

## SECTION 271000 - STRUCTURED CABLING SYSTEM

## PART 1 - GENERAL

## 1.1 SCOPE OF WORK

- A. General: Telecommunications Drawings apply to work of this section. The overall and detailed Structured Cabling System (SCS) design shown on the drawings, selected materials, device locations, installation details, mounting details, cabling routing and supporting and all technical specifications if provided on the drawings apply to work of this section.
- B. General: Furnish, install, test and certify complete with all accessories an ANSI/TIA 568C CAT6 SCS with a minimum 25 year performance warranty for the entire system from the manufacturers and a minimum of 3 years warranty for materials and labor from the SCS installer for all components not covered under the manufacturer's 25 year warranty. The goal of the project is to provide an enhanced SCS that shall serve as a vehicle for the transport of voice telephony, data, audio, video, security and low voltage devices for building controls and management, throughout the building and from building to building from designated demarcation points to outlets located at various desk, workstation and other locations as indicated in the contract drawings.
- C. Alternate: Provide an alternate price for ANSI/TIA 568C CAT6A SCS that meets the same criteria for performance warranty and manufacturer's warranty as stated above.
- D. Coordination with other trades: It is the responsibility of the installer of the SCS to verify and advise the installer of the raceway infrastructure (conduit, boxes, cable tray, in ground boxes, etc.) for this system on raceway routing to minimize the wiring distances to the telecommunication room. When J-hooks are acceptable for the use in structured cabling system, all J-hooks and supports for these devices shall be in the scope of work of the SCS installer.
- E. All patching and cross connect to owner provided equipment shall be included under the scope of work of this project.
- F. During the execution of the work, all required relocation, demolition, temporary connections, rerouting, etc., of existing cabling, equipment and systems in the existing building areas where the work is required, shall be performed by the SCS installer, as indicated on the drawings, or as required by job conditions and as determined by the Architect in the field, to facilitate the installation of the new systems. The Owner shall require continuous operation of the existing systems, while demolition, relocation work or new tie-ins are performed.
- G. WAP installation. The scope of work includes the installation of the Wireless Access Points (WAPs) provided by the owner. The scope includes the labor and installation materials (supports, anchors, etc.) to properly fasten the WAPs to the structure.

## 1.2 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section
- B. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section:

SECTION	TITLE
1. 270010	TECHNOLOGY GENERAL PROVISIONS
2. 270528	RACEWAYS FOR TECHNOLOGY
3. 270526	GROUNDING & BONDING FOR TELECOMMUNICATIONS SYSTEMS

- C. Owner standards: Comply with the document "Requirements for all Communication Cabling at Clients name" prepared by the Clients applicable office.
- D. Standards: All work related to the SCS shall be in compliance with the following industry codes and standards latest edition:
  1. ANSI/TIA-568.0-D "Generic Telecommunications Cabling for Customer Premises" with addendums and errata.
  2. ANSI/TIA-568.1-D, "Commercial Building Telecommunications Cabling Standard" with addendums and errata.
  3. ANSI/TIA-568-C.2, "Balanced Twisted- Pair Cabling Components Standard" with addendums and errata.
  4. ANSI/TIA-568.3-D, "Optical Fiber Cabling Component Standard" with addendums and errata.
  5. ANSI/TIA-569-D, "Telecommunications Pathways and Spaces" with addendums and errata.
  6. ANSI/TIA-606-C, "Administration Standard for Telecommunications Infrastructure" with addendum and errata.
  7. ANSI/TIA-607-C, "Generic Telecommunications Bonding and Grounding (earthing) for Customer Premises" with addendum and errata.
  8. ANSI/NECA/BICSI 607-2011, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
  9. ANSI/TIA 758-B, " Customer-Owned Outside Plant Telecommunications Infrastructure Standard" with addendum and errata
  10. ANSI/TIA 862-B, "Structured Cabling Infrastructure Standard for Intelligent Building Systems" with addendum and errata.
  11. ANSI/TIA-1152-A, "Requirements for Field Test Instruments and Measurement for Balanced Twisted Pair Cabling" with addendum and errata.
  12. ANSI/TIA-526-7-A, "Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant".
  13. ANSI/TIA-526-14-C, "Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant".
  14. TIA-598-C, Optical Fiber Cable color coding. .
  15. IEC/TR3 61000-5-2 - Ed. 1.0 and amendments. "Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling"

16. ANSI/TIA-942-B , “Telecommunications Infrastructure Standard for Data Centers” with addendum and errata
17. ANSI/BICSI 002-2014, Data Center Design and Implementation Best Practices
18. ANSI/NFPA 70 “National Electrical Code”, CSA C22.1.
19. BICSI Telecommunications Distribution Methods Manual (TDMM)
20. BICSI Telecommunications Cabling Installation Manual (TCIM)
21. BICSI Customer Owned Outside Plant Manual (COOPM)
22. Local County/City Codes, Ordinances and Regulations.
23. Underwriters Laboratories (UL)
24. FCC -Federal Communications Commission
25. ADA Requirements
26. Occupational Safety and Health Regulations (OSHA)
27. National Fire Protection Association (NFPA)
28. ANSI/TIA-1179, Healthcare Facility Telecommunications Infrastructure Standards
29. Florida Statutes and Administrative Rules
30. Manufacturers Product Cabling Catalogs
31. Manufacturers Training Manuals (Design and Installation).

- E. General: Installation practices for SCS as describe herein take precedence over any other section in the construction documents set.

### 1.3 STRUCTURED CABLING SYSTEM INSTALLER QUALIFICATIONS

- A. General: The installer selected for the project must be certified by the manufacturers of the products, adhere to the engineering, installation and testing procedures and utilize the authorized manufacturers components and distribution channels in provisioning the Project.
- B. General: The installer directly responsible for this work shall be a Structured Cabling System (SCS) Installer who is, and who has been, regularly engaged in the providing and installation of commercial and industrial telecommunications wiring systems of this type and size for at least the immediate past five years. Any other company working for the SCS installer of this system shall have the same training and certification as the SCS installer.
- C. Certification: The SCS installer’s Project Manager shall possess a current and in Good Standings BICSI Registered Communications Distribution Designer (RCDD®) certificate. All shop drawings submitted by the SCS Installer shall bear the RCDD's stamp.
- D. The SCS Installer shall have a (BICSI) RCDD on Staff. Third party RCDD’s shall not be acceptable.
- E. The Installer team leader assigned for the project shall be BICSI registered Level II installer or proven and qualified equal.
- F. Experience: The SCS Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The SCS Installer shall own and maintain tools and equipment necessary for successful installation and testing of SCS and have personnel who are adequately trained in the use of such tools and equipment. The Owner or

engineer may elect to request submittal of additional financial, operational and administrative information of the SCS installer to demonstrate the required experience.

- G. The SCS Installer shall possess a State of Florida Low Voltage License.
- H. The SCS Installer shall maintain a permanent office within 150 miles of the project site.

#### 1.4 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. SCS Installer shall follow all requirements for materials alternates and substitutions indicated in specification section 270010.
- B. Substitutions are only allowed for the SCS when the substitutions do not change the warranty of the SCS system as indicated in this specification section

#### 1.5 SHOP DRAWINGS AND SUBMITTALS.

- A. See additional requirements for shop drawings and submittals in specification section 270010.
- B. Proposal Submittals: The SCS Installer shall submit the following information with the proposal to execute the work:
  - 1. A list of five (5) recently completed projects of similar type and size with contact names and telephone numbers for each.
  - 2. A list of test equipment proposed for use in verifying the integrity of the installed SCS. Test equipment list shall include manufacturer part number, serial numbers and a copy of the last calibration report done by the manufacturer of the equipment of the unit, indicating the date when the calibration was done. Calibrations shall not be older than one year. Test equipment includes, cable certifiers, OTDRs, fiber splicers, etc.
  - 3. A technical resume of experience for the installer's engineer/RCDD and on-site foreman who will be assigned to the project, including RCDD license number.
  - 4. Similar documentation for any company working for the SCS Installers who will assist in the performance of this work.
  - 5. A copy of a current and valid Low voltage License for the State of Florida.
  - 6. Location of office from which installation and warranty work will be performed.
- C. Construction submittals: Once all proposal submittals have been received and approved by the Architect and Engineer (A&E) of the project, the SCS Installer shall provide all construction submittals. Construction submittals are composed of the following items.
  - 1. Manufacturer's cut sheets for all proposed equipment as described in Part 2 of this specification section. Cut sheets shall bear the printed logo or trademark of the manufacturer for each type of product being provided. Mark each copy of the cut sheets for the specific product being provided with an identifying mark, arrow, or highlighting.

2. Faceplate color selection.
  3. Detail explanation of the labeling scheme to be used for all components of the system. This explanation shall include examples of all types of labels to be used, like labels for cables, patch panels, outlet jacks, etc.
  4. Autocad® or Revit drawings in sheets matching the size of the design documents with the following information:
    - a. Floor plans with all outlets in the project. All outlets shall have the label to be used during identification and tagging process described in this specification section.
    - b. Enlarged telecommunication rooms with all equipment components and rack layouts for each room. All racks shall have the label to be used during identification and tagging process described in this specification section.
    - c. Drawings indicating rack elevations for all cabinets or racks in the project, identifying the precise quantity of patch panels, fiber distribution centers and wire managers and accurate RU heights based on equipment selection. All equipment shall have the label to be used during the identification and tagging process described in this specification section.
    - d. A spreadsheet indicating all patch cords (fiber and copper) to be provided in the project. The spreadsheet shall indicate the quantity, color of the jacket, cable type, length and connector termination on each side.
- D. Construction submittals received before proposal submittals are received or approved will be rejected.

## 1.6 ABBREVIATIONS

- A. General: The following abbreviations are used in this specification section:
1. A&E - Architect and Engineer. The Architect is the legal entity that holds a contract for the design the project. The Engineer is the consulting engineer firm or engineer of record for the project who prepared this specification.
  2. APC - Angle physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
  3. Array connector - a multi-strand fiber connector user for high density applications, such as the MPO connector
  4. BICSI - Building Industry Consultant Services International
  5. CCTV - Close circuit television system (surveillance video system)
  6. FCC - Federal Communications Commission.
  7. FTP - Foiled Twisted pair. One foiled screen around each cable pair.
  8. IDC - Insulation Displacement Connector
  9. NEC - National Electrical Code.®
  10. NEMA - National Electrical Manufacturers Association.
  11. OM1 - ISO 11801 designation for multimode 62.5/125µm glass fiber optics.
  12. OM2 - ISO 11801 designation for multimode 50/125µm glass fiber optics.
  13. OM3 - ISO 11801 designation for multimode laser optimized 50/125µm glass fiber optics.
  14. OM4 - TIA designation for multimode laser optimized 50/125µm glass fiber optics in compliance with TIA-492-AAAD.

15. OS1 - ISO 11801 designation for single mode 9/125 $\mu$ m glass fiber optics.
16. OS2 - ISO 11801 designation for single mode 9/125 $\mu$ m glass fiber optic with performance criteria identical to ITU-T G652.
17. OTDR - Optical Time Domain Reflectometer.
18. RU - Rack units. Height dimension for rack mounted equipment. 1 RU equivalent to 1.75".
19. SCS - Structured Cabling System
20. ScTP - Screened twisted pair. One foiled screen around all cable pairs
21. TIA - Telecommunications Industry Association.
22. TR - Telecommunications Room.
23. UPC - Ultra physical contact connector. Reference to the polish style of the ferrule in fiber optic connectors.
24. UTP - Unshielded twisted Pair
25. UV - Ultra violet
26. VAC - Volts alternating current.

## PART 2 - PRODUCTS

### 2.1 MODULAR SCS JACKS

- A. Structured cabling system outlets indicated in design drawings are composed of modular SCS jacks, mounted in a faceplate on an electrical box. Modular SCS jacks shall be 8-pin modules (RJ-45) that meet or exceed the following electrical and mechanical specifications:
  1. Electrical Specifications:
    - a. Insulation resistance: 500 M $\Omega$  minimum.
    - b. 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.
    - c. Contact resistance: 20 M  $\Omega$  maximum.
    - d. Current rating: 1.5 A at 68 ° F (20 ° C) per IEC publication 512-3, Test 5b
    - e. ISO 9001 Certified Manufacturer
    - f. UL verified for EIA/TIA electrical performance
    - g. Comply with FCC Part 68
    - h. Cable termination: IDC type universal T568A or T568B.
  2. Mechanical Performance:
    - a. Plug Insertion Life: 750 insertions
    - b. Contact Force: 3.5 oz (99.2 g) minimum using FCC-Approved modular plug.
    - c. Plug Retention Force: 30 lb (133 N) minimum between modular plug and jack.
    - d. Temperature Range: -40° to 150°F (-40 ° to 66 ° C)

- B. Design selection: modular SCS jacks shall be selected according to the following criteria:
  - 1. Performance requirement: CAT6
  - 2. Style: Rear loading
  - 3. Mounting orientation: straight mounting
  - 4. Color: To match faceplate
  - 5. Dust cover required: No
- C. Approved manufacturer: Ortronics, Panduit, Siemon, CommScope, Belden, Leviton or Hubbell.

## 2.2 FIELD TERMINATABLE 8 POSITION MODULAR PLUG

- A. When indicated in the design drawings to use Direct Attach connection for any field devices, field terminatable 8 positions modular plugs shall be used. This devices shall be 8-pin modules (RJ-45) plugs that meet or exceed the following electrical and mechanical specifications:
  - 1. General Specifications:
    - a. Shall include an IDC type of termination for the cable. Crimp type terminations not acceptable.
    - b. Shall support cable gauges from 22 to 26 AWG
    - c. Shall include a rubber boot
  - 2. Electrical Specifications:
    - a. ISO 9001 Certified Manufacturer
    - b. UL verified for EIA/TIA electrical performance
    - c. Comply with FCC Part 68
    - d. Cable termination: IDC type universal T568A or T568B.
- B. Design selection: modular SCS jacks shall be selected according to the following criteria:
  - 1. Performance requirement: Match performance of Modular SCS jacks
  - 2. Color of RJ-45 jack shall match the cable color code
- C. Approved manufacturer: Match selection for modular SCS jacks.

## 2.3 OTHER MODULAR JACKS

- A. Whenever indicated in the design drawings SCS outlets could have terminations for other media types like fiber optic cables, coaxial cables or audio cables. Whenever those type of media are identified in the drawings, the following specifications shall be meet for modular jacks mounted in SCS outlets:
  - 1. Style, mounting orientation and color: match design selection for modular SCS jacks.

2. Broadband distribution system connector: Use modular jack with F connector bulkhead rated at 75Ω.
3. Fiber optic connectors: use modular jack with adapter plate for LC duplex connector.

B. Approved manufacturer: Match selection for modular SCS jacks.

## 2.4 FACEPLATES

A. Faceplates shall be used for all flush mounted telecommunication outlets to house modular jacks. Faceplates shall have the following specifications:

1. Construction material: High impact thermo Plastic
2. Size: use single gang faceplates only unless specifically noted in the design drawings.
3. Capacity of modular jacks per faceplate: faceplate shall be selected as to accommodate the amount of cables in each telecommunication outlet. No more than one unused opening shall be present on each faceplate.
4. Color: submit color to A&E for approval.
5. Labels: faceplate shall have two (2) recesses for labels, top and bottom, and shall have transparent label snap-on covers.
6. Faceplate style: Direct modular plug rear loading style

B. All faceplates shall have a tamper resistant cover to access the modular jacks

C. Approved manufacturer: Match selection for modular SCS jacks.

## 2.5 FACEPLATES WITH SUPPORT STUDS

A. Telecommunication outlets indicated in the design drawings as to be wall mounted telephone outlets shall be composed of one modular SCS jack and one faceplate with support studs mounted on an electric box. Faceplates with support studs shall have the following specifications:

1. Construction material: Stainless Steel.
2. Size: use single gang faceplate with two support studs.
3. Capacity of modular jacks per faceplate: One.
4. Faceplate style: Direct modular plug rear loading style.

B. Approved manufacturer: Match selection for modular SCS jacks.

## 2.6 SURFACE MOUNTED BOXES

A. Telecommunication outlets indicated in the design drawings as to be surface mounted outlets shall be composed of modular jacks mounted in a surface mounted box inside an electrical enclosure. Surface mounted boxes shall have the following specifications:

1. Construction material: High impact thermo Plastic.

2. Capacity of modular jacks per surface mounted box: size of surface mounted box shall be selected as to accommodate the amount of cables in the surface mounted telecommunication outlet. No more than one unused opening shall be present on each box.
  3. Color: White.
  4. Labels: surface mounted boxes shall have at least one (1) recess for labels, and shall have transparent label snap-on covers
- B. Approved manufacturer: Match selection for modular SCS jacks.

## 2.7 MOUNTING FRAMES

- A. All telecommunication outlets shall be properly mounted in the electrical raceway system provided for the outlet. The SCS installer shall select the proper mounting frame and/or bezel to mount the modular plugs in the raceway system. Raceway systems include furniture systems, floor boxes, poke-thrus, power poles, surface raceways system, etc.
- B. Whenever design drawings indicate a telecommunication outlet to be mounted in a furniture system the SCS Installer shall select the proper mounting frame to hold the modular jacks in the furniture system selected by the owner. Color of the mounting frames shall match the color of the furniture system.
- C. If owner provided furniture system does not have a raceway system for telecommunication, and design drawings indicate outlet to be mounted in the furniture system, SCS installer shall provide a plastic surface mounted box that allows the mounting of the modular plugs in a standard telecommunication faceplate.
- D. SCS installer shall provide all mounting frames and bezels to mount modular jacks inside floor boxes or poke-thrus.
- E. All un-used ports in mounting frames shall be covered with blank inserts.
- F. Approved manufacturer: Match selection for modular SCS jacks.

## 2.8 HORIZONTAL 4-PAIR CABLE

- A. General: Horizontal 4-pair cables shall be extended between the telecommunications outlet location and its associated equipment inside the TR. The cable shall consist of 4 pair cable solid copper conductors, certified to the specified performance standard. All horizontal 4-pair cables shall be terminated in modular jacks and patch panels with IDC type connectors and shall have the following specifications:
1. Cable Gauge: minimum 23 AWG
  2. Performance standard: TIA/EIA CAT6
  3. Cable type: UTP
  4. Performance characterized to: 250 MHz
  5. Time delay skew: Maximum 45 ns/100m
  6. Input impedance (1-100MHz): 100Ω
  7. Cable diameter: ≤ 0.295 inch

- B. Cable jacket colors for 4-pair horizontal cables shall be:
  - 1. Collier County Sheriff's Office (CCSO): Green
  - 2. Clerk: Orange
  - 3. Public Defender (PD): White
  - 4. States Attorney: Yellow
  - 5. Collier County (BCC): Blue
  - 6. Court Admin (AOC): Purple
- C. Performance verification: All performance of horizontal 4-pair cable shall be verified by a Nationally Recognized Testing Laboratory (NRTL) for EIA/TIA electrical performance and comply with FCC Part 68.
- D. Jacket: Cable jacket for inside premise cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.
- E. OSP Jackets: All horizontal 4-pair cables run in conduits below the floor slab shall have a water resistant flooding compound and a jacket made of UV resistant polyethylene. Cables with PVC jackets are not acceptable for this application.
- F. Jacket marking: All horizontal 4-pair cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- G. Approved manufacturer: Corning, Superior Essex, Belden, Panduit, Siemon, CommScope General Cable, Hubbell, or Berk-Tek.

## 2.9 PATCH PANELS FOR HORIZONTAL CABLING

- A. All 4-pair horizontal cables shall be terminated in rack mounted path panel located in the telecommunication room's rack. These patch panels shall have the following specifications.
  - 1. Connector type: 8-position modular plug (RJ-45)
  - 2. Cable termination: IDC type universal T568A or T568B.
  - 3. Performance requirement: CAT6
  - 4. Maximum connectors per path panel allowed: 48
  - 5. Patch panel shape: straight (flat)
  - 6. Permanent marking: All connectors shall be labeled in sequential numbers
  - 7. Field labels: patch panels shall have a space for field labels covered with transparent protectors.
  - 8. Shielding: use shielded patch panels only with ScTP cable.
- B. Approved manufacturers. Match selection for modular SCS jacks

## 2.10 HORIZONTAL WIRE MANAGERS

- A. Horizontal wire managers shall be mounted in racks to route cables from patch panels to vertical wire managers and to equipment. Horizontal wire managers shall have the following specification:

1. Style: Finger duct style with hinged cover multiple rings finger duct style with removable cover
2. Sides: front of rack front and back of rack
3. Minimum height: two RU, four RU

B. Approved manufacturers. Match selection for modular SCS jacks.

#### 2.11 CROSS OVER WIRE MANAGERS

A. Cross over wire managers shall be used to route patch cables from the right vertical wire manager to the left vertical wire manager or between racks. Cross over wire managers shall have the following specification:

1. Style: six port finger spacing with a cover
2. Sides: front of rack
3. Minimum height: Four RU

B. Approved manufacturers. Match selection for modular SCS jacks

#### 2.12 FOUR (4) PAIR PATCH CORDS

A. Four (4) pair patch cords are required at the work area side and at the patch panel side to complete the connectivity path to the equipment. All 4-pair patch cords shall be factory tested and shall have molded boots to the cable jacket. Field made patch cords are not acceptable. Four pair patch cords shall have the following specifications:

1. Connectors: 8-pin modular plugs at both ends
2. Conductors: 4-pair stranded conductors.
3. Wire gauge: 23AWG for patch cords in the field site and 28 AWG for patch cords in the telecom room side
4. Wiring map: See section 3 of this specification
5. Performance requirement: To match horizontal 4-pair cable performance
6. Cable type: UTP

B. Provide one patch cord for each work area outlet and patch panel port installed.

C. Follow cable color code for patch cord jacket color.

D. Approved manufacturers. Match selection for modular SCS jacks

#### 2.13 SINGLE STRAND FIBER OPTICS CONNECTORS

A. All fiber optic cables (horizontal or backbone cables) shall be terminated on fiber optic connectors at both ends of the cable with either single strand fiber optic connectors or array connectors. Single strand fiber optic connector shall be compliant with industry standard ANSI/TIA-568-C.3 and the applicable TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA 604 series. Single strand fiber optic connectors shall have the following specification:

1. Physical contact type: use UPC type connector.
  2. Connector type: Duplex LC
  3. Security level: non-keyed connector
  4. Pairing style: duplex
  5. Acceptable connector attachment types:
    - a. Epoxy type connectors, field polished
    - b. Fusion spliced pig tail with factory polished connector. Mechanical splices for pig tails are not acceptable.
  6. Fiber type: SCS installer shall select the connector according to the fiber type where connector will be installed. As an example use OM1 connectors only in OM1 fiber optic cables.
  7. Fusion spliced pig tails. When using fusion spliced pig tails the SCS installer shall make sure the fiber type of the pig tail and the actual cable have the same optical characteristics, such as back scatter, core diameter, etc.
  8. Ferrule construction: use ceramic ferrule connectors only, plastic ferrules are not acceptable.
- B. All single strand fiber optic connectors shall include boots to protect the fiber optic cable. The SCS installer shall select the boot according to the fiber optic type selected. As an example use 900µm boots in 900µm coated fiber, use 250µm boots on 250µm coated fiber and use 2mm boots on 2mm jacketed fiber. All boots shall be color coded to identify the type of fiber connector used. Boots shall be beige for OM1 fiber, black for OM2, aqua for OM3 and OM4 or green.
- C. Single strand multimode fiber optic connectors shall have the following performance requirements:
1. The maximum insertion loss shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
  2. Connector reflectance shall be less than or equal to -26 dB when installed in accordance with the manufacturer's recommended procedure.
  3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.
  4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.
- D. Single strand single mode fiber optic connectors shall have the following performance requirements:
1. Maximum insertion loss shall be 0.75 dB per each mated connector pair when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171.
  2. Connector reflectance shall be less than or equal to -40 dB (UPC) when installed in accordance with the manufacturer's recommended procedure.
  3. Connectors shall sustain a minimum of 500 mating cycles without violating specifications.

4. Connectors shall have an optical axial pull strength of 2.2 N (0.5lbf) at 90° angle, with a maximum 0.5 dB increase in attenuation for both tests when tested in accordance with ANSI/EIA/TIA-455-6B.

5. Connectors shall meet the following performance criteria:

Test	Procedure	Maximum Attenuation Change (dB)
Cable Retention	FOTP-6	0.2 dB
Durability	FOTP-21	0.2 dB
Impact	FOTP-2	0.2 dB
Thermal Shock	FOTP-3	0.2 dB
Humidity	FOTP-5	0.2 dB

- E. Approved manufacturers. Ortronics, Corning, Belden, Panduit, Siemon, Leviton, CommScope or 3M

## 2.14 INSIDE PREMISE FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate fiber optics backbone cables to be run inside premises, the following specification shall be followed for those cables:

1. Strand Count: As indicated in design drawings
2. Fiber type: As indicated in design drawings
3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable.
4. Fiber protection: aramid yarn around all strands for cables under 24 strands, and aramid yarn and jacket around each subunit (6 or 12 strands) for cables above 24 strands.
5. Jacket type: Flame-retardant PVC jacket or materials with superior performance.
6. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.
7. Fiber termination: fibers shall be field terminated
8. Buffer type: tight buffer required
9. Center strength member material: dielectric material

- B. Jacket: Cable jackets for fiber optic cables shall comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.

- C. Approved manufacturers: Match selection for horizontal 4-pair cable

## 2.15 INDOOR/OUTDOOR FIBER OPTICS BACKBONE CABLES

- A. Whenever design drawings indicate indoor/outdoor fiber optics backbone cables to be run between buildings or outside premises, the following specification shall be followed for those cables:

1. Strand Count: As indicated in design drawings
2. Fiber type: As indicated in design drawings

3. Fiber coating: 900µm coating color coded. 250µm coating is acceptable for loose buffer cables but they shall be protected with break-out kits with color coded 900µm buffers at both ends of the cable. When fibers are terminated in outdoor non-conditioned spaces break out kits shall be used with 3 mm tubes with aramid yarn for each fiber. Unprotected 900µm fibers in non-conditioned spaces are not allowed.
  4. Rodent protection requirement: not required
  5. Buffer type: tight buffer required loose buffer acceptable.
  6. Center strength member material: dielectric material
- B. Jacket: All indoor/outdoor fiber optics backbone cables shall have UV resistant cable sheathing and a water blocking material to prevent water intrusion. All outside plant fiber optics backbone cables shall be tested and in compliance with following standards:
1. ANSI/TIA-568-C
  2. Telcordia GR-409
  3. ANSI/ICEA S-104-696
- C. Jacket: Cable jackets for indoor/outdoor fiber optic cables shall also comply with Article 770 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant riser rated jacket. Rating shall be printed in the cable jacket.
- D. Approved manufacturers. Match selection for horizontal 4-pair cable

## 2.16 FIBER OPTIC DISTRIBUTION CENTERS

- A. All fiber optic cables shall be terminated in fiber optic distribution centers. Inside premises horizontal fiber optic cables shall be terminated in one side (telecommunication room side) in a fiber optics distribution center (FODC). Backbone fiber optic distribution centers shall be terminated at both ends in a FODC. FODC are composed of an enclosure and snap on adapters. These are the specifications of the enclosures for the FODC:
1. Mounting: Use rack mounted FODC enclosures in all rooms where racks are available or any type of rack rails. Use wall mounted FODC enclosures only when racks are not available like in outdoor enclosures, or other spaces different than telecom rooms.
  2. Size: SCS Installer shall size the FODC based on the amount of fiber strands to be terminated in the FODC.
  3. Front locking doors are required.
  4. Locking door shall be transparent doors and shall have labeling cards.
  5. Whenever fiber splices are indicated in the design drawings next to an FODC, enclosures shall be selected by the SCS installer as to have spaces to hold splice trays. FODCs under these conditions shall be able to hold the amount of splice trays required for the fiber count indicated in the drawings.
- B. These are the specifications of the snap on adapters for the FODC:
1. Style: plate style cassette style for array connector

2. Connector type: to match fiber types of fiber optic cables
3. Maximum fiber strands allowed per adapter: 12
4. Security level: non-keyed connector keyed connector
5. Pairing style: duplex

C. Approved manufacturers. Match selection for fiber optic connectors

## 2.17 FIBER OPTICS PATCH CORDS

A. Fiber optic patch cords shall be required for connections from active equipment to FODCs and/or to telecommunication outlets. Fiber optic patch cords shall be required at both ends of fiber optics backbone cables or horizontal fiber optic cables. Direct connection of backbone cables or horizontal fiber optic cables to active equipment shall not be allowed.

B. Fiber optic patch cords shall be all factory tested. Field made fiber optic patch cords are not acceptable. The specifications of the fiber optic patch cords shall be:

1. Strand Count: 2 strands
2. Fiber type: Match fiber type of backbone cable or horizontal cable.
3. Fiber connector in FODC or outlet side: match connector for each adapter
4. Fiber connector in active equipment side: the SCS installer shall coordinate with supplier of equipment the type of connector required in this side.
5. Fiber protection: aramid yarn
6. Jacket type: 2.9mm flame-retardant PVC jacket zip-cord type.
7. Color jacket: jacket shall be orange for OM1 or OM2 fiber, aqua for OM3 or OM4 fiber and yellow for OS1 or OS2 fiber.

C. Provide 2 meter duplex patch cords for the quantity of fiber strands installed. Provide patch cords for both ends.

D. Approved manufacturers. Match selection for fiber optic connectors.

## 2.18 INSIDE PREMISE MULTIPAIR BACKBONE CABLES

A. Whenever indicated in the drawings multipair backbone cables to be run inside premises and above grade shall have the following specification:

1. Pair count: as indicated in the design drawings
2. Conductor: AWG 24 solid bare copper conductor
3. Input impedance: 100  $\Omega$
4. Conductor insulation: color coded thermo plastic
5. Performance requirement: UL verified to ANSI/TIA-568-C Category 3 5e backbone cable.

B. Jacket: Cable jacket for inside premise multipair backbone cables shall comply with Article 800 NEC for correct use in the environment in which they will be used. If at the moment of the bid the SCS installer does not know the environment, in which cables will be used, the SCS installer shall assume plenum rated is required for the project. At a minimum all cables shall have a flame retardant PVC jacket riser rated.

- C. Jacket marking: All inside premise multipair backbone cables shall have at least two types of markings imprinted in the jacket, transmission performance marking and NEC rating for environment to be used.
- D. Approved manufacturer: Belden, Superior Essex, General Cable, Berk-Tek or CommScope.

## 2.19 TWO POST RACKS

- A. Whenever indicated in the design drawings two post racks shall be provided as shown. Two post racks shall be made of aluminum or welded steel frames and shall have a powder coat finish. Two post racks shall have the following specifications:
  - 1. Height: Equipment cabinet shall provide a usable height between 44 and 45 RU.
  - 2. Channel depth: 3" ± 1"
  - 3. Rack rails type: standards EIA 19" located in the front and back of rack. Rack rails shall have RU marked and labeled.
  - 4. Rack screw type: #12-24 threaded rack rails. Screws shall be provided for all openings in rack rails and shall be made of steel.
  - 5. Weight capacity: UL listed for 1000 lb or more.
- B. Two post racks shall be provided with the following accessories:
  - 1. Cable runway mounting brackets to support cable runway installed above racks
  - 2. Isolation pads
  - 3. Grounding kit.
  - 4. Ground bar: all cabinets shall be provided with a copper vertical ground bar covering the complete length of the rack rails. The ground bar shall be 1/8" thick and 1" wide with threaded holes 1032 mounted to the cabinet using nylon insulation washers
  - 5. End panels to support vertical wire managers at both ends of each rack row.
- C. Front vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
  - 1. Style: Metal cage with dual hinged door cover [cage with latches] [finger-duct with removable covers] [D-rings]
  - 2. Sides: single sided wire manager or dual side wire manager.
  - 3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in
  - 4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- D. Rear vertical wire managers shall be provided in between all racks and at both ends of rack rows covering from top to bottom of each rack. The specifications of those wire managers shall be:
  - 1. Style: Metal cage with dual hinged door cover

2. Sides: single sided wire manager (rear only) or if dual side wire front managers are included, no need for rear vertical wire managers.
  3. Capacity: Usable cross sectional area shall be minimum of: 130 sq-in.
  4. Accessories: whenever cable manager supports the use of spools inside the unit, spools shall be provided at all locations in the unit.
- E. Approved manufacturer: Match selection for Equipment Cabinets Panduit, Ortronics, Belden, Middle Atlantic Products, Great Lakes, Chatsworth Products Inc.

## 2.20 RACK MOUNTED UNINTERRUPTED POWER SUPPLY (UPS)

- A. All equipment cabinets or racks in the project shall be provided with one uninterrupted power supply (UPS). UPS selection per rack shall be as indicated in design drawings. The following descriptions apply to each type of UPS:
- B. UPS units labeled in drawings as "208V UPS" shall have the following specifications:
1. Output power capacity: 4000 W/5000 VA
  2. Output voltage: 120V and 208V, using a transformer
  3. Efficiency at full load: 95%
  4. Output voltage distortion: Less than 5% at full load
  5. Output Frequency: (sync to mains) 57 - 63 Hz for 60 Hz nominal
  6. Topology: Line Interactive
  7. Waveform Type: Sine wave
  8. Output Connections: (12) NEMA 5-20R, (2) NEMA L6-20R and (1) L6-30
  9. Nominal Input Voltage 208V
  10. Input Frequency 50/60 Hz +/- 5 Hz (auto sensing)
  11. Input Connections NEMA L6-30
  12. Battery Type Maintenance-free sealed Lead-Acid battery with suspended electrolyte, leak-proof.
  13. Run time: 9 minutes at full load
  14. Communications: RJ-45 10 Base-T Ethernet for web/ SNMP/ Telnet management included.
  15. Surge energy rating 1020 Joules
  16. Filtering Full time multi-pole noise filtering : 0.3% IEEE surge let-through : zero clamping response time : meets UL 1449
  17. Rack Height: no bigger than 7U, including transformer
  18. Regulatory Approvals CSA, FCC Part 15 Class A, UL 1778.
- C. UPS units labeled in drawings as "120V Medium UPS" shall have the following specifications:
1. Output power capacity: 2700 W/2880 VA
  2. Output voltage: 120V
  3. Output voltage distortion: Less than 5% at full load
  4. Output Frequency: (sync to mains) 57 - 63 Hz for 60 Hz nominal
  5. Topology: Line Interactive
  6. Waveform Type: Sine wave
  7. Output Connections: (6) NEMA 5-15R, (2) NEMA 5-20R
  8. Nominal Input Voltage 120V

9. Input Frequency 50/60 Hz +/- 3 Hz (auto sensing)
10. Input Connections NEMA L5-30
11. Battery Type Maintenance-free sealed Lead-Acid battery with suspended electrolyte, leak-proof.
12. Run time: 3.5 minutes at full load
13. Communications: RJ-45 10 Base-T Ethernet for web/ SNMP/ Telnet management included.
14. Surge energy rating 459 Joules
15. Rack Height: no bigger than 2U
16. Regulatory Approvals CSA, FCC Part 15 Class A, UL 1778.

- D. Approved manufacturers: APC, Liebert, Tripplite or approved equal. All UPS types shall be provided from the same manufacturer

## 2.21 MEDIA CONVERTERS

- A. General. When telecommunications outlets exceed distance limitations to pass testing requirements, the SCS installer shall provide media converters and fiber optics connectivity to overcome this problem. The media converters shall have the following specifications:

1. Power: All power for media converters in the field end (i.e. camera or WAP side) shall be powered from the Telecom room side using a hybrid cable. Local power adapters for media converters are not acceptable in the field end.
2. Cabling: A composite cable shall be used for these devices. This composite cable shall have a minimum of 2 strands of fiber optics and 1 pair of copper cable AWG-12 for the remote end power. The quantity of fiber strands for this cable shall be as required by the type of media converter used. The fiber types shall be as required by the media converter. The cable jack for this composite cable shall be selected as required for the application. Any cables being pulled underground shall have a water blocking jacket.
3. Port count: Media converters with 1 port or 4 ports are acceptable.
4. PoE support: Media converters shall support PoE without the need of an external power adapter and the field end.
5. Fiber connection speed. Media converters shall support 1GB connections in the fiber port.
6. PoE capacity: Media converters shall support PoE+ (30W) for all outdoor cameras and all WAPs. Media converter shall support 15,4 W for all other PoE devices.
7. Power supplies: Media converters shall be provided with the corresponding power supplies at the telecom room.

- B. Basis of design; Berk-Tek One Reach, Transition Networks, Commscope solutions or similar.

## 2.22 CABLE TIES

- A. Cable ties shall be used at different locations of the project but with the same goal of producing a neat and organized installation. Cable ties shall be used to support cables to j-hooks (when j-hooks are allowed in the project) to organize cables in ladder trays, D-rings and cable trays, to support cables to wire managers

including managers behind patch panels, to bundle cables, organize patch cords, etc.

- B. To support and organize all horizontal cabling and inside premise backbone cables, only the following types of cable ties shall be used:
  - 1. Hook and loop style, re-usable with Velcro no smaller than 0.5" width.
  - 2. Pre-perforated rolls of re-usable ties with Velcro no smaller than 0.5" width
  - 3. Straps of other soft materials with cinch rings that allow for re-use of the cable ties in widths no smaller than 0.85".
- C. Nylon based cable ties (re-usable or not) can only be used to support and organize the following types of cables:
  - 1. Outside plant fiber and copper backbone cables.
  - 2. Inside premise fiber optic backbone cables with interlock armors.
  - 3. Grounding conductors
- D. Nylon based cable ties shall never be used to support or organize any type of horizontal cables or inside premise fiber optic backbone cable without armor.
- E. All cable ties to be used in outdoor environments shall be made of weather resistant Acetal. Outdoor cable ties used for aerial cable lacing shall be in compliance with Telcordia TR-TSY-000789 standard.
- F. All cable ties shall be selected in lengths as to properly secure the bundle of cable being supported.
- G. All cable ties to be used in air handling spaces, such as above ceiling and under raised floor areas, shall be UL listed for the use in those environments.
- H. Approved manufactures: Ortronics, Panduit or approved equal

## 2.23 IDENTIFICATION AND LABELING TAGS

- A. SCS installer shall follow labeling materials indicated in specification section 270010 17010.

## PART 3 - EXECUTION

### 3.1 INSTALLATION PRACTICES.

- A. GENERAL. All installation requirements indicated in specification section 270010 17010 shall be followed.
- B. WORKMANSHIP. All work shall be completed by the SCS installer in a neat and workmanlike manner. The use of all BICSI standards and recommendations for installation shall be followed as the benchmark for workmanship.
- C. CABLE LENGTHS. It is the SCS installer's responsibility to plan the cable routing in the cable tray and other raceways as to minimize all cable runs to be able to

stay under the 90 meter (295 ft) length limitation for Horizontal Cabling. All cable runs exceeding the wiring distance, due to raceways run in not the most efficient way to minimize distance, shall be re-run with horizontal fiber optic cables and with media converters, at no extra cost to the owner.

- D. WIRE MAPPING. All terminations of 4-pair horizontal cabling in this project and terminations of all 4-pair patch cords shall be per T568A T568B standard.
- E. FIBER OPTICS TERMINATION POLARITY. All fiber optic cables (horizontal or backbone) terminated in duplex style adapter panels shall be connected in a cross-over polarity configuration. As an example, if fibers 1 and 2 are terminated in one end in positions A and B respectively in one side of the cable, the same strands shall be terminated in B and A positions in the other side of the cable.
- F. POLARITY FOR FIBER OPTICS ARRAY CONNECTORS. Array connectors and cassettes for this project shall use Method C polarity system as outline in TIA-568.B.1
- G. LOCATION OF HORIZONTAL TERMINATIONS. In a multi-story facility with telecommunications room in every floor, all horizontal drops, whether terminated in the wall or in floor boxes shall be terminated in the same floor telecommunications room as the location of the final outlet.
- H. CABLE BUNDLES. In suspended ceiling and raised floor areas if duct, cable trays or conduits are shown on the contract drawings, the SCS installer shall bundle, in bundles of 40 or less, horizontal wiring with cable ties snug, but not deforming the cable geometry. The cable bundling shall be supported via "CLIC" fasteners in TR's and non-plenum areas and J-hooks in ceiling spaces. The SCS installer shall adhere to the manufacturers' requirements for bending radius and pulling tension of all cables.
- I. CLIC FASTENERS: Horizontal cables shall be suspended by "CLIC" fasteners with cable inserts in TR's on the plywood area where ladder tray or rack management is not available per the design documents. Listings: "CLIC" fasteners shall be in accordance with NEC and BICSI standards. Above the plywood area J-hooks or D-rings should be used.
- J. FIRE STOP PROTECTION: Sealing of openings between floors, through rated fire and smoke walls, existing or created by the SCS installer for cable pass through shall be the responsibility of the SCS installer. Sealing material and application of this material shall be accomplished in such a manner, which is acceptable to the local fire and building authorities having jurisdiction over this work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the SCS Installer's work. Any openings created by or for the SCS installer and left unused shall also be sealed as part of this work. Penetration rating shall equal structure rating.
- K. NEW MATERIALS: All components, wiring and materials to be used for the installation of the SCS shall be new and free of defects. Used components, wiring and materials shall only be used when specifically indicated in the design drawings.

- L. **DAMAGE:** The SCS Installer shall be responsible for any damage to any surfaces or work disrupted as a result of his work. Repair of surfaces including painting and ceiling tile replacement shall be included as part of this contract.
- M. **AVODING EMI:** To avoid EMI, all pathways shall provide clearances of at least 4 feet (1.2 meters) from motors or transformers; 1 foot (0.3 meter) from conduit and cables used for electrical-power distribution; and 5 inches (12 centimeters) from fluorescent lighting. Pathways shall cross perpendicular to fluorescent lighting and electrical-power cables and conduits. The SCS installer shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
- N. **WORK EXTERNAL TO THE BUILDING:** Any work external to the confines of this building as shown on the drawings shall be governed by the provisions of this specification.
- O. **DEMOLITION.** Any task part of the installation of the SCS requiring relocation, rerouting and/or demolition shall be done according to the following requirements:
1. **Coordination:** Prior to any deactivation and relocation or demolition work, arrange a conference with the Architect and the Owner's representative in the field to inspect each of the items to be deactivated, removed or relocated. Care shall be taken to protect all equipment designated to be relocated and reused or to remain in operation and be integrated with the new systems.
  2. **Provisions:** All deactivation, relocation, and temporary tie-ins shall be provided by the SCS installer. All demolition, removal and the legal disposal of demolished materials of system designated to be demolished shall be provided by the SCS installer.
  3. All Existing Voice/Data cables and connecting hardware not to be used after the new installation is complete and within the areas where work is required as part of this project shall be removed by the SCS installer. All existing cables to be left for future use if indicated by the owner shall be tagged for that purpose.
  4. **Owners Salvage:** The Owner reserves the right to inspect the material scheduled for removal and salvage any items he deems usable as spare parts.
  5. **Phasing:** The SCS installer shall perform all work in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.
- P. **ICONS.** Faceplates, jacks or patch panels with inserts for icons shall be filled with icons when unit capable of accepting icons. Icons in the work area side (outlet) shall match the color of the faceplate. Icons for path panels shall match the color of the horizontal cabling.
- Q. **BLANK INSERTS AND PANELS.** All telecommunications outlets with faceplates or mounting frames with unused terminations shall be plugged with blank inserts or panels. Blank inserts shall match the color of the faceplate or mounting frame. No more than one blank module shall be required for each faceplate. All unused ports in the FODC enclosures for adapter panels shall be filled with blank adapter panels.

R. PATCH PANEL AND FODC SEPARATION: Horizontal cables shall be terminated in separate patch panels according to the use of the cable. Each series of patch panels or FODC for a specific use shall have at least 20% spare capacity of ports. Patch panels of the same use shall be mounted consecutive in the equipment cabinets or racks. The following separation for patch panels and FODCs shall be provided:

1. Cables for Wireless Access Points (WAPS) shall be separated from cables for any other purpose.
2. Cables for surveillance cameras shall be separated from cables for any other purpose.
3. Cables for voice drops shall be separated from cables for data drops.
4. Cables for any other specialty systems like security systems, nurse call systems or others shall all be terminated in separate patch panels from any other cables.
5. Horizontal fiber optic cables shall be terminated in separate FODC from fiber optics backbone cables.
6. Single mode fiber optic backbone cables shall be terminated in separate FODC from multimode fiber optic backbone cables.

S. SUPPORTS FOR REAR OF PATCH PANELS. All patch panels for horizontal cables shall be provided with a rear support bar to hold the cable and to provide strain relief. At a minimum one rear support bars shall be provided for each two rows of 24 connectors.

T. HORIZONTAL WIRE MANAGERS. Horizontal wire managers shall be provided following this criteria:

1. At least one above and below each straight (flat) patch panel.
2. At least one top and bottom of each series of angled or curved patch panels.
3. At least one above and below any network switches.
4. At least one below any rack mounted termination block.

U. CROSS OVER WIRE MANAGERS. Cross over wire managers shall always be used with angled or curved patch panels. One cross over wire manager shall always be installed in the middle of each rack at the same height on every rack.

V. PATCH CORD QUANTITY, COLOR AND LENGTHS. Copper and fiber optics patch cords shall be provided per following chart. All percentage calculations shall be rounded off to the nearest integer number.

TYPE	QTY	COLOR JACKET	LEGTH
4-pair at work area outlet	One for 90% of all 4-pair horizontal cables in the project	Match horizontal cable color jacket	30% 8', 50% 10' and 20% 14'
4-pair at WAP location	One for 100% of all 4-pair horizontal cables for WAPS in the project + 10% spare	Match horizontal cable color jacket	The SCS installer shall field verify all lengths to match location of WAPS selected by owner or wireless survey. For pricing purposes use 12'
4-pair at	One for 100% of all 4-	Match horizontal	The SCS installer shall

Surveillance camera	pair horizontal cables for cameras in the project +10%	cable color jacket	field verify all lengths to match location of cameras. For pricing purposes use 12'
4-pair at patch panel side (excluding surveillance cameras and WAPS)	One for 90% of all 4-pair horizontal cables in the project	Match horizontal cable color jacket	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
4-pair at patch panel side (surveillance cameras and WAPS)	One for 100% of all 4-pair horizontal cables in the project +10%	Match horizontal cable color jacket	For pricing purposes use: 40% 6', 40% 8', 20% 12'. SCS installer shall field verify these percentages to provide more accuracy.
2-strand fiber optics at work area outlet	One for 100% of all 2-strand horizontal fiber cables in the project + 10% spare	Per fiber type	50% 8' and 50% 10'
2-strand fiber optics at FODC.	One for 100% of all horizontal 2-strand fiber cables and one for 83% of all fiber strands of backbone cables in the project. For example a 24 strand cable shall require 20-2-strand patch cords or 10 for each side of the cable	Per fiber type	For pricing purposes use: 20% 6', 60% 10', 20% 14' SCS installer shall field verify these percentages to provide more accuracy.
One or two pair for copper backbone cross connects	One for 90% of all backbone copper pairs installed in the project.	Gray	For pricing purposes use: 80% 8', 20% 10'. SCS installer shall field verify these percentages to provide more accuracy.

- W. CABLE SLACK. Cable slack shall be provided for all cables in the project following this guideline:
1. At each work area outlets, all horizontal cables shall have 12" of slack.
  2. At the telecom room side all horizontal cables shall have at least 6' neatly organized on the wall using a figure 8 configuration or a non-loop shaped arrangement with Velcro straps.
  3. Backbone cables at termination points shall have at least 15' of slack neatly organized on the wall using a standard loop and Velcro straps.
  4. Outside plant backbone cables run through in-ground pull boxes greater than 24"X24" shall include one service loop inside the box.
- X. BEND RADIUS. Installation of Fiber Optic Cables shall be in accordance with ANSI/TIA-568C guidelines and cable manufacturer specifications. Bend radius parameters shall be followed for load and no load conditions. Cable installation and terminations that do not comply shall be replaced by the SCS installer. If no

recommendation is specified by cable manufacturer, at least the following criteria shall be meet:

1. The bend radius for intrabuilding 2 and 4-fiber horizontal optical fiber cable shall not be less than 25 mm (1 in) under no-load conditions. When under a maximum tensile load of 222 N (50lbf), the bend radius shall not be less than 50 mm (2 in).
2. The bend radius for intrabuilding optical fiber backbone with fiber counts above 4 shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 15 times the cable outside diameter when the cable is under tensile load.
3. The bend radius for interbuilding optical fiber backbone shall not be less than 10 times the cable outside diameter under no-load conditions and no less than 20 times the cable outside diameter when the cable is under tensile load up to the rating of the cable, usually 2670 N (600lbf).

Y. INNERDUCT. Innerduct shall be provided from end to end of a raceway system under the following conditions:

1. Inside underground conduits as indicated in design drawings.
2. For horizontal fiber optic cable or inside premise fiber optics backbone cables without interlocking armor when routed through cable trays, ladder trays or vertical conduit sleeves. This requirement is usually not indicated in the drawings but indicated only in this specification.
3. For backbone fiber optic cable in vertical risers

Z. SCS PROTECTION DURING CONSTRUCTION. The SCS installer shall protect all SCS materials from damage during construction. Racks shall be covered with fabric or plastic after mounting to prevent dust, debris and other foreign materials having contact with SCS devices. The SCS installer shall protect at all times all fiber optic and copper cables from damage during installation. All cables shall maintain the physical integrity as manufactured for testing and delivery to the owner. All damaged cables shall be replaced at no additional cost to the owner.

AA. CABLE BONDING. Shielded cables or cables with metal strength or protection members (like interlocking armor) shall be bonded to the telecommunications grounding system as indicated in specification section 270526 - 17450.

BB. RACK INSTALATION. All racks shall be installed leveled and plumbed. Four post racks and two post racks shall be anchored to the floor and shall be installed with isolation pads. Equipment cabinets shall be leveled using the leveling feet unless design drawings specifically indicate to leave them on the casters.

CC. RACK BONDING. All equipment cabinets and racks shall be bonded to the telecommunication grounding system as indicated in specification section 270526 - 17450

### 3.2 IDENTIFICATION AND TAGGING

A. General: Identification and tagging of SCS components shall be executed by the SCS installer. At a minimum identification and tagging shall be provided for the following components of the system:

1. All horizontal and backbone cables at both ends of the cable in the cable jacket. Labels on each side shall be different indicating the location of the other side of the cable
  2. All faceplates indicating all jacks terminated in the faceplate.
  3. All patch panels.
  4. All racks
  5. All termination blocks
  6. All telecommunication rooms and outdoor enclosures.
  7. All interbuilding backbone cables inside in ground pull boxes outside of the building shall have a visible label in each box they pass through.
- B. The SCS installer shall follow the owner provided identification system. If owner does not have any preference or standard the SCS installer shall provide a system for approval of the A&E and the owner as indicated in the submittal paragraph of this specification. The identification system shall follow the TIA/EIA 606-B standard.

### 3.3 TESTING OF COPPER CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C, Cabling Transmission Performance and Test Requirements.
- B. For all 4-pair copper cabling terminated for the use of building systems or system provided under the contract, such as surveillance cameras, emergency phones, elevator phones, WAPs, Access control panels and building automation equipment, the required test shall be a Channel style test. This means copper test shall be done with patch cords that will be used for permanent installation of those devices.
- C. For all 4-pair copper terminated for the use in work areas such as computers and phones, the test method selected for all 4-pair copper cabling is a permanent link style test. Permanent link test is defined as a test that does not include the patch cords to be used in the project.
- D. General: In the event the A&E elects to be present during the tests, provide notification to the engineer two weeks prior to testing.
- E. General: The installer's RCDD shall sign off on all copper and fiber optic cable test results, indicating that he/she was in responsible charge of all cable testing procedures and that all cables were tested in compliance with the contract documents and met or exceeded the requirements stated herein.
- F. Testing Equipment: Tester shall be as manufactured by Agilent, Fluke, IDEAL or Wavetek. Tester shall be 100% Level III Level IIIe compliant with ANSI/EIA/TIA 568C specifications for testing of the CAT6 CAT6A cabling. No tester will be approved without meeting these requirements.
- G. Each jack in each outlet shall be tested at a minimum to the manufacturer's performance of the cable to verify the integrity of all conductors and the correctness of the termination sequence. Testing shall be performed between work-areas and the equipment rack patch panel. Prior to testing UTP runs, the

tester shall be calibrated per manufacturer guidelines. The correct cable NVP shall be entered into tester to assure proper length and attenuation readings.

- H. Documentation of cable testing shall be required. The SCS installer shall provide the results of all cable tests in electronic format (final results in PDF format and raw data). Each test page shall be separated by standard page break (one test per page). The test results shall include: sweep tests, continuity, polarity checks, wire map, Attenuation, NEXT, PSNEXT, FEXT, PSFEXT, ELFEXT, PSELFEXT, ACR, Return Loss, Delay Skew, and the installed length. Cables not complying with the EIA/TIA 568C tests results shall be identified to the A&E for corrective action which may include replacement at no additional expense to the Owner. All identification names of the cables used in the test shall match the labeling system approved for the project and the corresponding shop drawings.
- I. Any Fail, Fail\*, Pass\* or WARNING test result yields a Fail for the channel or permanent link under test. In order to achieve an overall Pass condition, the result for each individual test parameter must be passed. All test results shall come from a tester with the permanently enabled marginal reporting feature.
- J. Test results shall show and comply with the margin claimed by the manufacturers over CAT6 CAT6A permanent link specifications on all transmission parameters across the entire frequency range as shown on the manufacturer's cut sheets.
- K. General: Copper multipair backbone cabling shall be tested for length, continuity, polarity checks and wire map. The SCS Installer shall provide the results of all Copper Riser cable tests in electronic format. The use of pigtailed or special harness could be required to properly test these cables.
- L. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests.
- M. All 4-pair patch cords shall be factory tested only.

### 3.4 TESTING OF FIBER OPTICS CABLING

- A. General: Horizontal and backbone cabling shall be verified in accordance with ANSI/TIA/EIA-568-C and the addendum for fiber optic testing.
- B. General: In the event the Engineer elects to be present during the tests, provide notification to the engineer two (2) weeks prior to testing.
- C. Cleanliness: All fiber optics connector shall be cleaned properly before any testing and after testing. Proof of cleanliness shall be required during the acceptance test for the SCS by the A&E. SCS installer shall have available during this test a 200X microscope or a video probe to demonstrate the cleanliness of the randomly selected connectors by the A&E.
- D. End to End Attenuation Test: The SCS installer shall perform end-to-end attenuation testing for each multimode fiber at 850 nm and 1300 nm from both directions for each terminated fiber span in accordance with EIA/TIA-526-14A (OFSTP 14) and single-mode fibers at 1310 nm and 1550 nm from both directions for each terminated fiber span in accordance with TIA/EIA-526-7 (OFSTP 7). A one jumper reference shall be used for all testing. For spans greater than 90

meters, each tested span must test to a value less than or equal to the value

determined by calculating a link loss budget. For horizontal spans less than or equal to 90 meters, each tested span must be < 2.0 dB. When calculating the link loss budget for spans greater than 90 meters use the values listed below. End to end attenuation shall be done with a Level II meter using a meter and light source equipment (also known as main and remote unit)

<b>ATTENUATION DUE TO</b>	<b>FIBER TYPE</b>	<b>MAX. ATTENUATION</b>
Terminating connectors. Field terminated options	All fiber types	0.75 dB per connector
Terminating connectors, pre-term fibers	All fiber types	No more than 0.2 dB additional to total dB loss measured at the factory in report sent by cable manufacturer.
Splices	All fiber types	0.3 dB per splice
Distance	OM1 (850nm/1300)	3.4 dB /1.0 dB per Km.
Distance	OM2, OM3 and OM4 (850nm/1300)	3.0 dB /1.0 dB per Km.
Distance	OS1 and OS2 (1310 nm/1383 nm/1550 nm)	0.65 dB /0.65 dB/ 0.5 dB per Km.

- E. OTDR Test. Additional to end to end attenuation test, all fiber optic cables shall be tested with a Level III OTDR equipment for the following conditions:
1. Each known event (connector/splice) insertion loss at both windows for each fiber type (850/1300 nm for multimode and 1310/1550 nm for single mode). All events shall pass maximum allowed insertion loss for the event type as indicated in table above.
  2. Reflective events (connections) shall not exceed:
    - a. 0.75 dB in optical loss when bi-directionally averaged
    - b. -35 dB Reflectance for multimode connections
    - c. -40 dB reflectance for UPC singlemode connections
    - d. -55 dB reflectance for APC singlemode connections
  3. Non-reflective events (splices) shall not exceed 0.3 dB.
  4. Estimated distance for multiple strands of the same cable shall not vary more than 1% between strands.
  5. Cable signature in the form of traces along the complete distance of the cable. Unexplained cable reflections shown in the OTDR shall require the installer to submit letter explaining such events and pictures of cable conditions in the locations where the unexplained events are located to demonstrate cable has not been kinked or damaged during installation.
- F. OTDR Test conditions. All OTDR testing shall be performed with the following conditions:

1. Use a launch cable and a tail cable in accordance with fiber type being tested and requirements indicated by OTDR equipment manufacturer.
  2. Launch and tail cables shall be products sold by testing equipment manufacturer and not field made cables.
  3. Launch and tail cables shall be selected according to the type of connector being tested such as APC or UPC type connectors.
  4. Use launch compensation mode during the test to subtract the effects of the launch and tail cables.
  5. Test from one direction only, unless the presence of “gainers” are spotted during the test. In such case the installer shall test in both directions and adjust the test equipment to average measurements from both directions.
  6. The SCS installer shall verify the backscatter coefficient use in the test to make sure it matches the coefficient of the cable being tested.
- G. OTDR Testing Equipment used on this project shall have the specifications indicated in this following table:

SPECIFICATION	MULTIMODE	SINGLE MODE
Wavelengths	850 nm $\pm$ 10 nm 1300 nm +35 / -15 nm.	1310 nm $\pm$ 25 nm. 1550 nm $\pm$ 30 nm.
Event Dead Zone. Measured at 1.5 dB below non-saturating reflection peak with the shortest pulse width. Reflection peak < -40 dB for mm and < -50 dB for sm.	850 nm: 0.5 [3.7] m typical 1300 nm: 0.7 [3.5] m typical	1310 nm: 0.6 [3.5] m typical 1550 nm: 0.6 [3.5] m typical
Attenuation Dead Zone. Measured at $\pm$ 0.5 dB deviation from backscatter with the shortest pulse width. Reflection peak < -40 dB for mm. and < -50 dB for sm.	850 nm: 2.2 [10] m typical 1300 nm: 4.5 [13] m typical	1310 nm: 3.6 [10] m typical 1550 nm: 3.7 [12] m typical
Pulse Widths (nominal)	850 nm: 3, 5, 20, 40, 200 ns. 1300 nm: 3, 5, 20, 40, 200, 1000 ns.	3, 10, 30, 100, 300, 1000, 3000, 10000, 20000 ns
Loss Threshold Setting	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments	0.01 dB to 1.5 dB Adjustable in 0.01 dB increments

- H. The Test Report for each fiber strand shall include the following information:
1. Calculated Loss Budget for each optical fiber link (see attenuation table above)
  2. Cable/strand ID matching shop drawings labeling system.
  3. Name of technicians who performed the test.
  4. Date and time the test was performed.
  5. Measurement direction (from/to)

6. Jumper reference set up date/time and attenuation value
  7. Equipment model and serial number used and calibration date.
  8. End to End Attenuation Loss Data for each optical fiber link
  9. OTDR Traces, one page per strand. Expand chart to cover most of the page
  10. Each event loss data and test limits used, including test limit file date used.
- I. For fiber optic cables with factory terminated connectors or pre-terminated pig-tails, The SCS installer shall provide also the test results performed at the factory for fiber optic cables with factory terminated connectors to compare with the field test done by the SCS installer. No significant variation between the factory test results and the field test results shall be encountered.

### 3.5 SYSTEMS WARRANTY AND SERVICE

- A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.
- B. Warranty: The SCS shall be required to be under the manufacturer's warranty program for a complete channel configuration including cable, jacks, patch cords and patch panels and include cabling specifically approved for the channel configuration with the manufacturer's components. Manufactures shall provide the warranty worst-case performance data for the installed cabling system, and the performance data indicated in the warranty documents/certificate.
- C. A twenty five (25) year warranty available for the Structured Cabling System (Fiber optics and copper infrastructure) shall be provided for an end-to-end channel model installation which covers applications assurance, cable, connecting hardware and the labor cost for the repair or replacement thereof.
- D. Additional features of the warranty shall include:
1. That the SCS installed system complies with the margin claimed by the manufacturer above the category 6 6A channel specifications on all transmission parameters across the entire frequency range of 1-600 MHz as shown on the manufacturers catalogs and literature.

### 3.6 SPARE PARTS

- A. As part of this contract the SCS installer shall provide the following spare parts.
1. Ten (10) modular SCS jacks.
  2. Five (5) faceplates
  3. Two (2) faceplates with support post.
  4. Ten (10) fiber optic connector of each type used in the project.
- B. As part of this contract the SCS installer shall provide the following tools:
1. Two (2) modular SCS jacks termination tools when modular SCS jacks required a manufacturer specific tool.

2. One (1) punch down tool with a 110 blade and one 66 blade.
3. One electric (1) cable finder.

### 3.7 COMISSIONING

- A. SCS Installer shall follow all warranty and service requirements indicated in specification section 270010.

### 3.8 ENGINEER'S FINAL ACCEPTANCE TEST

- A. SCS Installer shall follow all requirements for final acceptance indicated in specification section 270010.
- B. The Engineer's final acceptance test will not include testing of structured cabling components, but could include verification of cleanness of fiber optic connectors.

### 3.9 TRAINING AND INSTRUCTION

- A. Training shall only be done after all testing, identification process and commissioning have been completed and passed as indicated in this specification. Any training done prior to final acceptance will not be accounted for the formal training requested and the SCS installer shall re-do all training after the final acceptance test is passed, at no additional cost to the Owner.
- B. SCS Installer shall follow all training requirements indicated in specification section 270010.
- C. The training for the SCS shall include the following topics:
  1. Detail explanation of the identification system.
  2. A walkthrough of all spaces and locations where terminations have been done in the project.

### 3.10 AS BUILT DOCUMENTS AND PROJECT CLOSE OUT

- A. The SCS shall follow all requirements for as-build and close out documents indicated in specification section 270010.
- B. The following are additional requirements supplementing the information provided in specification section 270010:
  1. Provide the Warranty certificate issued by the manufacturer of the SCS infrastructure.
  2. The installer's RCDD shall affix his/her stamp to the as-built drawings, indicating that he/she has reviewed and approved the drawings as being complete, accurate, and representative of the system as actually installed.

3. As built drawings inside each telecom room. The SCS installer shall plot all as-built drawings and locate them inside each of the telecom rooms in the project. Each telecom room shall have the as-built drawings of the areas being served from that room. Each drawing shall be placed inside a clear vinyl document protector the size of the actual design drawing and affixed to a wall/plywood in the telecom room. The document protector shall be reusable and shall allow the owner to replace the drawings as changes are done to the SCS infrastructure in the future. Without this information, substantial use of the system will not be provided to the installer.
4. The SCS installer shall provide Excel software spreadsheet that defines the telecommunications outlet number, location, number of voice, data and special jacks. This database shall also provide the outlet patch panel connection to the riser/inter-floor cable, equipment, and telephone company demarcation circuit pairs as part of the as-built documentation.
5. Electronic copies of all test results (copper and fiber). Electronic copies shall include raw data files and PDF files with results. PDF files shall be organized the following way:
  - a. All copper cables for cables terminating in one telecom room in a single PDF files with the name equal to the label used in the shop drawings for the telecom room where the cables are terminated.
  - b. All attenuation and OTDR test for all strands of a single cable shall be in one PDF file with the name corresponding to the Cable ID used in the shop drawings.