

SECTION 27 10 00
STRUCTURED CABLING

PART 1 GENERAL

1.01 DESCRIPTION

- A. This document describes the product and execution requirements related to furnishing and installing the Structured Cabling System as shown on the Drawings and specified herein.

1.02 SCOPE OF WORK

- A. The Structured Cabling Contractor (SCC) shall provide a complete Structured Cabling System (SCS) as defined in this section.
- B. As described elsewhere in these Documents the system consists of fiber optic and copper cabling, and related hardware. In addition to the basic cable plant requirements, the testing and identification requirements are also defined. Finally, racks, enclosures and other related hardware are indicated herein.
- C. The installation shall be of an "Open System," using standard media and layout, standard connections and interfaces. The Contractor shall adhere to this Specification, local and national codes and provide quality workmanship.
- D. This section includes:
1. Main Telecommunications Room (MTR)
 2. Telecommunications Room (TR)
 3. Racks, Enclosures and Cable management
 4. Ladder Rack
 5. Rack mounted surge suppressor
 6. Lightning Protector
 7. Backbone cabling
 8. Horizontal cabling
 9. Consolidation Points
 10. MTR and TR connections
 - a. Patch Panels
 - b. Fiber enclosures
 11. Work Area outlets
 - a. Faceplates
 - b. Connectors (jacks)
 12. Work Area Extensions to Device
 13. Hangers and Supports
- E. The components used on this project for voice, data, and CATV shall be as identified in Part 2 of this Section.
- F. Unless noted otherwise on the Drawings, for all 4 pair Category cable, this project shall use T568B termination for eight (8) position jack pair assignments as specified per the ANSI/TIA 568-C wiring standard. For fiber, follow ANSI/TIA 568-C.3, Optical Fiber Cabling Components Standard, and its published addenda.

- G. All continuous pathways (i.e., conduit, cable tray, raceway, etc.) required to support the cabling shall be provided by the Electrical Contractor under Division 26 unless indicated otherwise in the Contract Documents.
 - 1. All non-continuous or non-rigid pathways (i.e., J-hooks, inner-duct, etc.) required to support the cabling shall be provided by the SCC under the Structured Cabling System, unless indicated otherwise in the Contract Documents.
 - 2. All ladder rack, cable tray, and related pathway hardware built into Telecommunications Spaces shall be provided by the SCC.
- H. The SCC shall be responsible for providing the racks and enclosures as required and specified herein.
- I. The SCC shall test and label the entire installation as specified and required by the codes and standards.
- J. The SCC shall be responsible for providing the hangers and support system specified herein and shown on the Drawings.
- K. Final sizing and location of J-hooks, hangers, and supports shall be the responsibility of the Contractor. However, NO increases to the bid price and/or the schedule extension shall be allowed due to equipment alterations.
- L. For new installations, J-hooks fill capacity shall not exceed 70% of its rated cable fill capacity (i.e., if J-bracket is rated for 100 cables, no more than 70 shall be installed).
- M. J-hooks are intended for voice, data, video, audio, and security cables only. They are intended for cable routing in areas of less than 100 Category 6 cables. All other low voltage cabling systems, such as building controls, shall have cabling run-ins separate raceway system.
- N. All hangers and support material shall be galvanized or stainless steel, rust free material.
- O. The Telecommunications Contractor shall ensure that the General Contractor and Painting Contractor acknowledge that the painting or over spray of any single or group of 4 pair horizontal telecommunications Category cable is not allowed. Any painted or over sprayed cable(s) shall be completely removed and replaced at the Painting Contractor's expense. No in-line connectors, splices, taps or other repairs will be permitted. Painted cable will not be covered as part of an extended warranty. Painted cable obscures the print legend and can alter the cable's mechanical properties and fire rating. Painted cable compromises its integrity and/or performance. It may act as an accelerant or create an additional smoke hazard in the event of a fire and as such this is considered a life safety issue. Paint contamination and/or removing paint from the cable with a solvent can affect the cable's durability and its electrical characteristics.

1.03 QUALIFICATIONS

- A. The SCC must meet the following requirements to be approved for this project. He/she shall meet the following qualifications and provide the information, as listed, in the submittal package:

1. Must be a member of Building Industry Consulting Service International (BICSI) or Engineer approved, other Telecommunications Organization, and shall have at least five (5) years' experience installing Telecommunications Cabling and Equipment.
 2. Supply a list of a minimum of five (5) projects over \$100,000 that the firm has completed along with contact names and phone numbers of the Owners' Representatives for those projects. At least three (3) of the completed facilities shall have been occupied and in full operation for at least one (1) year.
 3. The SCC shall be a certified installer for the connectivity and cabling solution specified for this project and maintain that status with the warranting manufacturer, including all training requirements, for the duration of the cable infrastructure project.
 4. The SCC shall have, as a direct employee, a minimum of one (1) RCDD on staff. The RCDD must be a full-time employee of the company and must be listed with the company on the BICSI Credential Holder website. This individual shall review all submittals, RFIs, change order proposals, as-built documents, and shall provide system engineering support and oversight of all field work to ensure system installation is fully compliant with all requirements of ANSI/TIA-568-C, ANSI/TIA-569-D, and all associated TSBs, ANSI/TIA-606-B, labeling, and ANSI/TIA-607, bonding and grounding, including all addenda.
 5. The SCC's RCDD shall stamp all test results included in the Record and Information Manual and the final (field marked) As-Built Drawings, as being correct and accurate, that are included in the Record and Information Manual.
 6. It is the intent of this contract for the Contractor to provide sole responsibility for material, labor, and service for the communication cabling system. The Contractor shall, at a minimum, staff the project with BICSI certified installers for project foremen and crew leader positions.
 7. The SCC must own or have a current lease agreement for equipment to test up to Category 6a and fiber optic cable. He/she shall supply proof as required above in the submittal package, including latest calibration date.
- B. At the time of bid form submission, the SCC shall submit the following information:
1. The SCC's manufacturer certifications for:
 - a. Twisted pair cabling
 - b. Fiber optic cabling
 - c. Connectivity
 2. The RCDD's BICSI certification. Refer to SCC's Qualifications below.
 3. A listing of the like projects within the last three (3) years. Refer to SCC's Qualifications below.
- C. During the bid review, the SCC may be asked to provide any/or all of the following:
1. A listing of the probable team members
 2. BICSI and manufacturer certifications for the installation of the Structured Cable Plant.
 3. Certifications for the installation for any firestopping required under the scope of the Structured Cable Plant installation.
- D. Any/all items listed in paragraph 1.03 subparagraph B.1 or B.2, can and will be checked for authenticity and accuracy. The Owner reserves the right to reject any unauthorized or inaccurate submissions.
- E. Should the SCC either fail or refuse to provide any of the items listed and/or requested in paragraph 1.03 subparagraph B.1 or B.2, the Owner reserves the right to determine the SCC as being not fully responsive and as such discard the bid in its entirety.

1.04 SUBMITTALS

- A. Product Data Sheets
 - 1. All products
 - 2. Copies of all certifications
- B. Shop Drawings
 - 1. The SCC shall submit the following shop drawings:
 - a. A detailed riser diagram demonstrating the SCC's understanding of the backbone cabling.
 - b. Drawings of any floor boxes with details of the various internal faceplates and their respective contents.
 - c. Drawings of any through floor fittings with details of their contents.
 - d. Layout drawings for cable tray and cable runway (1/16" scale minimum) based on trade coordination efforts indicating anticipated routings based on the coordination among the various trades.

PART 2 PRODUCTS

2.01 MAIN TELECOMMUNICATIONS ROOM/DEMARC (MTR)

- A. The SCC shall provide plywood backboard as shown on the Drawings. If the Drawings do not indicate where or how much plywood is to be installed, Contractor shall provide, as a minimum, two (2) walls covered by 3/4 inch x 4 feet x 8 feet fire retardant plywood, painted industrial gray with two (2) coats of fire retardant paint. Plywood shall be AC grade or better and void-free with Grade A surface exposed. To reduce warping, plywood shall be kiln-dried to a maximum moisture content of 15%.
 - 1. Fire retardant plywood shall be securely fastened to wall such that it can and will support equipment to be mounted. Additionally, it shall be mounted such that the 8 feet is vertical. Unless otherwise noted, bottom of plywood shall be mounted 8 inches AFF.
 - 2. Contractor shall cover with masking tape the "Fire Retardant" stamp on the plywood, before painting, and remove tape after painting, so that the inspector can still see the original "Fire Retardant" stamp on the plywood.
 - 3. Cut out plywood around all wiring devices.
- B. The SCC shall provide all equipment required and/or shown on the Drawings to make MTR a safe and usable room for the Structured Cabling System.
- C. For fiber optic cable entering from outside or from another TR coil, provide 30 feet of slack on re-closeable storage ring before routing cable to rack for termination in rack mounted fiber panel using LC connectors (unless otherwise noted).
- D. Terminate copper station cable coming from TRs or work areas in a standard 19 inch data rack, rack mounted patch panel with 110 type punch down terminations located close to incoming protector unit.
- E. Terminate incoming coaxial cable on backboard. Terminate coax station cable coming from TRs or work area on same backboards with "F" connectors.

- F. Install racks, cable management, enclosures, patch panels, ladder racks, cables, and other equipment required in MTR as shown on Drawings. If no equipment location is indicated, coordinate rack and equipment location with Owner before installing equipment.
- G. Provide MTR with ladder racking or wire mesh cable tray as shown on Drawings. Fasten ladder racking or cable tray to data racks.
- H. Provide grounding and bonding as specified in Section 26 05 27, "Telecommunications Bonding Infrastructure."
- I. Provide "D" rings for cable routing support on backboards, for feeding cables up or down from ladder rack and/or floor.

2.02 TELECOMMUNICATIONS ROOM (TR)

- A. The SCC shall provide plywood backboard as shown on the Drawings. If the Drawings do not indicate where or how much plywood is to be installed, Contractor shall provide, as a minimum, each TR with at least two (2) walls covered by 3/4 inch x 4 feet x 8 feet fire retardant plywood, painted industrial gray with two (2) coats of fire retardant paint. Plywood shall be AC grade or better and void-free with Grade A surface exposed. To reduce warping, plywood shall be kiln-dried to a maximum moisture content of 15%.
 1. Fire retardant plywood shall be securely fastened to wall such that it can and will support equipment to be mounted. Additionally, it shall be mounted such that the 8 feet is vertical. Unless otherwise noted, bottom of plywood shall be mounted 8 inches AFF.
 2. Contractor shall cover with masking tape the "Fire Retardant" stamp on the plywood, before painting, and remove tape after painting so that the Inspector can still see the original "Fire Retardant" stamp on the plywood.
 3. Cut out plywood around all wiring devices.
- B. The SCC shall provide all equipment shown on the Drawings or as required to make TRs safe and usable for the structured cabling system.
- C. For fiber optic cable entering from another TR coil, provide 30 feet of slack on re-closeable storage ring before routing cable to rack for termination in rack mounted fiber panel using LC connectors.
- D. For copper station cable, terminate in a rack mounted patch panel with 110 type punch down termination.
- E. For coaxial station cable, terminate on "F" connectors in designated backboard area.
- F. For audio/video cable, terminate in the audio/video rack as required by the equipment using the proper connectors.
- G. Install racks, cable management, enclosures, patch panels, ladder racks, cables, and other equipment required in TR as shown on Drawings. If no location is indicated, coordinate with Owner before installing equipment.
- H. Provide TR ladder racking or wire mesh cable tray as shown on Drawings. Fasten to data racks.

- I. Provide grounding and bonding as specified in Section 26 05 27, "Telecommunications Bonding Infrastructure."
- J. Provide "D" rings for cable routing support on backboards, for feeding cables up or down from ladder rack and/or floor.

2.03 RACKS, ENCLOSURES, AND CABLE MANAGEMENT

- A. Two post network equipment racks nominal 19 inches
 1. Manufactured from extruded aluminum. Finish shall be flat black, post dimensions to be 84" tall x 20" wide x 3" deep with anchor plates at the top and bottom.
 2. Free standing data rack, 45RMU
 3. Floor anchored with minimum of four (4) floor anchors, anchor top of rack to either ladder racking / cable tray above rack or to backboard using angle iron or unistrut
 4. Minimum load rating for rack shall be 1,000 lbs. weight capacity
 5. EIA/ECA-310-E compliant, double sided universal mounting holes #12-24, supply minimum of twenty-four (24) #12-24 mounting screws
 6. Approved manufacturer Chatsworth #48353-703
 - a. Equivalents by Belden, B-line, Hoffman, Great Lakes, Ortronics, and Panduit
- B. Four post network equipment racks nominal 19 inches, adjustable depth
 1. Manufactured from extruded aluminum. Finish shall be flat black, post dimensions to be 84" tall x 20" wide with anchor plates at the top and bottom.
 2. Free standing data rack, 45RMU
 3. Floor anchored with minimum of four (4) floor anchors, anchor top of rack to either ladder racking above rack or to backboard using angle iron or unistrut
 4. Minimum load rating for rack shall be 1,000 lbs. weight capacity
 5. EIA/ECA-310-E compliant, double sided universal mounting holes #12-24, supply minimum of twenty-four (24) #12-24 mounting screws
 6. Approved manufacturer Chatsworth #1521X-703
 - a. Equivalents by Belden, B-line, Hoffman, Great Lakes, Ortronics, and Panduit
- C. Wall Mount Enclosure nominal 19 inches
 1. Manufactured from 14-gauge steel. Finish shall be flat black powder coat, post dimensions to be 24" tall x 21.5" wide x 24.5" deep.
 2. Wall mounted data rack, 12RMU
 3. Lockable solid steel front door.
 4. Dust resistance kit.
 5. Vented sides for airflow.
 6. Reversible cabinet for left and right-hand swing-out.
 7. EIA/ECA-310-E compliant, double sided universal mounting holes #12-24, supply minimum of twenty-four (24) #12-24 mounting screws
 8. Approved manufacturer Great Lakes GL24WMS
 - a. Equivalents by Belden, Chatsworth, Hoffman, Ortronics, and Panduit
- D. Vertical Cable Management
 1. The vertical cable manager nominal height shall match the height of the rack(s)/frame(s).
 2. The vertical cable manager shall bolt to the side of racks/frames with included hardware.
 3. The cable manager shall be sized to match cabling requirements. Maximum cable fill shall be calculated by dividing 50% of the usable area within the cable manager by the area of a single cable.

4. A single vertical cable manager may be used in between bayed racks/frames if it is sized to match cable requirements for both racks/frames.
 5. The double-sided vertical cable manager shall be a double-sided H-shaped trough with a front door and a rear door. The double-sided trough shall provide independent front and rear cable pathways. The front and rear sides of the cable manager shall have T-shaped cable guides separated by openings that align with each U space on the rack. The middle of the managers shall be mostly open to allow easy cable pass-through. Three movable mid-sections shall allow attachment of cable management accessories inside the cable manager.
 - a. Double-Sided Vertical Cable Manager, 80.5" High (minimum) x 4" Wide x 16.4" Deep (minimum), black.
 - b. Double-Sided Vertical Cable Manager, 80.5" High (minimum) x 6" Wide x 16.6" Deep (minimum), black.
 - c. Double-Sided Vertical Cable Manager, 80.5" High (minimum) x 10" Wide x 17.5" Deep (minimum), black.
 - d. Double-Sided Vertical Cable Manager, 80.5" High (minimum) x 12" Wide x 17.8" Deep (minimum), black.
 6. Approved manufacturers:
 - a. Belden
 - b. Chatsworth
 - c. Great Lakes
 - d. Ortronics
 - e. Panduit
 7. Basis of Design - 4 inches wide vertical cable manager: Chatsworth Velocity #13911-703
 8. Basis of Design - 6 inches wide vertical cable manager: Chatsworth Velocity #13912-703
 9. Basis of Design - 10 inches wide vertical cable manager: Chatsworth Velocity #13914-703
 10. Basis of Design - 12 inches wide vertical cable manager: Chatsworth Velocity #13915-703
- E. Horizontal Cable Management
1. Units shall be 1U to 3U construction.
 2. Units shall be single sided.
 3. Units shall have covers that have a dual hinge technology.
 4. Access into and out of the top and bottom of the Management shall be finger type construction.
 5. Approved manufacturers:
 - a. Belden
 - b. Chatsworth
 - c. Great Lakes
 - d. Ortronics
 - e. Panduit
 6. Basis of Design – 1U horizontal vertical cable manager: Chatsworth #30139-719
 7. Basis of Design – 2U horizontal vertical cable manager: Chatsworth #30130-719
 8. Basis of Design – 3U horizontal vertical cable manager: Chatsworth #30131-719

2.04 LADDER RACK

- A. Ladder rack shall be manufactured from tubular steel. Stringers (side rails) shall be 1.5 inches deep. Maximum fill is equivalent to TIA recommended maximum fill of 6 inches deep. Provide accessory cable retaining posts if cable fill height exceeds 2 inches. Where cable retaining posts are used, they shall be 8 inches high and shall attach to the side stringer of the ladder rack with included hardware. The top of the cable retaining posts shall be fitted with a rubberized end cap to protect cables.
- B. Unless otherwise noted on the Drawings, ladder rack width shall be 18 inches with cross member (rung) spacing on 9 inch centers.
- C. All cross members shall be welded into position for maximum strength and electrical continuity of elements. No cross members shall protrude below side members that would interfere with supporting structures.
- D. All straight sections shall be provided in standard 10 foot nominal sections.
- E. Provide a method of splicing ladder rack sections and fabricated turns together end-to-end or side-to-end to form a continuous pathway.
- F. Vertical-to-horizontal and horizontal-to-vertical 90-degree turns shall be provided as required
- G. Ladder rack supports shall be of the trapeze type. Supports shall be sized to match the width of the ladder rack that is supported. Support design shall allow the support to be placed under the ladder rack at any point mid-span, but not under a ladder rack splice.
- H. All ladder rack elbows, tees, and cross fittings shall be furnished in a radius of 12, 24, or 36 inches in 30, 45, 60, or 90 degrees of arc as necessary to meet the National Electrical Code and BICSI bending radius limitations of cables to be installed in the trays. Using straight runs with radius corner brackets is also acceptable.
- I. Dropouts shall be aluminum sheets with round radius attached to either side stringer or cross member to permit cable exit out of bottom of cable tray. Where cable exits or enters the side of overhead ladder rack to access a rack, frame, cabinet or wall-mounted rack, cabinet or termination field, a radius drop shall be used to guide the cable.
- J. End caps shall be provided to cover the ends of the ladder rack. End caps shall be manufactured from a black fire-retardant rubberized material.
- K. 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 3/4 inch wide, and sized for cable bundles that are 2 inches, 3 inches, or 4 inches in diameter.
- L. Unless otherwise noted, finish on all metal components shall be black epoxy-polyester hybrid powder coat.
- M. Separate different cable media types within the ladder rack pathway. Treat each type of cable media separately when determining cable fill limits.

- N. Provide touch-up paint color-matched to the finish on the component and correct any minor cosmetic damage (chips, small scratches, etc.) resulting from normal handling during the installation process prior to delivery to the Owner. If a component is cosmetically damaged to the extent that correction in the field is obvious against the factory finish, 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.
- O. Approved manufacturer: Chatsworth Universal Cable Runway
 - 1. Equivalents by Belden Runway Products, Great Lakes, Middle Atlantic, Panduit, and Snake Tray.

2.05 RACK MOUNTED SURGE SUPPRESSOR

- A. For all wall-mounted enclosures less than 4 feet in height, provide horizontal rack mounted power strip with surge protection and six NEMA 5-20R outlets. Basis of design is CPI 12816-707 with equivalents by APC, Belden, Geist, Panduit, or Tripp-Lite.
- B. For all other equipment racks and enclosures, provide two (2) vertical rack mounted power strip with surge protection and 14 NEMA 5-20R outlets. Basis of design is CPI 12850-706 with equivalents by APC, Belden, Geist, Panduit, or Tripp-Lite.

2.06 LIGHTNING PROTECTOR

- A. Provide one Telecom Building Entrance Terminal, sized for the number of pairs entering the building, at the demark to cover incoming and outgoing connections.
 - 1. Units shall utilize 110 blocks for both input and output.
 - 2. Units shall comply with UL 497.
 - 3. Units shall be powder epoxy coated.
 - 4. Units shall utilize a five pin socket for devices.
- B. Acceptable Manufacturer and Model
 - 1. Circa 1880ECA1 series (25, 50, 100), with C3B1S solid state protector modules.
 - 2. Equivalent by Siemon, Panduit or Porta Systems.

2.07 BACKBONE CABLING

- A. The SCC shall provide all backbone cabling system as shown on the Drawings and as required to make a complete installation (both copper and fiber).
- B. Outside Plant, Copper Cable
 - 1. Approved cable manufacturers for PE 89 type, 50/100/300 multi-pair cable:
 - a. Superior Essex
 - b. General
 - c. Omni Cable
 - 2. Approved cable manufacturers for Category 5e, UTP, 25 pair:
 - a. Belden
 - b. Mohawk
 - c. Superior Essex

- C. Outside Plant, Fiber Optical Cable shall be indoor/outdoor or outside plant "tight buffer" type cable. All fiber not installed in conduit must be armored or installed in inner duct.
 - 1. Strand count shall be as shown on the Drawings.
 - 2. Cable shall be single-mode and/or minimum OM3 50/125-micron multimode cable unless otherwise shown on the Drawings.
 - 3. Fiber must be protected from moisture with a moisture resistant jacket and a filling of water blocking material.
 - 4. Approved cable manufacturers:
 - a. Belden
 - b. BerkTek
 - c. CommScope
 - d. Corning
 - e. Mohawk
 - f. Panduit
 - g. Superior Essex
 - h. TCS

- D. Outside Plant, coaxial cable shall be hard line cable/coax size as shown on the Drawings.
 - 1. Approved cable manufacturers:
 - a. CommScope

- E. Inside Plant, Copper Cable
 - 1. Approved cable manufacturers for 25/50/100 multi-pair Category 3 copper plenum cable:
 - a. Belden
 - b. BerkTek
 - c. CommScope
 - d. Mohawk
 - e. Superior Essex
 - 2. Approved cable manufacturers for 25 PR Category 5e, UTP plenum cable:
 - a. Belden
 - b. BerkTek
 - c. CommScope
 - d. Mohawk
 - e. Superior Essex

- F. Inside Plant, fiber optical cable shall be tight buffer type plenum rated armored cable.
 - 1. Strand count shall be as shown on the Drawings.
 - 2. Cable shall be single-mode and/or OM3 50/125-micron multimode cable as shown on the Drawings.
 - 3. Approved cable manufacturers:
 - a. Belden
 - b. BerkTek
 - c. CommScope
 - d. Corning
 - e. Mohawk
 - f. Panduit
 - g. Superior Essex
 - h. TCS

- G. Inside Plant, coaxial cable shall be RG11 or 0.5" hardline, size as shown on the Drawings.

1. Approved cable manufacturers:
 - a. Belden
 - b. CommScope
 - c. West Penn

2.08 HORIZONTAL CABLING

- A. Copper Station Cabling from the TR to the work area jack shall be:
 1. Category 6, UTP, 4 pair, plenum rated approved manufacturers:
 - a. Belden 3613
 - b. BerkTek LANmark 1000
 - c. Mohawk AdvanceNet
 - d. Panduit PUP6004
 - e. Superior Essex DataGain Cat 6+
 2. Category 6a, UTP, 4 pair, plenum rated approved manufacturers:
 - a. Belden 10GXS13
 - b. BerkTek LANmark 10G2
 - c. Mohawk GigaLAN 10 Reduced Diameter
 - d. Panduit PUP6AV04
 - e. Superior Essex 10GainXP
 3. Category 6, UTP, 4 pair, OSP rated approved manufacturers:
 - a. Belden OSP6U 0101000
 - b. BerkTek LANmark 6 OSP UTP
 - c. Mohawk LAN-Trak 6 OSP M57622
 - d. Panduit PUO6C04
 - e. Superior Essex CMR/CMX Cat 6
 4. Coaxial cable, RG11 or RG6, plenum rated approved cable manufacturers:
 - a. Belden
 - b. CommScope
 - c. West Penn
- B. Fiber optical station cabling from the TR shall be terminated on LC connectors mounted in fiber duplex jack modules.
- C. Cabling for wireless access point shall be two Category 6a cables with a 25 foot figure 8 service loop for each AP (unless otherwise noted).
- D. Cabling for CCTV indoor Cameras shall be one Category 6 cable with a 10 foot figure 8 service loop for each camera (unless otherwise noted). Contractor may use a direct connect plug for the cameras, but the contractor must use a “modified single connector permanent link” test to test the cable run. The manufacturer must supply a warranty for the direct connect link. Examples: Belden REVConnect RJ45 Plug, Legrand High Performance Cat 6 RJ45 Modular Plug, Leviton Atlas X1 plus patch cord, and Panduit mini-com direct attachment plug FP6X88MTG.
- E. Paging speaker cable shall be 18 AWG UTP single pair cable as shown on Drawings.
 1. Approved cable manufacturers:
 - a. Belden
 - b. CommScope
 - c. West Penn
 - d. General

- F. Program speaker cable shall be 14 AWG UTP single pair cable as shown on Drawings.
 - 1. Approved cable manufacturers:
 - a. Belden
 - b. CommScope
 - c. West Penn
 - d. General

2.09 MTR AND TR CONNECTIONS

- A. Patch panels for Category 6 cables shall be:
 - 1. Belden Category 6 KeyConnect 6+
 - 2. Leviton eXtreme 6+
 - 3. Ortronics Category 6
 - 4. Panduit Cat 6 PanNet
- B. Patch panel for Category 6a cables shall be:
 - 1. Belden Category 6A KeyConnect 10GX
 - 2. Leviton eXtreme 6a
 - 3. Ortronics Category 6a
 - 4. Panduit Cat 6 PanNet
- C. Patch panel shall be standard or modular type punchdown patch panels.
- D. Fiber Patch Panels shall be LC connectors mounted in fiber duplex jack modules.
 - 1. Belden Fiber - FX UHD
 - 2. Leviton Opt-X Ultra
 - 3. Ortronics 1U Fiber Patch/Splice
 - 4. Panduit OptiCom
 - 5. TCS 1U Fiber Patch/Splice

2.10 CONSOLIDATION POINTS

- A. Wiring blocks for consolidation points shall be 110-style by Belden, Leviton, Ortronics, or Panduit.
- B. Passive, plenum-rated 2' x 2' telecommunications enclosures for consolidation points shall be Leviton Z1000-PC2 or equivalents by Belden, Ortronics, or Panduit.

2.11 WORK AREA OUTLETS

- A. Work area faceplates for flush devices in interior partitions shall be stainless steel.
- B. Work area faceplates for flush devices on concrete block walls shall match others but be "Jumbo" plates.
- C. Work area jacks for Category 6 cables shall be:
 - 1. Belden Category 6+ KeyConnect 6+
 - 2. Leviton eXtreme 6+
 - 3. Ortronics Category 6
 - 4. Panduit CJ688TGxx

- D. Work area jacks for Category 6a cables shall be:
 1. Belden Category 6a KeyConnect 10GX
 2. Leviton eXtreme 6a
 3. Ortronics Category 6a
 4. Panduit CJ688TGxx

- E. Wall Phone Plate, stainless steel, single gang, one-port shall be:
 1. Belden AX104230
 2. Leviton eXtreme 6+
 3. Ortronics Category 6
 4. Panduit KWP6PY

- F. Wireless 2-port surface mount box for connection shall be Leviton 41089-2WP or equivalents by Belden, Ortronics, or Panduit.

2.12 WORK AREA EXTENSIONS TO DEVICE

- A. Patch Cords shall be manufactured and supplied by the manufacturer of the connectivity and shall be rated for the same performance specifications as the cabling and connectivity being utilized. These cords shall be small diameter type patch cords, 24 to 28 AWG stranded conductors.

- B. Unless otherwise indicated on the Drawings, the Contractor shall provide two cables for each work area outlet data jack (one for work area outlet and one for TR) and one cable for each wall phone jack (for TR only). Of the cables provided, the Contractor shall supply 50% of the cables as 3 feet (1 meter) and 50% as 10 feet (3 meters). Refer to the Technology Drawings for any specific quantities and lengths that may override these criteria. Category 6a patch cords shall be used for category 6a connectivity.

- C. Unless otherwise noted, mounting and installing of work area equipment such as computers, phones printers, etc. are not part of the SCC's scope of work under this Specification.

2.13 HANGERS AND SUPPORTS

- A. J-Hooks
 1. J-hooks shall be at least 1 inch hook size, minimum.
 2. J-hooks shall not be over 4 inch hook size (for locations requiring 100 4-PR Category 6 cables or more, use basket tray).
 3. J-hooks shall be manufactured from Spring Steel. Securable to wall, beam, threaded rod, unistrut, or pipe.
 4. May utilize multi-tier configuration.
 5. J-hooks shall have no sharp edges.
 6. Approved J-Hook Manufacturers:
 - a. Cooper B-Line J-hook
 - b. ERICO, type Cable Cat 21 and 32
 - c. Mag Daddy
 - d. Panduit J-Pro Series
 - e. Or Engineer approved equivalent

- B. Threaded Rods

1. Threaded rod is to be attached to building steel in a permanent manner. Minimum size of threaded rod shall be 3/8.
2. Threaded rods are to be used for J-hook support where required.
3. When used for wire basket or cable tray support, use threaded rods with a hanger trapeze kit or unistrut to form a trapeze type support for the wire basket or cable tray.

PART 3 EXECUTION

3.01 DOCUMENTS

- A. Prepare and supply documents required. See "TESTING" below.

3.02 BACKBONE CABLING INSTALLATION

- A. The SCC shall provide labor, supervision, and materials as required for a complete installation of the backbone cabling system which includes, but is not limited to, the cabling to and from the MTR and to the TR, pulling, supporting, terminating, labeling and testing.
- B. Vertical cable runs shall be supported by split cable grip every 20 vertical feet.

3.03 MTR INSTALLATION

- A. The SCC shall provide labor, supervision, and materials as required for a complete installation of the MTR and cabling.
- B. The SCC shall route incoming cables to proper location by means of ladder racking, cable tray, and/or backboard. Cable shall be routed neatly (vertical/horizontal) with some slack before termination at the proper location.

3.04 TR INSTALLATION

- A. The SCC shall provide labor, supervision, and materials as required for a complete installation of the TR cabling and cabling going to and from the TR.
- B. The SCC shall route incoming cables to proper location by means of ladder racking, cable tray, and/or backboard. Cable shall be routed neatly (vertical/horizontal) with some slack before termination at the proper location.

3.05 HORIZONTAL CABLING INSTALLATION

- A. The SCC shall provide labor, supervision, and materials as required for a complete installation of the horizontal cabling system that includes, but is not limited to, cabling from the TR to the work area, pulling, supporting, terminating, labeling, and testing.
- B. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
- C. Where transition points or consolidation points are allowed, they shall be located in accessible locations and housed in an enclosure intended and suitable for the purpose.

- D. Each consolidation point (CP) shall serve a maximum of 12 work areas and shall be installed with a minimum of 25% spare terminations. No more than one CP shall be placed in each permanent link. CPs shall be located in fully accessible and permanent locations, a minimum of 50 feet from the TR or MTR.
- E. When CPs are installed in a suspended ceiling or access floor space, the ceiling or floor tile locations should be clearly and permanently marked and identified as containing a CP.
- F. Exception to ANSI/TIA 568-C distance limitations for horizontal category 6 cables. Extending Ethernet and POE Ethernet cabling distances beyond the 100 meter limit is permitted using Ethernet extenders for devices such as CCTV cameras, wireless access points, and IP blue light telephones. The cable must be tested to the extender manufacturer's specifications. Only use this exception where noted on the drawings.

3.06 WORK AREA INSTALLATION

- A. The SCC shall provide labor, supervision, and materials as required for a complete installation of work area that includes, but is not limited to, terminating cable, placing the jacks and modules, faceplates, labeling and testing.
- B. Upon completion of the project, the SCC shall clean work area and leave ready for move-in. He/she shall remove all marks, fingerprints, trash, and other debris from area.

3.07 HANGERS AND SUPPORTS INSTALLATION

- A. Hangers and supports for ladder rack and cable tray shall be supported every 5 feet or less in accordance with ANSI/TIA-569-D. Ladder rack and cable tray shall be supported within 2 feet of every splice and within 2 feet on both/all sides of every intersection. Support ladder rack and cable tray within 2 feet on both sides of every change in elevation. Support ladder rack every 2 feet when attached vertically to a wall.
- B. Threaded rod for support of hooks and/or trays shall be permanently fastened to structural steel.
- C. J-hooks shall be securely fastened to wall, steel, or pipe and shall not be spaced more than 4 feet on center.
- D. Contractor should install cable to be independently supported by approved cable tray or hanger and support products specified in this section. Avoid draping cable to be in contact and supported by other trades' products such as ductwork, sprinkler piping, plumbing, ceiling tile, etc.

3.08 WORK

- A. The SCC shall furnish all materials, labor, and supervision required to install and put into service the structured cabling system specified and shown on the Drawings.
- B. The SCC shall be aware that they must coordinate their work with other trades and lack of access to the job site does not relieve them of the responsibility to complete the work as scheduled.

- C. The SCC shall furnish sufficient manpower and resources to finish the project when scheduled for completion. If required, the SCC will work their crew overtime to meet the completion schedule with no additional compensation.
- D. All work shall be done in a professional manner; equipment installed vertical and horizontal; cables pulled neat and aligned, but allowing slack; cables bundled, but no tie wraps shall be used; use hook and loop straps loosely, do not tighten cable bundle.
- E. All conduits pull boxes, junction boxes, AP enclosures, cables, jacks, modules and other devices shall be labeled.

3.09 CABLE ROUTING

- A. The SCC shall avoid electromagnetic interference (EMI) by routing all structured cabling a minimum of:
 - 1. 4 feet from 480 volt motors and transformers
 - 2. 12 inches from electrical power distribution cables
 - 3. 6 inches from fluorescent lighting
- B. Horizontal cable shall not exceed 90 meters.
- C. Conduits shall have no more than an equivalent of two (2) 90 degree bends allowed in any single run between junction boxes.

3.10 TESTING

- A. The SCC shall provide a copy of the unaltered certification test reports to the Engineer in both hardcopy and electronic format. The Contractor shall also provide a copy of the associated Cable Tester's Database Management Software with unedited soft copy.
- B. Upon completion of the balanced twisted-pair cable installation, the SCC shall perform copper cable certification tests on the complete channel for every cable, included but not limited to:
 - 1. Wire map
 - 2. Length
 - 3. Attenuation
 - 4. Near End Cross Talk (NEXT)
 - 5. Attenuation to Crosstalk Ratio (ACR-F)
 - 6. Propagation Delay and Delay Skew
 - 7. Return Loss
 - 8. Power Sum Near End Cross Talk (PSNEXT)
 - 9. Power Sum Equal Level Far End Cross Talk (PSELFEXT)
 - 10. Insertion Loss
- C. Test shall be performed to published standards, including but not limited to, the latest revisions of ANSI/TIA 568-C, ISO/IEC 11802 and other applicable standards at the time of installation.
- D. All UTP/ScTP field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided to the Engineer for review prior to the start of testing.

- E. All Category 6 permanent links are qualified for linear transmission performance up to 250 MHz and all Category 6a permanent links are qualified for linear transmission performance up to 500 MHz to ensure that high frequency voltage phase and magnitude contributions do not prove cumulative or adversely affect channel performance.
- F. Upon completion of the coaxial cable installation, the SCC shall perform cable certification tests on every cable including, but not limited to:
 - 1. Direct current loop resistance
 - 2. Impedance
 - 3. Length
 - 4. TDR
 - 5. Noise
- G. Upon completion of the fiber optic cable installation, the SCC shall perform optical time domain reflectometer (OTDR) testing and optical loss testing with a light source power meter on every cable.
- H. In addition to any specific tests mentioned here, the SCC shall perform all required testing and documentation to obtain a fully certified installation from the manufacturer.
- I. As may be required for extended applications warranties by the manufacturer, the manufacturer shall provide site inspection services of the installation in completed and/or in progress. The SCC shall make all necessary arrangements for such site visits.
- J. Upon completion of all installation, termination and testing, the SCC shall review the entire installation with the Engineer and, at the discretion of the Owner, the Owner's authorized representative. At the time of this review, the Contractor shall present the hard copies of all unadulterated test results. The Engineer and Owner will review these test results, assess the installation, and return a written letter of acceptance to the Contractor for the Structured Cabling System.

3.11 WARRANTY

- A. The SCC shall provide a minimum twenty (20) year extended Product and Applications Warranty on parts and labor from the Connectivity Manufacturers (certified Contractor Program).

END OF SECTION