4. Panduit Corp.
 - 5. Molex
 - 6. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
 - 7. Approved equal
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Data Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables. All patch panels shall be 24 or 48 port.
 - 1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- D. Jacks and Jack Assemblies: Modular, color-coded, eight-position eight conductor modular receptacle units with integral IDC-type terminals.
 - 1. Comply with TIA/EIA-568-B.2, Category 6.
- E. Patch Cords: Factory-made, four-pair cables in 3'-20' in length; terminated with eight-position modular plug at each end. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure specified category performance. Patch cords shall have latch guards to protect against snagging.
 - 1. TR location: Provide one (1) patch cord to match cable and Jack Assembly category rating per port on the patch panel for rack mounted ONT to horizontal cable cross connection.
 - 2. Floor outlet locations: Provide one (1) ten foot modular patch cord to match cable and Jack Assembly category rating per eight-position eight conductor modular receptacle being fed from a rack mounted ONT.
 - 3. ONT outlet locations: Provide one (1) ten foot modular patch cord to match two (2) active connections per desk/cubicle being served from each ONT, or a single patch cord when an ONT is servicing an ancillary device (camera, wall phone, courtesy area, BMS, elevator connection, etc)

2.9 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Belden
 - 2. Tyco Electronics/AMP Netconnect
 - 3. Corning Optical Cables
 - 4. Molex
 - 5. Approved equal
- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, simplex and duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
 - 2. Fiber Optic enclosures shall be available as rack mountable with accommodations for splice trays.
 - 3. Fiber Optic enclosures shall be available as wall mountable with accommodations for splice trays
 - 4. Fusion splice tray as needed for transition point and factory terminated pigtails.
 - 5. SC-APC Duplex 12 fibers coupler panels shall be used for Single mode fiber.
 - 6. Size fiber enclosure for 25% percent spare capacity.
- C. Patch Cords: Factory-made, single-fiber cables in one (1) meter lengths. Supply one (1) SC-APC to SC-APC for all termination points in the passive optical splitter to horizontal WAO station cable per ONT and sparing as defined under Section 1.10A.8.

- D. Patch Cords: Factory-made, single-fiber single mode cables in three (3) meter lengths. Supply two (2) SC-APC to SC-APC cables for all termination points in the backbone to passive optical splitter cable permanent link per PON splitter and sparing as defined under Section 1.10A.8. LC patch cords may be utilized when high density adapter panels are utilized.
- E. Cable Connecting Hardware:
 - 1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA- 568-B.3.
 - 2. Singlemode connector type SC-APC.
 - 3. Connectors for Singlemode shall be factory field installation via fusion splicing
- F. Passive Optical Splitters
 - 1. Comply with TIA/EIA-568-B.3.
 - 2. Be available as either single or dual fiber inputs.
 - 3. Be available as either 1RU rack mounted or cassette based splitters
 - 4. Provide interface inputs and outputs as SC or LC connectors.

2.10 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Optical Jacks: Single Mode Connector type SC/APC at all optical workstation outlets.
- C. Workstation Outlets: Provide connector assemblies mounted in single or multi-gang faceplates as shown on contract drawings.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 16 Section "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - 3. Legend: Machine printed, desi-window mounted,
 - a. Adhesive "sticky-back" labels are not permissible.
- D. Horizontal Copper Cabling for Wireless Access Points
 - 1. Comply with TIA-162-A
 - 2. With the following exceptions:
 - a. Horizontal cabling for wireless access points should be two Category 6a as specified in ANSI/TIA/EIA-568-B.2 or two-fiber OM3 or higher mm, as specified in ANSI/TIA/EIA-568-B.3.
 - b. A 15 foot service loop shall be coiled in the channel to allow for movement of the access point to improve coverage;
 - c. Power Over Ethernet Plus will be used to power access points

2.11 INNERDUCT

- A. OSP applications

1. Description: Corrugated High Density Polyethylene (HDPE) 1 ¼ inch Orange in color with factory installed pull tape. Manufactured by Carlon or approved equal.
 2. Splices shall only be at Maintenance Hole locations if necessary. No splices shall be allowed in conduit.
 3. Use PIC1 Nonmetallic internal coupling to join sections as needed.
- B. ISP Backbone Applications
1. Description: Plenum-gard 1 ¼ inch Orange or White in color with factory installed pull tape. Manufactured by Carlon or approved equal.
 2. Splices shall only be in SEF or TR/MC/HC locations if necessary. No splices shall be allowed in conduit.
 3. Use manufacturer approved nonmetallic internal coupling to join sections.
 4. Use manufacturer approved nonmetallic internal coupling to join sections.
 5. Alternatively, plenum rated armored optical fiber cabling shall be permissible in the riser to eliminate innerduct requirements.

2.12 FIRE STOP CABLE PASS-THRU SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are limited to, the following:
1. Basis of design: Specified Technologies Inc.
 2. Approved equal by:
 - a. 3M Corporation.
 - b. Hilti Corporation.
 - c. Wiremold- Legrand Corporation.
- B. Fire Rated Cable Pathways: STI EZ-PATH Brand device modules comprised of steel raceway with intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
1. Specified Technologies Inc. (STI) EZ-PATH Series 44 Fire Rated Pathway
 2. Specified Technologies Inc. (STI) EZ-PATH Series 33 Fire Rated Pathway
- C. EZ-path series 44 wall sleeves in Telecommunications rooms shall be quantity as shown on contract drawings.
- D. Horizontal cable pathway locations greater than 20 cables fire stop sleeves shall be STI EZ-Path series 33.
- E. Horizontal cable pathway locations fewer than 20 cables EMT sleeve with UL listed system for firestopping is acceptable. Caulks and sealants shall be as manufactured by STI, 3M, Nelson, or approved equivalent.
- F. Fill ratio for fire stop EMT sleeves is based on a not to exceed 40% fill capacity.

2.13 GROUNDING

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- A. Comply with requirements in Division 27 Section "Grounding and Bonding" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A

2.14 ER LADDER RACK, SUPPORTS, AND ACCESSORIES

- A. Ladder Rack (Universal Cable Runway) for Equipment Rooms only
 - 1. Ladder rack shall be manufactured from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness.
 - 2. Ladder rack (side stringers) will be 9'-11 1/2" long. Cross members will be welded in between stringers on 12" centers beginning 5-3/4" from one end so that there are 10 cross members per ladder rack. There will be 10-1/2" of open space in between each cross member.
 - 3. Ladder rack will be delivered individually boxed, and available in the multiple widths.
 - 4. Finish shall be epoxy-polyester hybrid powder coat (paint) black in color.
 - 5. Design Make: Chatsworth Products, Inc. (CPI), Universal Cable Runway: Part Number 10250-712, Universal Cable Runway, 12" Wide, Black 10250-718, Universal Cable Runway, 18" Wide, Black or approved equal.
 - 6. Design Make: Chatsworth Products, Inc. (CPI), Universal Cable Runway: Part Number 10250-724, Universal Cable Runway, 24" Wide, Black placed in vertical positions or approved equal
- B. Ladder Rack Splices
 - 1. Splice kits will provide a method of mechanically connecting ladder rack sections and turns together end-to-end or side-to-end to form a continuous pathway for cables.
 - 2. Grounding kits will provide a method of bonding ladder rack sections and turns together that is independent of the pathway splices. The grounding kit should be constructed of UL Listed components. The preferred solution is a #6 AWG green insulated stranded copper conductor connected on both ends to ladder rack using two-hole compression lugs and stainless steel hardware.
 - 3. Splices (splice plates) will be manufactured from steel. Splice, grounding and insulator bar kits will include installation hardware.
 - 4. Finish (of splice plates and hardware) shall be zinc plate in the color(s) specified below. Colors are applied as a chem. film over the zinc plate.
 - 5. Design Make: Chatsworth Products, Inc. (CPI), Cable Runway Splices or approved equal.
- C. Ladder Rack Supports
 - 1. Supports will be sized to match the width of the ladder rack that is supported. Some supports will work with all widths of ladder rack.
 - 2. Each support will include a means of securing ladder rack to the support.
 - 3. Supports will be manufactured from steel or aluminum.
 - 4. Finish shall be epoxy-polyester hybrid powder coat (paint) in the color(s) specified below or zinc plate with a gold chem. finish specified gold. Included hardware shall be zinc plated with a gold chem. finish.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

5. Design Make: Chatsworth Products, Inc. (CPI), Cable Runway Supports or approved equal.
- D. Ladder Rack Accessories
1. Cable straps used for attaching cable bundles to the ladder rack cross members must be reusable with a hook and loop-style closure, at least $\frac{3}{4}$ " wide, and sized for cable bundles that are 2", 3" or 4" in diameter. Permanent tie-wraps are not permitted.
 2. Cable retaining posts used to keep cable from falling off of the side of the ladder rack shall be manufactured from 1" by $\frac{1}{2}$ " tubular steel with .065" wall thickness. Cable retaining posts will be 8" high and will attach to the side stringer of the ladder rack with included hardware. The top of the cable retaining posts will be fitted with a rubberized end cap to protect cables.
 3. End caps used to cover the ends of ladder rack will be manufactured from a black fire- retardant rubberized material. End caps will be sized for $\frac{3}{8}$ " wide by 1-1/2" high side stringers and will be sold in pairs.
 4. End closing kits used to cover the end of ladder rack will be manufactured from $\frac{3}{8}$ " wide by 1-1/2" high tubular steel with .065" wall thickness. Kits will consist of a bar cut to match the width of the ladder rack and the hardware required to attach the bar to the end of a length of ladder rack.
 5. Radius drops used to create a radius to form cables over as the cables exit or enter the ladder rack will be manufactured from aluminum extrusion. The extrusion will be formed in a 90° arc with a minimum bend radius of 3". Radius drops will attach to either the side stringer or the cross member of the ladder rack using a clevis pin. Radius drops will include 1-1/2" high cable spools that attach to the top of the radius drop to guide cables.
 6. Movable cross members used to support cross member radius drops in between welded cross members on ladder rack will be manufactured from $\frac{3}{8}$ " by 1-1/2" aluminum bar. Movable cross members will attach to ladder rack at the side stringers with included hardware so that the location of the movable cross member can be adjusted. Moveable cross member will support a cross member radius drop.
 7. Cable spools used to separate ladder rack into multiple cable pathways will be made from a black flame retardant ABS. Cable spools will attach to the cross members with a clip that allows the width of the ladder rack to be divided into any proportion. The spools will be 3.94" tall, with a 1.94" diameter top, and a body that tapers from .88" (diameter) at the top to .62" (diameter) at the bottom.
 8. Auxiliary support brackets used to support cables that should be physically separated from the cables in the ladder rack will be made from $\frac{1}{8}$ " x 1" steel bar. The bracket will be L-shaped and will attach to the side stringer of the ladder rack. The bracket will hang below the ladder rack a minimum of 4". The bracket support surface will be 4" long. The bracket will be zinc plated with a gold chem. finish.
 9. Touch-up paint used on ladder rack and ladder rack system components will be color- matched to the finish on the ladder rack or component. A spray on and brush on option will be available.
 10. Unless otherwise noted, finish on all metal components shall be epoxy- polyester hybrid powder coat (paint) black in color. Hardware will be zinc plated with a gold chem. finish.

11. Design Make: Chatsworth Products, Inc. (CPI), Cable Runway Accessories or approved equal.

2.15 ER & TR BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches A-C Grade.
 1. Provide materials that comply with performance requirements in AWWPA C27. Identify fire-retardant-treated wood with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
 2. Use treatment for which chemical manufacturer publishes physical properties of treated wood after exposure to elevated temperatures, when tested by a qualified independent testing agency according to ASTM D 5516, for plywood.
- B. All 4 walls of an ER shall be covered with rigidly fixed 3/4 inch A-C plywood with the A grade side facing outward. The plywood shall be void free and extend from 6 inches above the finished floor (AFF) to 102 inches AFF and capable of supporting the attached equipment.
- C. When a TR is used, a design specified wall shall be covered with rigidly fixed 3/4 inch A-C plywood with the A grade side facing outward. The plywood shall be void free and extend from 6 inches above the finished floor (AFF) to 102 inches AFF and capable of supporting the attached equipment.
- D. Comply with requirements in Division 09 Section "Paints and Coatings" for fire-retardant plywood.

2.16 EQUIPMENT RELAY RACKS & FRAMES

- A. Free Standing Relay Racks for ERs and large TRs when used:
 1. Racks shall be manufactured from aluminum and/or steel extrusions.
 2. Each rack will have two L-shaped top angles, two L-shaped base angles and two C-shaped equipment-mounting channels. The rack will assemble with bolt hardware. Equipment-mounting channels will be threaded for easy assembly. The base angles will be pre-punched for attachment to the floor.
 3. Equipment mounting channels will be 3" deep and punched on the front and rear flange with the EIA-310-D Universal hole pattern to provide 45 rack-mount spaces for equipment. Each mounting space will be marked and numbered on the mounting channel.
 4. When assembled with top and bottom angles, equipment-mounting channels will be spaced to allow attachment of 19" EIA rack-mount equipment. Attachment points will be threaded with 12-24 roll-formed threads. The rack will include assembly and equipment-mounting hardware. Each rack will include 50 each combination pan head, pilot point mounting screws.
 5. The assembled rack will measure 7' (84") high, 20.3" wide and 15" deep. The sides (webs) of the equipment-mounting channels will be punched to allow attachment of vertical cable managers along the sides of the rack or for rack-to-rack baying.
 6. The rack will be rated for 1,500 lb. of equipment.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

7. The rack will be UL Listed.
 8. Finish shall be epoxy-polyester hybrid powder coat black in color.
- B. Wall Mounted Telecommunications Equipment Rack for TRs when used:
1. Rack shall be manufactured from aluminum and/or steel extrusions.
 2. Equipment mounting rack rails will be set back 4" to accommodate cable managers. Accommodations shall be available for rear rack rails.
 3. When assembled, the center section will swing open to allow for front and rear access to equipment and cabling.
 4. Rack shall feature a wall-mounted back pan, to include 1/2", 2", and 3" electrical knockouts for conduit connections, as well as a 12-1/2" x 12-1/2" cutout for electrical pull-box.
 5. Rack shall include top and bottom side vents, capable of accommodating cooling kits.
 6. The assembled rack will measure between 20" and 30" deep, and shall feature between 12 and 18 useable RUs.
 7. The rack will be rated for 200 pounds of equipment.
 8. The rack will be UL Listed.
 9. The rack shall be grounded per requirements in Division 27 Section "Grounding and Bonding" for grounding conductors and connectors.
 10. Finish shall be epoxy-polyester hybrid powder coat black in color.

2.17 POL POWER STRIPS

- A. Each ER equipment rack or TR wall mounted equipment rack supporting remote ONT powering is to contain a rack mounted power distribution panel that is to occupy the first rack space in each rack.
- B. Power strips shall be connected either to building generator and UPS power, or to an appropriately sized UPS that will provide 4-hours of system run-time for the POL OLT, rack mounted ONTs, or remote ONT powering N+1 power source feeding a zone or direct ONT horizontal drop cables.

2.18 POL ZONE ENCLOSURE REQUIREMENTS

- A. Zone enclosures shall be provided to support horizontal ONT drop cable assemblies to passive optical splitter output connectivity:
1. Shall be available in 2'x2' configurations to allow for installation in the suspended ceiling grid system.
 2. Shall be provided with supports for threaded rod or hanger wire supports.
 3. Shall be capable of being mounted on or within a wall environment.
 4. Shall be capable of being mounted under a raised floor environment.
 5. Zone enclosure back pan and side panels, to include 1/2", 3/4", 1" and 2" electrical knockouts for conduit connections, as well as a 12-1/2" x 12-1/2" cutout for electrical pull-box.
 6. Shall provide optical connector module support in various configurations:
 - a. The zone box shall provide up to 12 adapter panel inserts to support
 - i) 12-fiber or 24-fiber SC bulkhead panels

- ii) Cassette based passive optical splitters
 - iii) Cassette based ONT remote PDU rate limiting modules
- b. The zone box shall provide up to 4-RUs of space for rack mounting of equipment, to include
 - i) Fiber optic rack mounted patch panels for both adapter panels and cassette based splitters
 - ii) Fiber optic rack mounted splitters
 - iii) Rack mounted ONT remote PDU rate limiting modules
- 7. Shall provide for integrated cable management of the optical slack loops and maintaining the proper bend radii of the cables.
- 8. When utilizing remote ONT powering from a non-rate limited 100VA bulk power source, shall be fed with ¾" or 1" EMT conduit from the power source room location and grounded.
- 9. Be UL listed to permit for the installation of an optional ONT within the enclosure.
- 10. Finish shall be epoxy-polyester hybrid powder coat white in color.
- 11. Be provided with a locking latch mechanism capable of being key-locked, white in color.
- 12. Be available with recess door configurations allowing for a false ceiling tile to be adhered to the box entry.

2.19 REMOTE POL/ONT POWERING SOURCES & POWER DISTRIBUTION UNITS (PDU)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are limited to, the following:
 - 1. Corning Optical Cable PDU or ICU
 - 2. Alpha eLimiter Line
 - 3. Tellabs ODH/PDH
 - 4. N-Lightened Networks.
 - 5. Dongah Elecom
- B. PDUs shall be available to support remote ONT powering from a TR or zone enclosure.
 - 1. PDU in the TR shall support 100VA NEC compliant rate limiting for Article 725 of the NEC (Class 2 Circuits) and GR-1089-CORE compliance
 - 2. PDU shall be a UL listed and supported device
 - 3. PDUs fed from bulk DC power shall utilize an N+1 AC-DC rectifier source.
 - 4. PDUs that integrate the power conversion shall be available with either a single or dual AC input source for redundancy.
 - 5. Single RU PDUs shall support powering of the ONT in multiple scenarios:
 - a. TR based ONT powering:
 - i) Shall provide up to 32 rate-limited outputs in increments of eight (8) outputs.
 - ii) Outputs shall support 18AWG, 20AWG and 22AWG cable pairs when utilizing quick-disconnect mate-and-lock or "Phoenix" style connectors.
 - iii) Outputs shall support cable gauges of 22AWG or 24AWG when using an RJ45 8-pin/8-conductor connector type.

- iv) PDUs in a ER/TR deployment option do not require conduit for the non-rate limited input DC power source.
 - b. Zone based ONT powering:
 - i) Shall provide up to 32 rate-limited outputs in a modular manner in increments of eight (8).
 - ii) Outputs shall support 18AWG, 20AWG and 22AWG cable pairs when utilizing quick-disconnect mate-and-lock or "Phoenix" style connectors.
 - iii) Outputs shall support cable gauges of 22AWG or 24AWG when using an RJ45 8-pin/8-conductor connector type.
 - iv) PDUs in a zone based deployment option require conduit for the non-rate limited input from the DC power source or armored cable.
 - v) It is recommended that multiple, higher-gauge copper power pairs be utilized to feed multiple inputs on a PDU or be bonded together of no more than 16AWG per conductor.
- C. ONT Remote Powering sources can be either a bulk DC power plant, or integrated AC power into the PDU based on the application.
 - 1. PDUs fed from bulk DC power shall utilize an N+1 AC-DC rectifier source capable of outputting at 56Vdc to the PDU to accommodate for voltage drop over distance based on cable gauge.
 - 2. The source power shall be sized to support a minimum of .625A@48Vdc receive power to the ONT and a maximum of 1.5A@48Vdc at the ONT for future growth via additional rectifier modules.
 - 3. AC powered PDU units shall be provided with redundant 10A electrical circuits fed from separate breaker panels in the ER/TR.
 - 4. AC plug types shall be coordinated with the powering source manufacturer with the common basis of design being a C19 male plug on the source.

3 EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.
- B. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- C. Install pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.
 - 1. Install entrance pathway complying with Division 16 Section "Raceways and Boxes."

3.2 INSTALLATION OF PATHWAYS

- A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- B. Comply with requirements in Division 26 Section "Raceways and Boxes" for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- D. Pathway Installation in Communications Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits 3 inches (76 mm) above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to TGB/TMGB.

3.3 NON-CONTINUOUS CABLE SUPPORTS

- A. Installation and configuration shall conform to the requirements of the current revision levels of ANSI/ EIA/TIA Standards 568 & 569, NFPA 70 (National Electrical Code), applicable local codes, and to the manufacturer's installation instructions.
- B. Do not exceed load ratings specified by manufacturer.
- C. Adjustable non-continuous support sling shall have a static load limit of 100 lbs.
- D. Follow manufacturer's recommendations for allowable fill capacity for each size non-continuous cable support.

3.4 WIRING METHODS

- A. Wiring Method: Install cables in raceways, J hooks, and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables accessible ceilings, walls, and floors except in unfinished spaces.
- B. Install plenum cable in environmental air spaces, including plenum ceilings.
- C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- D. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- E. Provide equipment frames and ladder racking as outlined in telecommunications series drawings.

3.5 INSTALLATION OF CABLES

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Current Edition, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
 - 10. In the communications equipment room, install a 10-foot long service loop on each end of cable.
 - 11. Pulling Cable: Comply with BICSI ITSIM, current edition, "Pulling Cable." Section. Monitor cable pull tensions.
- C. UTP Cable Installation:
 - 1. Comply with TIA/EIA-568-B.2.
 - 2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
 - 3. Terminate patch panels and outlets to a pin/pair assignment as directed by owner.
- D. UTP Cat 6 Patch Cords 1. Provide modular cords required to connect LAN switches to modular jacks on cross connect panel shall be furnished as part of this solicitation. Quantities should be equal to the total number of network outlets. At the Patch panel location provide patch cable lengths as needed for a neat installation utilizing vertical wire managers. At the user outlets provide 10 foot patch cables for each 8 pin modular connector
- E. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Installation of Cable Routed Exposed under Raised Floors:
1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 10 feet long not less than 12 inches in diameter below each feed point.
- G. Group connecting hardware for cables into separate logical fields.
- H. Optical Fiber Cable Installation:
1. Comply with TIA/EIA-568-B.3.
 2. Cable may be terminated on connecting hardware that is rack, zone enclosure or cabinet mounted.
 3. Fiber shall be installed in innerduct within conduits unless armored.
 4. Bend insensitive fiber shall be utilized for all horizontal WAO station drop assemblies to eliminate conduit, innerduct or other protection requirements.
 5. Multiple fibers shall be pulled in the same innerduct whenever possible.
 6. Fiber shall be installed in one continuous piece.
 7. Any excess fiber shall be coiled neatly and secured to a wall above the plywood backboard so it is out of the way of normal traffic and is not subject to unusual flexing.
- I. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open Category rated copper cables or Category rated cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 3. Separation between Category rated communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
 4. Separation between Category rated communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

5. Separation between Category rated communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Category rated communications Cables and Fluorescent Fixtures: A minimum of 5 inches.
7. Separation for optical fiber cabling from electrical sources shall not be of concern, however attempts shall be made to accommodate separate pathways for optical components.

3.6 INSTALLATION TELECOMMUNICATIONS ROOMS

- A. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- B. Bond the shield of any shielded cable to the grounding bus bar in communications rooms and spaces.
- C. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.
- D. Free Standing Relay Racks
 1. Assemble relay racks according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the floor.
 2. All racks must be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below.
 3. Racks shall be grounded to the TGB using appropriate hardware. The ground will meet local code requirements and will be approved by the JHA.
 4. Ladder rack shall be attached to the top of the racks/cabinets to deliver cables to the rack. The rack should not be drilled to attach ladder rack. Use appropriate hardware from the ladder rack manufacturer.
 5. The equipment load should be evenly distributed and uniform on the rack/cabinets. Place large and heavy equipment towards the bottom of the racks/cabinets. Secure all equipment to the racks/cabinets with equipment mounting screws.
- E. Wall Mounted Equipment Cabinets
 1. Assemble cabinet according to manufacturer's instructions. Verify that equipment mounting rails are sized properly for rack-mount equipment before attaching the rack to the wall.
 2. All racks must be attached to the wall using appropriate wall mounting anchors.
 3. Cabinets shall be grounded to the TGB using appropriate hardware when supporting electrical components (remote ONT power sources or rack mounted ONTs) or copper cable terminations. The ground will meet local code requirements and will be approved by the JHA.
 4. The equipment load should be evenly distributed and uniform on the rack/cabinets. Place large and heavy equipment towards the bottom of the

racks/cabinets. Secure all equipment to the racks/cabinets with equipment mounting screws.

F. Ladder Rack

1. Provide all components of the ladder rack system (ladder rack, turns, splices, supports, and accessories) from a single manufacturer.
2. Ladder rack shall be installed with side stringers facing down so that the ladder forms an inverted U-shape and so that welds between the stringers (sides) and cross members (middle) face away from cables.
3. Ladder rack shall be secured to the structural ceiling, building truss system, wall, floor or the tops of equipment racks and/or cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).
4. Ladder rack splices will be made in mid-span, not over a support, with the manufacturer's recommended splice hardware.
5. Ladder rack shall be supported every 5' or less in accordance with TIA-569-B. Ladder rack shall be supported within 2' of every splice and within 2' on both/all sides of every intersection. Support ladder rack within 2' on both sides of every change in elevation. Support ladder rack every 2' when attached vertically to a wall.
6. Heavy-duty splices are recommended for ladder rack in excess of 18" width (18" wide ladder rack). Heavy-duty splices are required for any splice formed in the vertical orientation including changes in elevation formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).
7. When the pathway is overhead, ladder rack shall be installed with a minimum clearance of 12" above the ladder rack. Leave a minimum of 12" in between ladder rack and ceiling/building truss structure. Leave a minimum of 3" in between ladder rack and the tops of equipment racks and/or cabinets. Multiple tiers of ladder rack shall be installed with a minimum clearance of 12" in between each tier of ladder rack. When located above an acoustical drop ceiling, leave a minimum of 3" clearance between the top of the drop ceiling tiles and the bottom of the ladder rack.
8. When installed under a raised floor, ladder rack shall be installed with a minimum 3" clearance between the top of the ladder rack and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3" clearance between ladder racks wherever ladder racks cross.
9. Within each telecommunications room, ladder rack should be bonded together, electrically continuous, and bonded to the TGB, unless otherwise noted in the specifications and contract documents. Ladder rack and turns shall be bonded across each splice with a bonding kit. Ladder rack shall be bonded to the Telecommunications Grounding Busbar (TGB) using an approved ground lug on the ladder rack and a minimum #6 grounding wire or as recommended by the JHA. Remove paint from the ladder rack where bonding/ground lugs contact the ladder rack so that the lug will contact bare metal. Use antioxidant joint compound in between the bare metal on the ladder rack and ground lug. Use antioxidant joint compound in between the bus bar and the ground lug. Verify continuity through the bonds at splices and intersections between individual ladder rack sections and turns and through the bond to the TGB.

10. Actual cable fill for ladder rack equipped with cable retaining posts will not exceed 6" in height.
11. The combined weight of cables within the ladder rack will not exceed the stated load capacity of the ladder rack as stated in the manufacturer's product specifications or load/design tables.
12. Cables (cable bundles) will be secured to the cross members of ladder rack with $\frac{3}{4}$ " wide reusable straps. Straps are not required when ladder rack is equipped with cable retaining posts.
13. Add 8" high cable retaining posts to the open sides of ladder rack when cable fill exceeds 2" in height or when cable bundles cannot be secured directly to the ladder rack cross members with a strap. Cable fill within any ladder rack should not exceed 6" in height.
14. When a single ladder rack supports different types of cable media, the cable media will be separated within the pathway by cable spools that attach to the cross members on the ladder rack. Treat each type of cable media and divided area of the ladder rack separately when determining cable fill limits.
15. Use a radius drop to guide cables wherever cable exits overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field. If necessary, provide a moveable cross member also to attach and align the radius drop in between the welded cross members of a ladder rack.
16. Cover the exposed ends of cable runway that do not terminate against a wall, the floor or the ceiling with end caps or an end closing kit.
17. Use auxiliary support brackets that attach to the side stringer of the ladder rack to support interconnect cabling (patch cords, equipment cords, jumper cords) that is routed between racks using the ladder rack. Auxiliary support brackets can be used to support other conductors that should be physically separated from cables within the ladder rack as defined by local code or the JHA.
18. Whenever possible, maintain a 2' separation between ladder rack used for communications cables and pathways for other utilities or building services.
19. Provide touch-up paint color-matched to the finish on the ladder rack and correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, the component will be replaced with a new component finished from the factory. If a component is physically damaged due to mishandling or modification during the installation process, it shall not be used as part of the ladder rack system.
20. The quantity of cables within the ladder rack will not exceed a whole number value equal to 50% of the interior area of the ladder rack divided by the cross-sectional area of the cable. The interior area of ladder rack will be considered to be the width of the ladder rack multiplied by a height of 2", unless cable retaining posts are added to the ladder rack. The interior area of ladder rack equipped with cable retaining posts will be considered to be the width of the ladder rack multiplied by a height of 6". Actual cable fill for ladder rack that is not equipped with cable retaining posts will not exceed 2" in height.

G. Horizontal Cable Managers

1. When more than one horizontal cable manager is used on a rack/cabinet or group of racks/cabinets, use the same make, and style of cable manager on the rack/cabinet or racks/cabinets.
2. The color of the racks and cable managers must match.
3. Attach horizontal cable managers to the rack/cabinet with four screws according to the manufacturer's installation instructions. Each cable manager should be centered within the allocated rack-mount space (RMU).
4. Horizontal managers will be located so that the number of ports (cables) they support will not exceed the cable fill capacity of the cable manager.
5. Covers should be attached to the cable manager and in the closed position after cabling is complete.

H. FIRESTOPPING

1. Comply with requirements in Division 07 Section "Penetration Firestopping."
2. General: Install through-penetration firestop systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
3. Install modular floor grid system in Telecommunications Rooms as shown on contract drawings.
4. Install EMT sleeve where horizontal cables penetrate a fire or smoke rated wall.
5. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of firestopping products.
6. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
7. Comply with BICSI TDMM, "Firestopping Systems" Article.
8. Any penetrations created for the passage of telecommunications which remains vacant at the completion of the installation shall be fire stopped.

3.7 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with requirements in division 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- C. Comply with ANSI-J-STD-607-A.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 8 AWG equipment grounding conductor.

3.8 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 16 Section "Electrical Identification."
- B. Comply with requirements in Division 9 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- destinations. Protect with rigid frame and clear plastic cover. Furnish an AutoCad electronic copy of final comprehensive schedules for Project.
- D. D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish AutoCad - latest version -electronic record of all drawings.
- E. Cable and Wire Identification:
1. Label each cable within 4 inches of each termination, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel for remote ONT power low voltage copper pairs
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building- mounted device shall be identified with name and number of particular device as shown.
 - b. Each low voltage copper pair shall designate the closet/rack/zone number and binding position on both ends of the pair.
 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.9 SOURCE QUALITY CONTROL

- A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568- B.3.
- D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- E. Cable will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.10 12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect UTP, multi-pair copper and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - 2. Visually confirm cable category marking of outlets, cover plates, outlet/connectors, and patch panels.
 - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 5. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - i) Horizontal and singlemode ISP backbone link measurements: Test at 1310 and 1490 nm in 1 direction for power test results.
 - ii) Singlemode OSP backbone link measurements: Test at 1310 and 1490 nm according to TIA/EIA-526-14-A, Method B, One Reference Jumper and OTDR testing.
 - iii) Attenuation test results for the entire channel link (OLT to ONT WAO fiber) shall not exceed 28dB and include the passive optical splitter.
 - 6. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
 - 7. Remote ONT DC powering cabling shall be tested for continuity from WAO point to either the PDU point in the zone/terminal box location or back to the closet power source. Any remote ONT powering cables that fail a continuity test shall be replaced prior to system turn up.
 - 8. Remote ONT DC powering shall be commissioned and tested with a DC power meter to receive within ranges of 44-52Vdc at the ONT with a commissioned bulk DC power source.

- a. Cables terminated into a Phoenix-style connector shall be tested on the output terminals.
 - b. Cables terminated into RJ45 8P8C connectors shall utilize a breakout adapter that bonds the appropriate positive and return pairs together prior to testing.
- C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

3.11 CLEANING

- A. At the completion of the System, restore aspects of the project site to its former condition. Remove daily waste and excess materials, rubbish debris, tools and equipment resulting from or used in the services provided under this Contract. Remove trash from all work areas. Do not use dumpsters or trash disposal without prior approval.

SECTION 27 21 00 – POL TELECOMMUNICATIONS DATA COMMUNICATIONS EQUIPMENT

1 PART 1

1.1 POL GENERAL GUIDELINES

- A. This Section defines the general design requirements for a uniform Data Communications Network Infrastructure that shall be followed for a Passive Optical LAN. This subsection is relevant when the decision is made to deploy POL. Otherwise, all applicable standards are those for an active Cat 6 active Ethernet network.

1.2 QUALITY ASSURANCES

- A. All equipment shall be UL listed.
- B. All Passive Optical LAN equipment shall be compliant with ITU G.984.x requirements and have support for ITU G.987.x offerings.
- C. The OLT components and ONT shall support the ITU G.984 OMCI specifications.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- D. The OLT and subcomponent optics must support a 30km distance reach per the ITU G.984.6 standard.

1.3 GENERAL

- A. Each facility or end user building shall be provided with a local area network (LAN)
- B. Any facilities being upgraded shall be brought up to the requirements and levels specified herein.
- C. Buildings shall be designed as to minimize the quantity of ERs and subordinate TRs and to centralize as much of the Passive Optical LAN Equipment as possible.
- D. Whenever possible, the POL OLT chassis shall be located in a remote distribution building with a secondary chassis for maximum fault tolerance located at another node. When not possible, OLT chassis shall be located as geographically diverse from each other as possible. This may include:
 - 1. OLT chassis placed on low and high floors within a single building.
 - 2. OLT chassis placed in alternate data centers within the same floor.
 - 3. OLT chassis placed within differing racks and rows of racks when placed within the same data center.
- E. Network applications that shall be designed for the POL shall include at a minimum the following:
 - 1. Access Control Management Systems (ACMS)
 - 2. Analog voice circuits (POTS)
 - 3. Building Automation Systems
 - 4. Clock systems
 - 5. Coaxial C/MATV networks
 - 6. Data networks
 - 7. Intrusion Detection Systems (IDS)
 - 8. IP Surveillance systems
 - 9. IPTV
 - 10. Patient Entertainment and Education systems
 - 11. Point of Sales (PoS) systems
 - 12. Real Time Location Systems (RTLS)
 - 13. Voice over Internet Protocol (VoIP) systems
 - 14. Video Teleconferencing (VTC) systems
 - 15. Wireless (802.11 family) controller systems and endpoints
 - 16. Paging systems
 - 17. Mass notification systems
 - 18. Distributed Antennae Systems (DAS)

1.4 POL SYSTEM REQUIREMENTS

- A. Equipment must be environmentally hardened to support 40 to +149°F
- B. Shall support Class B+ optics (28 dB optical loss budget) as defined in the ITU standards.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

- C. POL module shall support field replaceable GPON SFP modules to minimize downtime.
- D. POL equipment shall support redundant OLT Processor.
- E. POL equipment shall support redundant OLT Processor and Timing modules.
- F. POL OLT shall provide a fully redundant backplane for all communications from the switching units to the GPON cards with a minimum of 640Gbps backplane with current cards, and capability for a 2.5Tbps overall redundant backplane.
- G. POL OLT shall support layer-2 bridging functionality.
- H. POL OLT shall support up to 40 Gigabit aggregate of uplink capacity composed of four (4) 10 Gigabit Ethernet interfaces to facilitate high bandwidth ether-channels for uplink for larger chassis based platforms supporting greater than 512 ONTs.
- I. POL OLT shall support concurrent use of 10 Gigabit and 1 Gigabit Ethernet uplinks.
- J. POL OLT shall support full Link Aggregation configuration of uplink interfaces.
- K. POL OLT shall support Rapid Spanning Tree Protocol (RSTP) for redundancy on 1G and 10G network uplinks
- L. POL OLT shall support Multiple Spanning Tree Protocol (MSTP) for redundancy on 1G and 10G network uplinks
- M. POL OLT shall be available in either a 23-inch or 19-inch high density chassis.
- N. The POL platform shall support the following network protocols and services:
 - 1. Ethernet Link Aggregation Group (LAG), Rapid Spanning Tree Protocol (RSTP), Virtual Router Redundancy Protocol (VRRP) for Dual Homing, and Link Aggregation Control Protocol (LACP).
 - 2. Multiple Spanning Tree Protocol (MSTP) for multiple concurrent Dual Homing paths from the OLT.
 - 3. Industry standard Ethernet Bridging as defined in 802.1D
 - 4. Multiple VLAN per end user Ethernet interface including VLAN translation, trunking, and termination.
 - 5. IEEE 802.1q Priority Tag.
 - 6. IEEE 802.1p Q-Tag.
 - 7. VLAN Group provisioning (multiple end-user interface/service into a common VLAN Group).
 - 8. Each VLAN Group shall support provisioning of Ethernet Bridging and Private VLAN on a per port basis.
 - 9. Service-based Quality of Service (QoS) for each service VLAN using 802.1p and DSCP markings for both upstream and downstream traffic.
 - 10. IPv4 and IPv6 concurrently with all network and security features supported.

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

11. QoS through a combination of ingress policing, queue management, scheduling and shaping at the user service level.
 12. Service level traffic prioritization support combination of Round Robin (RR), and Strict Priority (SP) queuing.
 13. Private VLAN
 14. Multiple service QoS on each end user Ethernet interface.
 15. RSTP loop detection and redundancy on the ONT end user network ports.
 16. ITU G.984.x compliant "Type-B PON Protection" schemas, allowing for a 2-input PON splitter to be dual homed to geographically diverse OLT locations without requiring the ONTs to be re-provisioned or any services lost. PON Protection shall provide capability for sub 5-second of system restoration.
 17. Layer2 (Ethernet), Layer 3 (IP), Layer 4 (TCP/UDP) Access Control Lists (ACL).
 18. Multiple ACL filter profiles attached to each end user interface and service.
 19. Limiting the number of IP addresses to each user port
 20. Sticky MAC address for port security function.
 21. 802.1x authentication for port control.
 22. Dynamic VLAN.
 23. Network Access Control (NAC) integration for automatic ONT user port configuration based upon Active Directory/LDAP, 802.1x or CAC/smart card credentials.
 24. MAC Bypass (MAB)
 25. Link Layer Data Protocol (LLDP) for automatic provisioning of VoIP phones, E911, and MED/Inventory services as well as power negotiations.
 26. Guest VLAN functions via RADIUS/802.1x authentication.
 27. RADIUS interface on OLT.
 28. SYSLOG integration and monitoring.
 29. DHCP Option 82.
 30. ONT Range Locking to prohibit tampering with the ONTs.
 31. Support for POL Threshold Crossing Alarms to provide full PON utilization statistics and alarming based on certain percent utilization of a PON link and SNMP alarm notification.
 32. POL System shall not store any user data (VLANs, IPs, MACs, etc) at the ONT and shall not have any user interface (CLI, web, serial) at the ONT to permit for user login and configuration of the ONT that could result in data breaches.
- O. All ONT port shall support 10/100/1000-BaseT interfaces.
- P. All ONT ports shall support PoE and/or PoE+ across all ports.
- Q. All non-closet based ONTs shall be natively 48Vdc powered, permitting for remote ONT powering.

1.5 WARRANTY

- A. The Local Area Network Electronics and software shall be fully warranted for three (3) years from date of substantial completion by the contractor and manufacturer. If any defects are found within this warranty period, the defective system component shall be replaced at no extra cost to the Owner for parts or labor. Provide a statement of this warranty with the O&M manuals and to the Director of IT. Make

SECTION 27 10 00 - TELECOMMUNICATIONS STRUCTURED CABLING

available a service contract offering continuing factory authorized service of this system after the initial warranty period.