SECTION 27-2000

FIBER OPTIC STRUCTURED CABLING SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fiber-optic structured cabling systems for audio, video, and data communication
B. Ethernet-based Switches
C. Climate-Controlled NEMA-Rated Equipment Housing

1.2 RELATED SECTIONS

A. Section 00-1116 Instructions to Proposers
B. Section 11-1236 Parking Access and Revenue Control System (PARCS)

1.3 WORK INCLUDED

A. All cables and related termination, support and grounding hardware, bonding, shall be furnished, installed, wired, terminated, tested, labeled, and documented by the Contractor, as detailed in the following sections.
B. All media converters, switches, switch modules, cabinets, racks, patch panels and patch cables shall be furnished, installed, wired, terminated, labeled, and documented by the contractor as detailed in the following sections.
C. Provide all labor and materials necessary to construct the system as described herein. This includes - but is not limited to - furnishing and installing cable, cable supports, conduits, inner-duct, racking and termination components, termination, testing, labeling, and documentation.
D. Wireless Networking will be allowed for connection between the Garage Structure and the Overflow Lot.

1.4 SCOPE OF WORK

A. This document describes the products and execution requirements relating to furnishing and installing Telecommunications Cabling for the backbone cabling comprised of Optical Fiber Cabling, and support systems which are covered under this document.
B. Install a structured cabling system that will be able to support interconnections to active telecommunications equipment for voice and data applications in a multi- vendor, multi-product environment. The structured cabling system should adhere to ANSI/TIA 568 B; 569-A; 606-A; J-STD-607-A, NECA/FOA 301and TIA 942 standards with respect to pathways, distribution, administration, and grounding of the system. The structured cabling system to be installed should also follow the guidelines spelled out in this specification in accordance to applicable local codes and regulations.
C. Contractor may also be required to make matching additions to any existing cable tray to complete the system according to ANSI/TIA 569
D. This section includes minimum requirements for the following:
    1. Optical Fiber from Telecommunications Closet in Parking Office to the parking

structure's entry/exit plazas; Long-Term exit plazas; Long-Term Entry Plazas; entry/exit plazas of South Employee Lot; entry/exit plaza of North Employee Lot; entry/exit plazas of valet lot; and Wireless Bridging Location on Parking Structure Northern stair tower.

2. Cat6a cabling for short distance island connectivity
3. Wireless Bridging from Northern stair tower to Overflow Lot
4. Optical Fiber Connector Modules
5. Climate-controlled NEMA-rated equipment housing
6. Fiber patch cords
7. Cat6a patch cords
8. Fiber patch panels
9. Ethernet switches

E. All cables and related terminations, support and grounding hardware shall be furnished, installed, wired, tested, labeled, and documented by the Telecommunications contractor as detailed in this document.

F. Product specifications, general design considerations, and installation guidelines are provided in this document. Quantities of telecommunications outlets, typical installation details, contractor to determine cable routing and outlet types upon site evaluation and specification review.

1.5 REFERENCES

A. General:
1. National Electrical Code (NEC).
2. National Electrical Safety Code (NESC).
3. Occupational Safety and Health Act (OSHA).

B. Communications:
1. ANSI/TIA/EIA - 455: Fiber Optic Test Standards.
2. ANSI/TIA/EIA - 526: Optical Fiber Systems Test Procedures.
3. ANSI/TIA/EIA - 568-B: Commercial Building Telecommunications Cabling Standard.
4. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces.
5. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
6. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications.
7. ANSI/TIA/EIA -TSB67: Transmission Performance Specifications for Field Testing of Unshielded Twisted Pair Cabling Systems.
8. ANSI/TIA/EIA -TSB75: Additional Horizontal Cabling Practices for Open Offices.
9. NECA/FOA 301: Standard for Installing and Testing Fiber Optic Cables.
10. NECA/BICSI 568: Standard for Installing Commercial Building Telecommunications Systems.
11. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard.
12. IEEE 802.11 (series): Wireless Local Area Networks
13. ISO/IEC IS 11801: Generic Cabling for Customer Premises.
14. BICSI: BICSI Telecommunications Cabling Installation Manual.
15. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM).
16. Underwriters' Laboratories: UL 444 - Communications Cables.
17. Underwriters' Laboratories: UL 910 - Standard for Safety Test for Flame-

Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air.

1.6 SUBMITTALS

A. Under provisions of Division 1, submit each of the below items, grouping together to form a single submittal. Submittals shall be in electronic format supplied by manufacturer. Poor quality photocopies or fax sheets shall not be accepted. Engineer's opinion of photocopy quality shall be final and binding.

B. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.
   1. Submit a cover letter stating that the materials shall be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
   2. Provide standard manufacturer's cut sheets and the operating and maintenance (Operations and Maintenance) instructions at the time of submittal review for each device in the system. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

C. Labeling Plan.
   1. The contractor shall develop and submit for approval a labeling system for the cable installation. The Owner will negotiate an appropriate labeling scheme with the successful contractor. At a minimum, the labeling system shall clearly identify all components of the system: racks, cables, panels and outlets. The labeling system shall designate the cables origin and destination and a unique identifier for the cable within the system. Racks and patch panels shall be labeled to identify the location within the cable system infrastructure. All labeling information shall be recorded on the as-built drawings and all test documents shall reflect the appropriate labeling scheme.
   2. All label printing will be machine generated using indelible ink ribbons or cartridges. Self-laminating labels will be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel and wiring block labels shall be installed on, or in, the space provided on the device.

D. Installer Certification:
   1. Documentation from the SCS manufacturers demonstrating that the Contractor is trained and certified by the Manufacturers to install, test, and maintain the SCS and is certified by the SCS Manufacturers to provide the SCS Manufacturer's Warranty.
   2. Documentation indicating that the Contractor shall have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
      a. A list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers' training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
   3. Documentation demonstrating that the Contractor employs a minimum of one

Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The document shall declare that the RCDD is a direct full-time employee of the Contractor also that the Contractor will continue to employ a minimum of one RCDD throughout the duration of the project.

E. Closeout Submittals: Provide submittal information for review as follows:
   1. Operations and Maintenance Manual for Communications: At the completion of the project, submit Operations and Maintenance information from product data submittals, updated to reflect any changes during the course of construction, to the Owner in the telecommunications-specific Operations and Maintenance Manual for Communications binder labeled with the project name and description. Provide three bound copies of the Operations and Maintenance Manual for Communications.
   2. Records: Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of changes to Contract Documents such as drawings, specifications, and spreadsheets.
      a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
      b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
      c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
      d. Show identifiers for major infrastructure components on Record Drawings.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Contractor shall be trained and certified by the Manufacturers to install, test, and maintain the SCS and be certified by the SCS Manufacturers to provide the SCS Manufacturers' Warranties.
   2. Contractor shall employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The RCDD shall be a direct full-time employee of the Contractor (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one RCDD throughout the duration of the project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.
B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
C. Coordinate with Owner for storage of items on-site. Only Owner-approved items may be stored on-site.
D. Under no circumstances will any material or equipment be stored within publicly accessible areas of the site.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under

environmental conditions outside manufacturer's absolute limits.

1.10 WARRANTY

A. Warranty: Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Optical Fiber Cable manufacturer: Belden, CommScope, Corning, Panduit, Siemons
B. Approved Fiber Optic patch panel product manufacturer: Belden, CommScope, Corning, Panduit, Siemons
C. Approved Fiber Optic connectors/splices/couplers: Belden, CommScope, Corning, Panduit, Siemons
D. Approved wireless bridge manufacturer: Ubiquiti, Cisco, EnGenius, Ruckus, SonicWall
E. Approved Rack and Cabinet manufacturer: Hoffman/Pentair, Belden, Chatsworth, Hubbell, Panduit
F. Approved Ethernet switch manufacturer: Cisco, Netgear, Trendnet, Linksys
G. Approved climate-controlled NEMA enclosure manufacturer: Hoffman/Pentair
H. Approved Patch Cord manufacture: Belden, CommScope, Corning, Panduit, Siemons
I. Requests for substitutions will be considered in accordance with provisions of Division 1

2.2 SYSTEM DESCRIPTION

A. "SCS" shall mean Structured Cabling System. The SCS is defined as all required equipment and materials including (but not limited to) ANSI/TIA/EIA 568-B and ISO/IEC 11801 compliant copper station cable (Category 3, Category 5E, Category 6, etc.) and fiber optic cable (multimode and single mode) and patch cables as specified in this section and as required for a fully operational, tested, certified, and warranted system, compliant with all applicable codes and standards.
   1. Materials required but specified in other sections are stations and station connectors, termination blocks, patch panels, racks/enclosures (such as EIA standard equipment racks, enclosures, and vertical and horizontal cable management hardware), pathway/raceway materials (such as conduit, sleeves, D-rings, surface raceway, ladder rack, cable tray, etc.), and other incidental and miscellaneous equipment and materials.
   2. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of Gigabit Ethernet operation as specified in IEEE 802.3z.
   3. Plenum HDMI cable shall comply with UL 444 and UL 910.
B. Fiber Optic Cable
   1. All fiber-optic cable to meet the following specifications:
      a. Single-mode, 12 strand fiber-optic cable
      b. Meets or exceeds Telcordia GR-20, Issue 2, and ICEA 640
      c. Bend Radius: Dynamic: 15 x Cable O.D. Static: 10 x Cable O.D.
      d. Tensile Rating: 600 lbs. (2669 N) Long term: 150 lbs. (670 N)
      e. Attenuation (single-mode): 0.7dB/km @ 1310 and 1550nm

f. Manufacturer-recommended for installation location (i.e. indoor, outdoor, innerduct, direct burial)
g. Dielectric cable containing no metal components

C. Fiber Optic Connectors
1. Connectors shall operate as a single system within tray/patch panel meeting the following specifications:
a. LC Connectors
b. Zirconia ceramic ferrules
c. TIA-604 FOCIS-10 compatible; exceeds TIA-568-B.3 requirements

D. Fiber-Optic Patch Cables
1. All fiber-optic patch cables to meet the following specifications
a. Cables to have appropriate connectors to match patch panel and switch hardware
b. Cables to be of appropriate length to minimize excess slack
c. Cables to be installed in a neat and orderly manner and bound only using manufacturer recommended methods

E. Fiber-Optic Transceivers/Converters
1. Use only Cisco-manufactured SFP modules to convert fiber-optic media

F. Wireless Bridges and Antennae
1. Use only FCC licensed frequency
2. IP-67 Rating
3. Mounted securely per manufacturer instructions
4. Weather-proof connections

G. Ethernet-based Switches
1. Cisco IE-series switches for remote (non-telco-room) locations
2. Cisco Catalyst-series switches for telco-room and data center locations
a. Access layer switches to provide 1GBps per access port and 10bps per uplink port
b. Aggregation layer switches to provide 10Gbps per port and 40Gbps per uplink port
c. Core switches to provide 40Gbps per port
3. All Ethernet-based switches to offer layer 2 functionality.

H. NEMA-Rated Equipment Housing
1. Hoffman PROTECK PTHS362428XA or equivalent
a. Stainless steel door
b. NEMA 4X rating
c. AC Unit model number 150116G100
d. 19 rack unit capacity
e. Padlocking L Handle
2. 7-pin padlock with Boron alloy shackle padlock

PART 3 EXECUTION

3.1 EXAMINATION

A. The contractor shall follow all guidelines and polices of the Owner when implementing the physical and logical network designs.
B. The Contractor shall be solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
C. The Work shall comply with applicable safety rules and regulations including OSHA. The

Work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes or regulations are more stringent, in which case the local codes or regulations shall govern.

D. The Work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

E. Replace or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

F. Remove surplus material and debris from the job site and dispose of legally.

G. Do not begin installation until substrates have been properly prepared.

H. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. Coordinate with Owner for field inspection of installation.

3.3 CABLE INSTALLATION

A. General (applicable to all cable types): Provide non-plenum (CM/CMR, OFNR) rated cable for locations where cable is to be installed in conduit. For cable not installed in conduit, provide plenum (CMP, OFNP) rated cable if cable is installed in a plenum air space environment, non-plenum rated otherwise. Cabling shall bear plenum or non- plenum markings for the environment in which it is installed.

1. For Horizontal Distribution: Provide station cable in types, sizes, and quantities as shown on the Contract Documents. Install cable between the station and its associated telecommunications room. Provide one cable per each connector at each station. Provide cables of the same type in the same color - multiple colors of the same cable type are not acceptable.
2. For Intrabuilding Backbone Distribution: Provide intrabuilding backbone cable in types, sizes, and quantities as shown on the Contract Documents. Install intrabuilding backbone cables between telecommunications rooms within the same building. Provide cables of the same type in the same color - multiple colors of the same cable type are not acceptable.
3. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
4. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
    a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
    b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
    c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.
5. Install cable in a continuous (non-spliced) manner. Splicing is prohibited unless

explicitly authorized in writing by Owner, with copy to Engineer.

6. Install exposed cable parallel to and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
7. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc. - with the exception of ceiling support anchors) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not over-tighten tie wraps or cause cross-sectional deformation of cabling.
8. Cable at the backboards:
   a. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
   b. Route cable as close as possible to the ceiling, floor, sides, or corners to ensure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
   c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables together and attach to D-rings vertically or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.
9. Cable in the telecommunications rooms:
   a. For telecommunications rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals with tie-wraps or velcro straps.
10. Cable terminating on patch panels located on racks:
    a. Route cables in telecommunications rooms to patch panels on racks by routing across ladder rack across top of rack and then down vertical ladder rack to patch panel.

B. Fiber Cable: Terminate all fiber strands within a fiber cable. The installation of "dark fiber" is not acceptable.
   1. For Intrabuilding Backbone Distribution:
      a. Test fiber optic cable on the reel upon delivery to the job site, and again prior to installation. Permanently affix the test results to the reel and submit a copy to the Owner prior to installation. Do not install cables that fail the on-reel test. Replace any cables that fail the on-reel test at no additional expense to the Owner.
         1) Test shall conform to the procedures as required by this specification section.
         2) Demonstrate that the test results are in harmony with the factory test results as shipped with the reel.
      b. For shielded cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB as furnished under Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
      c. Provide a service loop long enough in the ER/TR's to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum of 10 feet (33.3 m) at each end.
      d. The service slack stored inside the fiber patch panel cabinets shall be a

minimum of 10 feet (3.3 m).

e. Fiber slack shall be neatly coiled within the fiber splice tray, enclosure, or ceiling.
f. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cables strength member shall be securely attached the cable strain relief bracket in the enclosure.
g. Each fiber bundle shall be stripped upon entering the splice tray and the individual fibers routed in the splice tray.
h. Each cable shall be clearly labeled at the entrance to the splice enclosure. Cables labeled within the bundle shall not be acceptable.
i. A maximum of 24 strands of fiber shall be spliced in each tray
j. All spare strands shall be installed and stored into spare splice trays.

3.4 CABLE ASSEMBLIES (PATCH CORDS) AND CROSS-CONNECTS

A. Furnish copper patch cables for modular copper cross-connects. Deliver patch cables to Owner in the sizes, colors and quantities as scheduled.
B. Furnish fiber patch cables for fiber cross connects. Deliver patch cables to Owner in the lengths and quantities as scheduled.
C. Furnish hook-and-loop cable managers for managing patch cords in the telecommunications rooms. Provide in colors, sizes and quantities as indicated below. Cable managers shall be the same color as the patch cable type that they manage.

3.5 LABELING AND ADMINISTRATION

A. General: Labeling and administration shall comply with ANSI/TIA/EIA 606 and standard industry practices. Label scheme shall match scheme from submittal.
B. Color Coding: Apply industry standard color coding to cable termination fields. Always apply the same color at both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, may be the color of a cover on the termination equipment, or may be the actual color of the insert label on the termination equipment.
C. Racks: Label racks as shown on the Contract Documents. Affix label centered across top cross-member of rack.
D. Grounding/Bonding Conductors: Label bonding conductors; "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"
E. Cables:
    1. Label Location: Affix at each end of the cable.
    2. Station Cables: Label station cables with the same label as the station connector (see STATION CONNECTORS(PORTS) below) that terminates the cable at the station location. Include a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable.
    3. Fiber Backbone Cables: Label intrabuilding fiber backbone cables in the form "F (TR to TR), ###-ST, type, ###-FT " where "F" stands fiber, "(TR to TR)" is the origination and destination telecommunications rooms between which the cable routes, "###-ST" is the strand count, "type" is the fiber type (i.e. SM, 62.5MM, etc), and ###-FT is the cut length.
    4. Provide labels at each end of each cable within 24 inches (610 mm) of

telecommunications room entrance and again within 24 inches (610 mm) of termination point.

F. Termination Blocks:
   1. General:
      a. Label termination block ports/pairs sequentially beginning on the first row of each termination block column. Begin with "001" for the first port/pair.
      b. Label termination strip pairs sequentially (left to right).
   2. For Horizontal Distribution: Label termination blocks used for horizontal distribution with a single label affixed above the entire termination block column indicating the floor number on which the outlets are located, whose cable terminates on that column.
      a. Termination strip pairs shall be of the form "###" where "###" denotes the sequential cable number terminated.
   3. For Backbone Distribution: Label termination blocks used for backbone distribution with a single label affixed above the entire termination block wall field which reads "Backbone". Additionally, label each termination block column within the termination block wall field as follows:
      a. Label columns in the form "TR", where "TR" is the telecommunications room where the backbone cable originates. Use a new column for each telecommunications room. Do not intermix cables from multiple telecommunications rooms in a single termination block column.
      b. Termination strip pairs shall be of the form "###" where "###" denotes the sequential cable number terminated.

G. Patch Panels:
   1. For Horizontal Distribution:
      a. General: Label patch panels as shown on the Contract Documents.
      b. Ports: Ports are typically pre-labeled by the manufacturer with sequential numbers (i.e. 1 to 48). For ports which are not pre-labeled, label port in the form "##" where "##" is the sequential port number within the panel. Each patch panel shall start at port number "01".

H. Station Connectors (Ports):
   1. Connected to Termination Blocks in the Telecommunications Room:
      a. Label connectors in the form "FTR-###" where "F" is the floor of the communications outlet where the horizontal cable terminates, "TR" is the telecommunications room where the cable terminates, and "###" is the sequential cable number for that telecommunications room. Cross reference connector labels with the Port Designation label on the Contract Documents.

I. Conduits: Label each conduit end (existing or new) in a clear manner by designating the location of the other end of the conduit (i.e. room name, telecommunications room identifier, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.

J. Pull Strings: Label each pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, telecommunications room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).

3.6 TESTING

A. Provide test records on a form approved by the Architect. Include the test results for each

cable in the system. Submit the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results for review and acceptance within two weeks of Substantial Completion.

1. Print test records for each cable within the system directly from the tester and submit in paper form (in a binder) and in electronic form (on diskette or CDROM) to the Owner and Designer for review. Handwritten test results will not be accepted.

B. Test the SCS after installation for compliance to all applicable standards as follows:

1. Fiber: Test fiber optic cable on the reel upon delivery to the job site prior to installation, and again after installation.
    a. Prior to testing, calculate the cable loss budget for each fiber optic cable and clearly show the result on the test documentation. Calculate maximum loss using the following formula, assuming no splices:
        1) For Horizontal Distribution:
            a) Max Loss = 2.0db (per ANSI/TIA/EIA 568-B).
        2) For Backbone Distribution:
            a) Max Loss = [(allowable loss/km) * (km of fiber)] + [(.3db) * (# of connectors)].
            b) A mated connector to connector interface is defined as a single connector for the purposes of the above formula.
            c) A given fiber strand shall not exceed its calculated maximum loss (per the above formula).
    b. Test all strands using a bi-directional end-to-end optical transmission loss test instrument (such as an OTDR) trace performed per ANSI/TIA/EIA 455-61 or a bi-directional end-to-end power meter test performed per ANSI/TIA/EIA 455-53A, and ANSI/TIA/EIA 568-B.
        1) Calculate loss numbers by taking the sum of the two bi-directional measurements and dividing that sum by two.
        2) Provide test measurements as follows:
            a) For Multimode Cable: Test at both 850 and 1300nm.
    c. For Singlemode Cable: Test at both 1310 and 1550nm.
    d. Test results shall conform to:
        1) The criteria specified in ANSI/TIA/EIA-568B
        2) The Contractor's calculated loss budget above
        3) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet):
            a) In addition to the above, perform tests both recommended and mandated by the manufacturer. Tests shall confirm/guarantee compliance to manufacturer's performance standards and also IEEE 802.3z for a maximum end-to-end dB loss of 2.5 dB.
        4) The criteria specified in IEEE 802.3z (1000Base-X Gigabit Ethernet).

C. Identify cables and equipment that do not pass to the Architect. Determine the source of the non-compliance and replace or correct the cable or the connection materials, and retest the cable or connection materials at no additional expense to the Owner. Provide new test results in the same manner as above.

1. In addition to the above, if it is determined that the cable is at fault, remove the damaged cable and replace it with a new cable. Cable "repairs" are not acceptable. The procedure for removing the cable shall be as follows:
    a. Prior to removal of damaged cable and installation of new cable:

1) Inform the Owner of the schedule for the removal and installation.
2) Test the new cable on the reel.
3) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable, regardless of whether or not they are new cables installed as part of this project or existing cables installed prior to this project.
4) Provide test results for approval.

b. Remove the damaged cable and provide new cable.

c. After the removal of the damaged cable and installation of the new cable:
1) Test the new cable.
2) Test cables that occupy the same innerduct or conduit (if not in innerduct) as the damaged cable, regardless of whether they are new cables installed as part of this project or existing cables installed prior to this project.
a) If any of the cables requiring testing are in use, coordinate with the Owner to schedule an outage opportunity during which the testing can be performed.
3) Provide test results for approval.

d. If a cable which occupies the same innerduct or conduit (if not in innerduct) as a damaged cable is damaged by the extraction and installation process, replace the cable at no additional expense to the Owner.
1) Damaged cables which are replaced shall be subject to the testing procedures.

3.7 FIRESTOPPING

A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.

B. Maintain fire rating of penetrated fire barriers. Fire stop and seal penetrations made during construction.
1. Provide firestopping material for through and membrane penetrations of fire- rated barriers.
2. Install firestops in strict accordance with manufacturer's detailed installation procedures. Refer to Section 07 84 53 - Building Perimeter Firestopping.
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards. Apply sealing material in a manner acceptable to the local fire and building authorities.
4. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

C. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire- rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide 1 of the following:
   a. "Dow Corning Fire Stop Foam", Dow Corning Corp.
   b. "Pensil 851", General Electric Co.

3.8 PROTECTION

A. Protect installed products until completion of project.
B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION