

SECTION 27 15 00 – COMMUNICATIONS CABLING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide a complete, tested, cable distribution system for data network system (local area network). The data distribution system shall include fully terminated fiber optic backbone and UTP station cables.
- B. Fiber Optic Cables: Fiber optical cables shall be installed from the Demarcation Point to the Main Cross-connect Frame, and from the Main Cross-connect Frame to the Intermediate Cross-connect Frame Communications Closet, terminating all fiber optic strands in termination enclosures (patch panels).
- C. UTP Cables: UTP cables shall be routed to each data outlet location.
- D. Provide specific details consistent with the contract documents as required to complete shop drawings for data cable systems including detailed documentation for Owner review and detailed documentation of as-built conditions.

1.2 APPLICABLE STANDARDS

- A. TIA/EIA-569-A: "Commercial Building Standard for Telecommunications Pathways and Spaces."
- B. TIA/EIA-568-C.2: "Commercial Building Telecommunication Standard" with all addendums.
- C. ISO/IEC 11801 Ed. 2.0 (Class E)
- D. TIA/EIA-TSB 67: "TIA/EIA Telecommunications Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted-Pair Cabling Systems."
- E. TIA/EIA-568-3: "Optical Fiber Cabling Components Standard," with all addendums.
- F. TIA/EIA-455-61: "FOTP-61, Measurement of Fiber or Cable Attenuation Using An OTDR."
- G. IEEE 802.3: "Carrier Sense Multiple Access with Collision Detection."
- H. IEEE 802.3ab: Gigabit transmission over UTP
- I. TIA/EIA-606: "Administration Standard for the Telecommunications Infrastructure of Commercial Buildings."
- J. TIA/EIA-607: "Commercial Building Grounding and Bonding Requirements for Telecommunications."
- K. TIA/EIA-455-171-D: "Standard Test Procedures for Fiber Optic Cables."
- L. TIA/EIA-4750000-B: "Generic Specification for Fiber Optic Connectors."
- M. TIA/EIA-475E000: "Sectional Specification for Fiber Optic Connectors Type BFOC/2.5."
- N. TIA/EIA-604-X: "Fiber Optic Connector Intermateability Standards (FOCIS)."

1.3 REGULATORY REQUIREMENTS

- A. All work shall be performed in accordance with the latest revisions of the following standards and codes:
 - 1. Uniform Construction Code (UCC)
 - 2. National Electrical Code (NEC)
 - 3. Standards as previously listed
 - 4. The supplied manufacturers structured cabling system installation guidelines.
- B. Governing Codes and Conflicts: If the requirements of this section or the Project Drawings exceed those of the governing codes and regulations, then the requirements of this section and the Drawings shall be construed to permit work not conforming to all governing codes and regulations.

1.4 SUBMITTALS

- A. Documentation:
 - 1. The name of the person who will act as the Contractor's official contact with the Owner/Engineer.
 - 2. A copy of an RCDD certificate from a full-time staff member.
 - 3. Complete manufacturer's product literature for all cable, patch panels, cable supports, cable labels, outlet devices, and other products to be used in the installation. Cabling and outlets must show compliance with the performance criteria specified herein. In addition, whenever substitutions for recommended products are made (pre-approved prior to bid by Owner/Engineer), samples and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included.
 - 4. Shop Drawings:
 - a. The Contractor shall submit scaled drawings of all IDF/MDF rooms with backboard layouts showing hardware frame placements and rack locations with wire management. The name/number of the room shall be included. The contractor must show dimensions for LAN network equipment.
 - b. The Contractor shall submit individual rack layouts for Owner review indicating all hardware as well as Owner furnished network electronics and servers. Coordinate with Owner network electronic and server dimensions, etc.
 - 5. Proposed TIA/EIA Category cable matching specified, and fiber optic cable test result forms. Provide complete product information on proposed meter to be used and verification that meter is acceptable for use to provide warranty as specified.
 - 6. Certifications: Contractor must be pre-certified by the manufacturers of the products that comprise a partnership guaranteeing 20-year performance. Submit copy of certifications and 20-year performance warranty. Contractor must show record of at least five (5) previous projects of this type with required warranties.
 - 7. Warranty: Warranty must guarantee all performance values in accordance with proposed TIA/EIA Category cable matching specified. The warranty shall include application assurance beyond Gigabit Ethernet and future 500MHz applications. Additional warranty must guarantee performance of the fiber optic cable.
 - 8. 3rd party certification of Channel and component compliance meet or exceeding the performance criteria herein.
- B. Labeling:
 - 1. The Contractor shall work with the Owner's IT department to verify the labeling to be used throughout the building. Once the labeling has been determined, the Contractor shall submit the labeling scheme to the Engineer for review. The submittal shall include a sign-off by the Owner's IT department.
 - 2. Racks and cabinets shall be labeled with closet designation with self-adhesive labels.

C. Rack Layouts:

1. The Contractor shall work with the Owner's IT department to verify the rack layouts to be used throughout the building. Once the layouts have been determined, the Contractor shall submit the layout drawings to the Engineer for review. The submittal shall include a sign-off by the Owner's IT department.

- D. When preparing submittals and any required final drawings/labeling, use a room number schedule generated by the architect and/or the Owner, which indicates the actual room numbers that will be used when the building is occupied. If the schedule is not available, revise the initial submittal, when a schedule is available, to reflect the proper room numbers.

1.5 FUNCTION AND OPERATION

- A. The intended function of the data communications cable system is to transmit data signals from a central location to the individual data outlet locations. Upon completion of the work outlined in this specification, the system shall be capable of transmitting data signals at a rate of 1Gbps, and future applications.
- B. The multimode optical fiber cable system shall be capable of transmitting laser signals at 10 Gigabit Ethernet (10 GbE) operating at 850 nm (10GBASE-SR) for a minimum distance as specified below (IEEE 802.3 Performance). The multimode optical fiber cable system shall also be capable of transmitting Gigabit Ethernet (GbE) operating at 850 nm (1000BASE-SX) for a distance as specified below and 1300 (1000BASE-LX) nm for a distance as specified below.
- C. The single-mode optical fiber cable system shall have a cutoff wavelength of less than 1260nm.
- D. Work station cable, from the MDF/IDF to the work area, shall be installed in accordance with TIA/EIA-568-C.2 specified installation practices, TIA/EIA-TSB-67 recommended installation practices, TIA/EIA-569, and the manufacturer specified installation practices.
- E. The Permanent Link shall be tested for TIA Category standards. Channel Manufacturer or Partners must submit 3rd party verification of category performance using "WORST CASE" 4 connector model. "Typical" or "Average" measurements will NOT be accepted.

1.6 PROJECT COMPLETION

- A. As a condition for project acceptance, the Contractor shall submit the following for review and approval:
1. Inspection and Test Reports: During the course of the Project the Contractor shall maintain an adequate inspection system and shall perform such inspections to ensure that the materials supplied and the work performed conform to Contract requirements. The Contractor shall provide written documentation which indicates materials acceptance testing was conducted as outlined Part 3 below. The Contractor shall also provide documentation which indicates that all cable termination testing was completed and that all irregularities were corrected prior to job completion for Owner/Engineer analysis.
 2. A manufacturer warranty shall be provided by the Communication Systems installer. This warranty shall include defects in material and workmanship. Warranty shall also cover applications assurance beyond 1000BaseT. The warranty period shall begin at the date of Substantial Completion. Quality and workmanship evaluation shall be solely by the Owner/Engineer and designated representatives.
- B. Acceptable Cable Tester
1. Refer to part 3 for tester information.

1.7 SYSTEM INSTALLER

- A. The Owner reserves the right to exercise its discretion to require the contractor to remove from the project any such employee of the contractor to be incompetent, careless, or insubordinate.
- B. Where applicable, the installer must be licensed and bonded in the state.
- C. Installer must have RCDD on staff as a full-time employee.
- D. Prior to bid date, the installer must be certified by the manufacturer of the cabling components he intends to use.
- E. All clean up activity related to work performed will be the responsibility of the Contractor and must be completed daily before leaving the facility.

1.8 ABBREVIATIONS AND DEFINITIONS

- A. MDF/MCF – Main Distribution Frame/Main Cross-Connect Frame.
- B. IDF/ICF – Intermediate Distribution Frame/Intermediate Cross-Connect Frame consisting of station wire terminals, riser cable terminals, and various equipment.
- C. UTP – Unshielded Twisted Pair (telecommunications station cable).

1.9 MINIMUM WARRANTY

- A. The Cabling System shall meet the performance requirements of the ANSI/TIA/EIA-568-C.2 standard and TIA/EIA Telecommunications Systems Bulletin 67. The warranty on the material, services, and operation of the cabling system to this specification must be for a period of at least 20 years.
- B. The warranty must include the following statements regarding the cabling system:
 - 1. "will support and conform to TIA/EIA-568-C.2 specifications covering ANY CURRENT OR FUTURE APPLICATION which supports transmission over a properly constructed horizontal cabling system premises network which meets the channel and/or basic link performance as described in TIA/EIA-568-C.2 and TIA/EIA TSB67 for category cable systems."
 - 2. "will be free from defects in material or faulty workmanship."
- C. Warranty must also include the fiber optic backbone for the complete warranty duration.
- D. The warranty must be provided by the hardware manufacturer and must be fully executed prior to project closeout.
- E. Individual warranties shall be provided for horizontal and backbone wiring. They shall comply with the performance specifications for each wiring system.

PART 2 - PRODUCTS

2.1 GENERAL WIRING

- A. The cabling shall be installed per requirements of these specifications utilizing materials meeting all applicable TIA/EIA standards for Category cable specified.

COMMUNICATIONS CABLING

- B. Materials shall meet the TIA/EIA 568A category specification matching specified. Must supply 3rd party verification of this performance as specified herein. In some cases, specific materials are called out to maintain a uniformity of application across all installations.
- C. All installed wire shall be tested and labeled 100% good after installation by the installer.
- D. All cabling, outlets, and termination patch panels used for the Category cable specified data system may be provided by a single manufacturer and shall be certified as part of the 20-year minimum warranty. Where the installer chooses to use one (1) manufacturer for cabling and a different manufacturer for the outlets and termination patch panels, the two (2) manufacturers must prove to have compliant interconnecting hardware and shall be certified as part of the 20-year minimum warranty. The components manufacturer shall take responsibility for the end-to-end system performance certification.
- E. All components, modules, adapters, and fittings required for a complete and first-class installation shall be provided whether or not enumerated herein. Model numbers given are meant to set a standard for performance criteria and general style of device. It is the contractor's responsibility to verify the completeness and proper fit of devices including depth and necessary cable bend radius within raceways, and compatibility of outlets in surface raceway or floor boxes before installation.
- F. All device colors shall be as per the TIA/EIA Standards and as approved by the Owner and/or Engineer before installation.
- G. All products shall be new, and brought to the job site in original manufacturer's packaging. Electrical components (including innerduct) shall bear the Underwriter's Laboratories label. All communications cable shall bear flammability testing ratings as follows:
 - 1. For Copper Cable
 - a. CM: Communications Cable
 - b. CMP: Plenum Rated Communications Cable
 - c. CMR: Riser-rated Communications Cable
 - 2. For Fiber Optic Cable
 - a. OFN: Communications
 - b. OFNP: Plenum Rated
 - c. OFNR: Riser-rated
- H. Initial Cable Inspection: The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket which would indicate possible problems. Damaged cable, or any other components failing to meet specifications shall not be used in the installation.

2.2 CATEGORY 6 HORIZONTAL CABLING

- A. Manufacturers for Category 6/ISO Class E Cable – ISO 9001 Certified
 - 1. Belden GigaFlex 4800LX
 - 2. Mohawk GigaLan
 - 3. Berk-Tek LANmark 2000
 - 4. Hitachi Supra 660
 - 5. General Cable GenSpeed 6500 Premium
 - 6. CommScope Systimax 2071 GigaSpeed XL
 - 7. Hubbell Nextspeed Cat 6 Enhanced
 - 8. Superior Essex NextGain

COMMUNICATIONS CABLING

- B. Description: Unshielded twisted pair cable, Category 6/ISO Class E, CMP listed, for use with IEEE Std. 802.3 network, and TIA/EIA-568 compliant using 4 pairs, 23/24 AWG solid copper conductors all 4 pairs FEP insulated, colored plenum rated jacket, meeting or exceeding the category 6/ISO Class E requirements, tested to at least 500MHz. Provide different color jackets for different cable systems as follows. Verify with Owner colors prior to ordering.
 - 1. CCTV = Orange
 - 2. Intercom = Green
 - 3. WAP = Yellow
 - 4. Data = Blue
- C. All 4-pair station cables shall:
 - 1. Conform to TIA/EIA-568-C.2.
 - 2. Be part of the UL LAN Certification and Follow-up Program.
 - 3. Tested and approved by ETL or similar independent testing facility.
- D. The copper cabling provided for each data outlet shall be one 4-pair UTP Category 6/ISO Class E cable per jack. For example, where multiple jacks are indicated at a single location, each jack shall have its own dedicated 4-pair UTP cable.
- E. The Category 6/ISO Class E 4-pair UTP cable, must be UL Performance Level Tested and 3rd party verified that the cable meets or exceeds these specifications.

2.3 CATEGORY 6A HORIZONTAL CABLING (Wireless access points (above ceiling jacks), and where indicated)

- A. Manufacturers - ISO 9001 Certified – must be compliant with Category 6a.
 - 1. Belden GigaFlex
 - 2. Mohawk
 - 3. Berk-Tek
 - 4. Hitachi
 - 5. General Cable
 - 6. CommScope Systimax
 - 7. Hubbell Nextspeed
 - 8. Superior Essex
- B. Description: Unshielded twisted pair cable, Category 6a, CMP listed, for use with IEEE Std. 802.3 network, and TIA/EIA-568 compliant using 4 pairs, 23 AWG solid copper conductors all 4 pairs FEP insulated, colored plenum rated jacket, meeting or exceeding the category 6a requirements, tested to at least 500MHz. Provide different color jackets for different cable systems as follows. Verify with Owner colors prior to ordering.
 - 1. CCTV = Orange
 - 2. Intercom = Green
 - 3. WAP = Yellow
 - 4. Data = Blue
- C. All 4-pair station cables shall:
 - 1. Conform to TIA/EIA-568-C.2.
 - 2. Be part of the UL LAN Certification and Follow-up Program.
 - 3. Tested and approved by ETL or similar independent testing facility.

- D. The copper cabling provided for each data outlet shall be one 4-pair UTP Category 6a cable per jack. For example, where multiple jacks are indicated at a single location, each jack shall have its own dedicated 4-pair UTP cable.
- E. The Category 6a 4-pair UTP cable, must be UL Performance Level Tested and 3rd party verified that the cable meets or exceeds these specifications.

2.4 CATEGORY 6 STATION HARDWARE (Outlets)

- A. Manufacturers for Category 6/ISO Class E Cable – ISO 9001 Certified.
 - 1. Panduit MiniCom TX-6
 - 2. Hubbell Nextspeed Xcelerator
 - 3. Ortronics Clarity TracJack
 - 4. The Siemon Company Max 6 Modules
 - 5. Leviton eXtreme
- B. Data Outlets - Category 6 modular jack with single gang 4-port angled faceplate for “gravity-feed” outlets at wall mounted locations. Provide quantity of data outlets at the locations as indicated on the drawings. Provide blank inserts for unused openings in faceplate. Flush type outlets shall be provided at floor boxes.
- C. Jacks shall be high quality Category 6/ISO Class E 8-position modular jack with mechanical stress relief for cable. Jacks shall provide dual color code to allow both T568A and T568B wiring on the same jack. Jacks shall be terminated using TIA/EIA-568-C.2 requirements for Category 6 connecting hardware. Provide four (4) termination tools.
- D. Faceplates shall match manufacturer style for modular jack outlets at all locations. Color and material (nylon or stainless steel) shall match wiring devices in the area being installed. Faceplates shall accommodate color-coded icons for different applications and a separate location for labeling.
- E. Where outlets are installed in surface raceway, jacks must be compatible with the surface raceway faceplate and the surface raceway depth. Faceplate color shall match raceway color. Where outlets are installed in floor boxes, jacks must be compatible with the floor box faceplate or mounting strap.
- F. All terminating hardware for 4-pair Category 6/ISO Class E cabling shall:
 - 1. Conform to TIA/EIA-568-C.2 - Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section.
 - 2. Be part of the UL LAN Certification and Follow-up Program.
 - 3. Meet or exceed the specifications for Category 6/ISO Class E Channel.
- G. Additional electrical and mechanical specifications are:
 - 1. Insulation resistance: 500 MW minimum.
 - 2. Dielectric withstand voltage: 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
 - 3. Contact resistance: 20 mW maximum.
 - 4. Current rating: 1.5 A at 68 deg F (20 deg C) per IEC Publication 512-3.

2.5 CATEGORY 6A STATION HARDWARE (Outlets)

- A. Manufacturers - ISO 9001 Certified - must be compliant with Category 6a.
 - 1. Panduit
 - 2. Hubbell

3. Ortronics
 4. The Siemon Company
 5. Leviton
- B. Data Outlets - Category 6a modular jack with single gang 4-port faceplate for outlets as specified for category 6 locations.
- C. Jacks shall be high quality Category 6a 8-position modular jack with mechanical stress relief for cable. Jacks shall provide dual color code to allow both T568A and T568B wiring on the same jack. Jacks shall be terminated using TIA/EIA-568-C.2 requirements for Category 6a connecting hardware.
- D. Faceplates shall match manufacturer style for modular jack outlets at all locations. Color and material (nylon or stainless steel) shall match wiring devices in the area being installed. Faceplates shall accommodate color-coded icons for different applications and a separate location for labeling.
- E. All terminating hardware for 4-pair Category 6a cabling shall:
1. Conform to TIA/EIA-568-C.2 - Commercial Building Telecommunications Cabling Standard, Horizontal Cable Section.
 2. Be part of the UL LAN Certification and Follow-up Program.
 3. Meet or exceed the specifications for Category 6a Channel.
- F. Additional electrical and mechanical specifications are:
1. Insulation resistance: 500 MW minimum.
 2. Dielectric withstand voltage: 1,000 VAC RMS, 60 Hz minimum, contact-to-contact and 1,500 VAC RMS, 60 Hz minimum from any contact to exposed conductive surface.
 3. Contact resistance: 20 mW maximum.
 4. Current rating: 1.5 A at 68 deg F (20 deg C) per IEC Publication 512-3.

2.6 CATEGORY 6 CHANNEL – PERFORMANCE REQUIREMENTS

- A. The Channel performance levels shall not be less than the minimum values shown in the following table.

Frequency MHz	Pair-To- PairNEXT Loss(dB)	Pair-To- PairELFEXT Loss(dB)	Power SumNEXT Loss(dB)	Power SumELFEXT Loss(dB)
1	80.3	73.8	78.3	70.8
10	65.3	53.8	63.3	50.8
31.25	57.9	43.9	55.9	40.9
100	50.3	33.8	48.3	30.8
200	45.8	27.7	43.8	24.7
250	44.3	25.8	42.3	22.8

- B. The Channel performance levels shall not be less than the minimum values shown in the following table.

Frequency MHz	Attenuation (dB)	Pair-To- PairACR(dB)	Power SumACR(dB)	Return Loss(dB)
1	2.0	78.5	76.5	20.0
10	5.9	60.0	58.0	25.0
31.25	10.6	48.3	46.3	23.6
100	19.7	31.6	29.6	20.1
200	28.8	18.0	16.0	18.0
250	32.6	12.7	10.7	17.3

- C. The channel performance shall be based on a 4 connector, worst pair, independently tested solution.

2.7 CATEGORY 6A CHANNEL – PERFORMANCE REQUIREMENTS

- A. The Channel performance levels shall not be less than the minimum values shown in the following table.

Frequency MHz	Pair-To- PairNEXT Loss(dB)	Pair-To- PairELFEXT Loss(dB)	Power SumNEXT Loss(dB)	Power SumELFEXT Loss(dB)
1	74.3	67.8	72.3	64.8
10	59.3	47.8	57.3	44.8
31.25	51.9	37.9	49.9	34.9
100	44.3	27.8	42.3	24.8
200	39.8	21.8	37.8	18.8
250	38.3	19.8	36.3	16.8

- B. The Channel performance levels shall not be less than the minimum values shown in the following table.

Frequency MHz	Attenuation (dB)	Pair-To- PairACR(dB)	Power SumACR(dB)	Return Loss(dB)
1	2.1	72.2	70.2	20.0
10	5.9	53.4	51.4	25.0
31.25	10.5	44.0	39.4	23.6
100	19.1	25.2	23.2	20.1
200	27.6	12.2	10.2	18.0
250	31.1	7.3	5.3	17.3

- C. The channel performance shall be based on a 4 connector, worst pair, independently tested solution.

2.8 SINGLE-MODE FIBER OPTIC CABLE SPECIFICATIONS - Indoor

- A. Manufacturers - ISO 9001 Certified

1. Berk-Tek
2. Corning Cable Systems
3. Mohawk
4. CommScope
5. General Cable
6. Superior Essex
7. Hubbell

- B. Fiber must be manufactured using Corning or Alcatel glass for 10 Gigabit Ethernet link length of 2000 meters at 1310nm.

- C. Description: Fiber Optic Cable shall be riser rated UL listed type OFNP and UL listed for indoor applications; single mode strands as indicated on the drawings, each with a color-coded PVC buffer. Provide strand counts between closets as indicated on drawings.

- D. Provide plenum rated steel or aluminum armored cable.

2.9 FIBER OPTIC CABLE TERMINATIONS

- A. Manufacturers - ISO 9001 Certified

1. Corning Cable Systems
2. Hubbell
3. CommScope

4. Leviton
5. 3M

- B. Use type ceramic LC fiber optic connectors (verify connector type with Owner prior to ordering). Coordinate connectors with the duplex connectors in the patch panels and possibly the ethernet switches. Connectors shall be ceramic.
- C. Terminate all of the fibers of the fiber optic cables. Provide all termination accessories for a complete fiber optic distribution system.

2.10 PATCH CORD ASSEMBLIES

- A. Copper patch cord assemblies must meet the requirements of the Category cable specified performance criteria, and shall be factory-manufactured in 3-foot, 5-foot, 7-foot, 10-foot, 15-foot, and 25-foot lengths. The cables shall be manufactured by the selected connectivity manufacturer.
 1. Prior to ordering, the Contractor shall verify, with the Owner, patch cord lengths for each system.
- B. Patch cords shall only be provided for contractor installed equipment including, but not limited to IP speakers, cameras, projectors, wireless access points, phones, etc. Only provide the cord at the device side. The Owner shall provide cords at the closet and for non-contractor installed items, including station outlets.
 1. Provide patch cords of sufficient length to connect the equipment to the jack.
 2. Patch cords shall be the same color as the wiring system with which it's connected

2.11 PATCH PANELS - Copper Cables

- A. Manufacturer - ISO 9001 Certified - shall match the manufacturer of the data outlets.
- B. Provide patch panels separated by system (do not mix different systems on the same patch panel), unless directed otherwise by the Owner.
- C. All patch panels shall be of the channel manufacturer or partner. The data station cables shall be terminated on modular jack patch panels with circuit board construction in all MDF/IDF locations. The patch panels shall have rolled upper and lower edges for rigidity, metal covering over PCB for protection, and shall provide front and rear side labeling visible after the cables and cords are installed. The 8-position modular jack patch panels shall be rack mounted. Provide 48 port, 2-rack unit high (single rack unit high density shall not be acceptable), and 24 port, 1-rack unit high, pre-loaded panels (T568B or T568A wired (per Owner direction), TIA/EIA-568) in quantities required for the number of data outlets.
 1. **Provide a minimum of 10% spare ports in patch panels for each system on each rack.**

2.12 PATCH PANELS - Fiber Optic Cables

- A. Manufacturer - ISO 9001 Certified - Corning Cable Systems or equivalent
- B. Provide the following at the data closets and racks. Manufacturer shall match connections to maintain system warranties.
 1. Closet connector housings shall be similar to Corning Cable Systems Part CCH-xxU for rack mount and WCH-xxU for wall mount. Provide sufficient space to allow for a minimum additional two (2) empty panel spots. Provide blank covers for unused openings.

COMMUNICATIONS CABLING

2. Connector panels similar to Corning Cable Systems Part CCH-CP12-xx shall be provided to match the fiber being specified (single-mode, multi-mode (class as indicated)). Provide panels with 6 duplex (12 total) jacks, and connect 3 duplex jacks in each panel (if 12 fibers are specified, provide two (2) panels).
 3. Fiber connections shall match those as specified in the terminations, unless noted otherwise.
- C. Provide blue color connectors for single-mode fibers.
- D. The contractor may NOT use pig-tail type connector housings and fusion splice strands in lieu of the specified.

2.13 EQUIPMENT RACKS

- A. Unless specifically addressed below, or on the drawings, provide 4-post adjustable rack in locations indicated on the drawings. Racks shall be standard 19" mounting width and 84" high. Racks shall be Chatsworth #15212-703 with #11729-703 6" wide double-sided ring type vertical cabling sections, or equivalent by B-Line, Middle Atlantic Products, Hubbell or Rittal. Cable managers shall be provided on each side of rack. Where racks are lined up, two (2) cable manager between racks shall be required so that each rack retains two (2) vertical managers. Bolt rack to floor. Verify mounting hole style and rack depth with owner prior to ordering. Provide cable managers and power strips as specified above.
- B. Where indicated, provide enclosed server rack, APC model #AR3100. Bolt to floor.
- C. Where indicated, provide open wall mounted rack. Rack shall be standard 19" mounting width by 38.5" deep by approx. 24" high. Racks shall be Chatsworth #15320-724, or equivalent by B-Line, Middle Atlantic Products, Hubbell or Rittal.
- D. Cable Manager: The cable manager shall be no more than 2RU high, fit a standard 19" rack and provided with 3" deep rings. Provide Chatsworth #11753-719. Cable managers shall be of the same manufacturer as equipment rack.
- E. Provide cable managers and patch panels in the following sequence from the top of the rack: One (1) cable management, one (1) 48-port patch panel, one (1) cable management, one (1) 48-port patch panel, etc, until completed or rack is full. Ethernet switches will be furnished and installed by the Owner below the patch panels or in the adjacent rack. Each system shall have their own patch panel(s) (system shall not share panels). All drops, and each systems hall be evenly distributed between the racks in each closet to provide additional free space. Coordinate the exact rack layout with the Owner in field.
- F. In the back of all floor mounted data racks/cabinets, provide two vertical rack mounted power strips, each with 24, 20A outlets, 1 20A circuit breaker, current monitor and 10-foot power cord with a 30A, 120V plug. Provide from Geist, Hubbell, Wiremold or Server Technology. Provide mounting brackets as required.
- G. Rack Grounding: Provide grounding kit for all racks. Rack shall be grounded using stranded #6 AWG insulated copper conductor. Provide all required bonding material and hardware and bond to building ground system. 4/0 cable, unless otherwise noted, shall be used for the grounding conductors from the MDF to the IDF and from the electric service grounding to the MDF.

2.14 VOICE OUTLETS

- A. Voice Outlet - Same as data outlets.
- B. Wall Mount Type - Hubbell Catalog No. P630SR1GJ8 or equivalent with one (1) Cat 6 RJ-45 modular jack, 8-conductor, stainless steel wall plate, and mounting screws. Verify jack compatibility with wall phone to ensure proper installation of phone.

COMMUNICATIONS CABLING

2.15 RISER CABLES - Voice Backbone

- A. Manufacturers - ISO 9001 Certified
 - 1. Mohawk/CDT Part #M58142 (25PR)
 - 2. Belden
 - 3. Essex
 - 4. Commscope
 - 5. Berk-Tek
 - 6. Avaya
- B. Description: Power Sum Backbone Cable, 25 pair, unshielded twisted pair cable, category 5e, verified to 100MHz, CMP listed, for use with IEEE Std. 802.3 network, and TIA/EIA-568-c.2 compliant using 4 pairs, 24 AWG solid copper conductors all FEP insulated, colored plenum rated jacket.
- C. Terminate riser cable in data closet on voice backbone patch panels.
- D. Where cables enter a building from the exterior, provide solid state lightning protection in building at termination location.

2.16 PATCH PANELS - For Voice Backbone

- A. Manufacturer - ISO 9001 Certified - shall match the manufacturer of the data outlets.
- B. All telco patch panels shall be of the channel manufacturer or partner and clearly identified as telco backbone. The Category 5e backbone cabling shall be terminated on Category 5e 8-position modular jack patch panels with circuit board construction in all MDF/IDF locations. The patch panels shall have rolled upper and lower edges for rigidity, metal covering over PCB for protection, and shall provide front and rear side labeling visible after the cables and cords are installed. The 8-position modular jack patch panels shall be rack mounted. Provide 24 and 48 port pre-loaded panels (T568A or T568B wired (as directed by Owner), TIA/EIA-568) in quantities required for the number of data outlets. Provide quantity of panels required to terminate all pairs of backbone cabling and terminate for voice only. Backbone cable shall be terminated with a single pair at each jack.
- C. Provide additional RJ45 patch cords to match quantity of backbone pairs in each MDF/IDF in 5-, 10- and 25-foot lengths, same certification as the data patch cords, but in a different Owner directed color to identify them as voice. Provide 1/3 in each length.
- D. Rack mount patch panels with appropriate wire management, unless noted otherwise. Where panels are to be wall mounted, provide necessary wall mount kits and provide wire management such as wire distribution spools as required to organize wiring on backboards.

2.17 PLYWOOD BACKBOARD

- A. Backboard: 3/4-inch interior, fire-rated, grade 'B' plywood furnished and installed by the electrical contractor. Provide a light-colored, fire-retardant paint to the backboard.

2.18 LABELING REQUIREMENTS

- A. Refer to Division 26 "Electrical Identification" for additional labeling requirements.

B. Cable Ties:

1. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

- a. Minimum Width: 3/16 inch.
- b. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
- c. UL 94 Flame Rating: 94V-0.
- d. Temperature Range: Minus 50 to plus 284 deg F.
- e. Color: Black.

C. Provide manufacturer jack labeling inserts, etc. at patch panels and jacks.

D. All data devices, installed by the contractor, including, but not limited to CCTV cameras, WAPs, IP speakers, etc., shall be provided with labels match jack label. Verify location of label with owner prior to adhering.

E. All labeling must be typewritten or engraved.

2.19 NETWORK ELECTRONICS

A. Network Electronics will be furnished and installed by Owner, unless noted otherwise.

B. The Owner shall furnish wireless access points to the Contractor. The Contractor shall install the access points in the rooms where directed by the Owner. The Contractor shall assume all of the wireless access jacks will receive an access point.

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor shall provide minimum 1" conduit sleeves or as indicated on the drawings above ceilings between corridors and areas where data outlets are located, and elsewhere where required to install data cabling, avoiding penetration of fire rated walls.

B. Any penetration through fire rated walls (including those in sleeves) will be resealed with an Underwriter Laboratories (UL) approved sealant. Use fire stop material as specified in Division 26 "Common Requirements – Electrical." Contractor shall also seal all floor, ceiling, and wall penetrations in fire or smoke barriers and in the wiring closets.

C. Cable Lubricants: Lubricants specifically designed for installing communications cable may be used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue.

D. Recommended Products:

1. Twisted-pair cable: Dyna-Blue, American Polywater
2. Optical fiber cable: Optic-Lube, Ideal

E. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over tightened bindings, loosely twisted and over twisted pairs at terminals, and sheath removed too far (over 2").

COMMUNICATIONS CABLING

- F. All low voltage cabling, run in walls, shall be installed in minimum 1" rigid conduit. Back boxes must be full 3.5" deep backboxes (low voltage rings shall not be acceptable). Refer to applicable Division 26 sections for additional requirements.
- G. J-Hooks:
 - 1. J-hooks shall be galvanized, comply with TIA-569-D, and be listed for the use.
 - 2. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 - 3. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 - 4. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 - 5. Space hooks no more than 5 feet (1.5 m) o.c.
 - 6. Provide a hook at each change in direction.

3.2 LABELS

- A. The labeling plan shall be developed by the Contractor and approved by Owner/Engineer. The Contractor will label all outlets following the detailed shop drawing design, using permanent/legible typed or machine engraved labels. Terminals in the data closets shall be labeled by the Contractor using designation strips as applicable to terminal hardware. All copper/fiber terminal for riser cables in the data closets shall correspond to terminal numbering in the MDF. All voice outlets will be installed together on a patch panel at the top of the racks.
- B. The labels on IDF station terminals shall be labeled in accordance with TIA/EIA standards. Outlets shall be labeled to match the labels on the corresponding terminal position. The room number component shall reflect the final room numbering system utilized for door labels or room numbers when the Owner occupies the building. **Should the actual final room numbers not be used, the contract will be required to re-label all jacks and wiring, and retest the entire system.**
- C. A floor plan clearly labeled with all outlet jack numbers shall be included in the as-built plans. Plans shall be the size of the construction documents.
 - 1. An additional copy of the floor plans, laminated, shall be posted in each data room. Plans shall be the size of the construction documents.
- D. All labels shall correspond to as-built and to final test reports.
- E. The cables themselves shall also be labeled at each end of the cable matching the labeling method.
- F. Where jacks are installed above the accessible ceiling, labels shall be applied to the T-Bar. The label shall match the jack label.
- G. All devices, installed by the contractor, including, but not limited to wireless access points, IP speakers, etc. shall receive a label with the jack information. Verify with owner, location of label (exposed, or behind device).
- H. Racks and cabinets shall be labeled with closet designation with self-adhesive labels.
- I. Where jacks are installed above ceilings, labels shall be provided on T-bar of ceiling to identify location of jack. Label shall match jack label.

3.3 WIRING INSTALLATION

- A. All copper horizontal data cables and Fiber Optic cables shall be installed by individuals trained and certified in data cable system installation.
- B. All Category (4) pair UTP cable must be handled with care during installation so as not to change performance specifications. The Contractor shall not over tighten fasteners or over bend the Category UTP cable. Creased or kinked cables will not be accepted and will be replaced. Tie wraps are NOT permitted to organize or bundle cables. Contractor must use velcro wraps to bundle cables. Velcro wraps shall be UL rated for installation above plenum ceilings.
- C. **Should the Engineer/Owner find tie wraps on cables, the contractor shall be responsible to remove the tie wraps and all cables housed within the tie wraps will be assumed to be damaged and will require replacement.**
- D. All wiring and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All wiring and associated hardware shall be placed so as to not impair the use or capacity of other building systems, equipment, or hardware placed by others (or existing).
- E. All cabling installed in ceiling areas must be supported or installed in cable tray. Cable tray will be provided by this Contractor as indicated on the drawings. Where cabling is installed in ceiling areas or other non-exposed areas without cable tray, supports shall be placed by the Contractor at random intervals no greater than 60 inches and preferably on 48-inch centers. Cable sag between supports shall not exceed 12 inches. Attaching wire to pipes or other mechanical items is not permitted. At all runs of twenty or more cables, provide J-hooks at 60-inch (maximum) centers to hang cable.
 - 1. Where cables are installed in exposed areas (exposed structure, etc.) they shall be installed in conduit. Conduit shall be sized for 40% fill, but shall be no smaller than 1". **Should any cable be installed exposed, the cable will be required to be replaced and retested at no additional cost to the Owner.**
- F. All low voltage cable shall be routed to avoid light fixtures (18 inches minimum spacing), sources of heat (12 inches minimum spacing) power feeder conduits (12 inches minimum spacing). Low voltage cabling must be spaced a minimum 120 inches (10 feet) from bus duct.
- G. Use Brandy type labels on cable ends in the data racks and in the outlet boxes.
- H. An additional minimum ten (10) foot of slack shall be provided at both ends of all cables. The slack shall be wrapped in Velcro straps supported from the steel, walls or cable tray. The cables shall not touch the ceiling.

3.4 FIBER OPTIC CABLE INSTALLATION

- A. Conduit and cable shall be installed in accordance with manufacturer's instructions and industry standards. Care shall be taken to avoid kinking the cable or applying excessive tension during the installation process.
- B. Armored type cables shall be installed in cable tray or on j-hooks.
- C. Non-armored type shall be installed in minimum 1" plenum rated innerduct, attached to cable tray or in j-hooks.

3.5 STATION HARDWARE

- A. Eight (8) position modular jack Pin Assignments:
 - 1. Pin connections for data station 8 position modular jacks and patch panels shall match TIA/EIA-568-c.2.
 - 2. Pin connections at data jacks and panels shall be TIA 568A or 568B as directed by the Owner.

3.6 BACKBOARD CABLING/EQUIPMENT RACK CONFIGURATION

- A. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, ventilation mixing boxes, network equipment mounting, access hatches to air filters, switches or electrical panels, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty at a later time by maintaining a working distance from these openings. Provide a minimum of 36 inches for a service loop to the patch panel.
- B. Cable shall be routed as close as possible to the ceiling, floor, or corners to ensure that adequate wall or backboard space is available for current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. Minimum bend radius shall be observed.
- C. Lay cables via the shortest route directly to the nearest edge of the backboard from the mounted equipment or block. Lace or tie-clamp all similarly routed cables together, and attach by means of clamps screwed to the outside edge(s) of the backboard vertically and/or horizontally, then route via "square" corners over a path that will offer minimum obstruction to future installations of equipment, backboards, or other cables.
- D. Do not over tighten cable ties or binding on data station cable. Observe data cabling bend radius, and IEEE and NEC conduit fill ratios (40%).
- E. Use cable tray or runway to support cables from walls to rack or crossing the data closets.

3.7 CABLE TESTING

- A. This contractor shall submit to the Owner/Engineer the proposed testing procedure and testing report form. The test report shall include the test equipment operator's name, date, time, test equipment manufacturer's name, model number, and software version.
- B. The Owner/Engineer shall be notified one week prior to any testing so that the testing may be witnessed.
- C. Before requesting a final inspection, the Contractor shall perform a series of end-to-end installation performance tests. The Contractor shall submit for approval a proposal describing the industry standard test procedures, test result forms, and timetable for fiber optic and all copper plant wiring.
- D. Acceptance of the sample test procedures discussed below is predicated on the Contractor's use of the recommended products (including but not limited to twisted pair cable, patch panels, and outlet devices specified in the Products paragraph) and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.
- E. Test Criteria: The system shall be tested to Category Level III compliance matching specified cable. The test path shall include workstation jacks, station cables, patch panels, and adapter cables. Test shall be performed with a MicroTest Omniscanner, Fluke, or equivalent product. Tester must have minimum dynamic range of 87dB and scan to at least 400MHz.

- F. The Contractor shall test:
 - 1. All station drop cable pairs from termination patch panels to outlet device 8 position modular jacks.
 - 2. All backbone cabling.
- G. Each wire/pair shall be tested at both ends for the following up to 400MHz in accordance to Category cable specified:
 - 1. Termination order
 - 2. Polarity (pair reversals)
 - 3. Continuity
 - 4. Shorts
 - 5. Grounds
 - 6. Power-Sum NEXT (near end cross talk) from both directions
 - 7. Cable length (record all length)
 - 8. Attenuation
 - 9. Power-Sum Return Loss
 - 10. Power-Sum ELFEXT from both directions
 - 11. Impedance
- H. When errors are found, the source of each error shall be determined, corrected, and the cable re-tested. All defective components shall be replaced and retested. Defective components not corrected shall be reported to the Owner/Engineer with explanations of the corrective actions attempted.
- I. Test records shall be maintained using the test results forms outlined below. The form shall record closet number, riser pair number or outlet ID, outcome of test, indication of errors found (e.g., a, b, c, d, or e) cable length, re-test results after problem resolution and signature of the technician completing the tests.
- J. Test results for each (4) pair UTP cable must be submitted with identification to match labels on all patch panel ports and 8 position modular jacks, and identification to match as-builts associated with that cable.
- K. Owner will observe and verify the accuracy of test results submitted, and reserves the right to randomly check any connection prior to acceptance.
- L. The results of the work station cable tests shall be provided in the form of print-outs from the test equipment and USB disk with PDFs.

3.8 FIBER OPTIC TESTING SPECIFICATIONS

- A. Each fiber strand shall undergo bi-directional testing for signal attenuation, and connector and splice losses. In addition to the attenuation testing, provide OTDR signature trace testing and documentation by computer file or print out for each fiber strand.
- B. Test Equipment: Light Source and Level III Power Meter manufactured by Microtest (Certifiber), Wavetek, or Fluke. Utilize additional modules and equipment to provide specified OTDR signature trace in addition to the signal attenuation and loss tests.
- C. Test Criteria: Connector loss shall not exceed 0.75 dB per termination.
- D. All testing shall be performed by trained personnel.
- E. All installed fiber optic cable EIA 455-171 Method D procedures will be adhered to. (Bi-directional)
- F. For single-mode fiber, the maximum attenuation for the fiber optic cable shall not exceed 1dB per kilometer tested at 1310 nm and 1550 nm.

COMMUNICATIONS CABLING

- G. The contractor is responsible for obtaining minimum loss in fiber connections and polishing per manufacturer's specifications.
- H. All single-mode fibers shall be tested for continuity and attenuation in both directions at 1310nm with a fiber optic light source and power meter. Before beginning test, the contractor shall submit to the Engineer/Owner a design fiber optic loss budget for the segment to be tested, based upon the length of the fiber optic cable installed. When tested at both windows in both directions, the measured attenuation of each fiber optic cable segment shall be less than or equal to the design attenuation of the segment being tested. Until this condition has been met, the installation shall not be considered complete and will not be accepted.
- I. While the specified OTDR signature trace is not required for manufacturer warranty acceptance, it will be used to ensure the fiber did not sustain any kinks or hits during installation that might allow for an approved acceptance test, but will create problems for ancillary systems other than data transfer. Should an anomaly be present in the testing in any of the fibers, the cable will be required to be removed and replaced with a new cable. Fusion splices in new cables without prior written approval from the Engineer/Owner shall not be acceptable.

3.9 DOCUMENTATION

- A. Contractor shall provide documentation to include test results and as-built drawings.
- B. Fiber Test Results: The results of the fiber testing shall be recorded on a form entitled "Fiber Attenuation and OTDR Test Results." Results shall be in digital format and printed hard copies. Electronic copies are required with date/time stamping, circuit identification, and Pass/Fail listing.
- C. As-built drawing showing data outlets (with labels) of area served by each data closet shall be laminated and attached a wall in each respective data closet. Coordinate location in field with Engineer and Owner.

3.10 ACCEPTANCE

- A. Acceptance of the Data Network System shall be based on the results of testing, functionality, and the receipt of documentation. With regard to testing, all fiber segments and all copper cables must meet the criteria established above. With regard to functionality, Contractor must demonstrate to Owner that 1000BaseT data signals can be successfully transmitted, bi-directionally, from the MDF to and from some number of individual data outlets by using OmniScanner testing IEEE 802.3ab for 1000BaseT. The number of outlet locations to be tested shall be determined by Owner/Engineer. With regard to documentation, all required documentation shall be submitted to Owner/Engineer.
- B. The backbone cable shall also be tested for functionality to the Owner for 10 GbE.

END OF SECTION 27 15 00