

SECTION 27 15 00 - BACKBONE CABLING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

- A. Backbone cabling includes optical fiber, coaxial and copper cable from the utility demarcation to the communication equipment room (CER), cabling between multiple CERs in a building, and optical fiber and copper cable between buildings on the campus.
- B. This section includes minimum requirements for the following:
 - 1. Interior UTP Copper Cable and Terminations
 - 2. Interior Optical Fiber Cable and Terminations
 - 3. Coaxial Trunk Cable and Connectors

1.3 QUALITY ASSURANCE

- A. All cable shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA/EIA - 568A
 - 2. ANSI/TIA/EIA - 569
 - 3. NFPA 70 - 1996
 - 4. BICSI Telecommunications Distribution Methods Manual
 - 5. FCC 47 CFR 68
 - 6. NEMA - 250
 - 7. NEC - Articles 725, 760, 770 and 800
 - 8. ANSI/TIA/EIA - TSB 72
 - 9. ISO/IEC 11801
- C. The optical fiber cable plant shall be used to support 622 Mbps ATM and Gigabit Ethernet networks. At the time of installation all optical fiber products shall support the latest draft or formal specification released by the ATM Forum Technical Committee and the IEEE 802.3z committee.

1.4 SUBMITTALS

- A. Manufacturers catalog sheets, specifications and installation instructions for all cable, connecting hardware and patch cables.
- B. Termination details for all cable types.
- C. Provide a 1' connectorized sample for the Coax cable.
- D. List of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references).
- E. Cable Test Reports (at substantial completion).
- F. Cable tension reports for optical fiber pulls

PART 2 - PRODUCTS

2.1 INTERIOR GRADE OPTICAL FIBER CABLE FOR BUILDING BACKBONES

- A. OM3 fiber its core size is 50µm. It supports 10 Gigabit Ethernet at lengths up to 300 meters. Besides OM3 is able to support 40 Gigabit and 100 Gigabit Ethernet up to 100 meters. 10 Gigabit Ethernet is its most common use.
- B. Cable shall be plenum rated and meet the requirements Flame Test: UL 910 (NFPA 262)
- C. Fiber Characteristics
 - 1. All fibers in the cable must be usable fibers and meet required specifications.
 - 2. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
 - 3. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.
 - 4. All optical fibers shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.
 - 5. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
 - 6. The coated fiber shall have a layer of Teflon® placed between the dual layer acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be $900 \pm 50 \mu\text{m}$.

7. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass.
- D. The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492AAAA-1989, "Detail Specification for 50 μm Core Diameter/125 μm Cladding Diameter Class Ia Multimode, Graded Index Optical Waveguide Fibers."
1. Core diameter: $50 \pm 3.0 \mu\text{m}$.
 2. Cladding diameter: $125.0 \pm 2.0 \mu\text{m}$.
 3. Core-to-Cladding Offset: $\leq 3.0 \mu\text{m}$.
 4. Cladding non-circularity: $\leq 2.0 \%$.
 5. Core non-circularity: $\leq 6.0 \%$.
 6. Coating Diameter: $245 \pm 10 \mu\text{m}$
 7. Graded index
 8. Numerical Aperture: 0.275 ± 0.015 .
 9. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.
- E. Fiber Parameters
1. All fibers in the cable shall meet the requirements of this specification.
 2. The attenuation specification shall be a maximum attenuation for each fiber at $23 \pm 5^\circ\text{C}$.
 3. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.1 dB at 1310 nm/1550 nm (single-mode) or 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.
- F. Physical Characteristics
1. Plenum Cables up to 24 Fibers:
 - a) The fibers may be stranded around a dielectric central member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable.
 - b) A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal.
 - c) The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
 2. Strength Members:
 - a) The strength member shall be a high modulus aramid yarn.
 - b) The aramid yarns shall be helically stranded around the buffered fibers.
 - c) A non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.
 3. Cable Jacket:

- a) The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections.
 - b) The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable.
 - c) The jacket shall be smooth, as is consistent with the best commercial practice.
 - d) The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
4. The cable and subunit jacket color shall be orange for cables containing multimode fibers. The cable and subunit jacket color shall be yellow for cables containing single-mode fibers.
 5. For cables with more than two fibers, the cable jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. A non-toxic, non-irritant talc shall be applied to the aramid yarns to allow the yarns to be easily separated from the fibers and the jacket.
 6. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable.
 7. The cable shall be all-dielectric.

G. Identification

1. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered on the unit jacket for identification. The number shall be repeated at regular intervals.
2. The outer cable jacket shall be marked with the manufacturer's name or file number, date of manufacture, fiber type, flame rating, listing mark, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket.

H. Additional Requirements

1. The storage temperature range for the cable on the original shipping reel shall be -40°C to +70°C. The installation/operating temperature range for plenum cables shall be 0°C to +70°C. Testing shall be in accordance with FOTP-3.

2. Crush Resistance - The cable shall withstand a minimum compressive load of 89 N/cm (50 lbf/in) applied uniformly over the length of the compression plate. The cable shall be tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables." While under compressive load, the fibers shall not experience an attenuation change greater than 0.4 dB at 1550 nm (single-mode) or greater than 0.6 dB at 1300 nm (multimode). After the compressive load is removed, the fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).
3. Impact Resistance - The cable shall withstand a minimum of 20 impact cycles. The cable shall be tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).
4. Cyclic Flexing - The cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The cable shall be tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).
5. Flammability - All cables shall comply with the requirements of the National Electrical Code® (NEC®), Article 770. Plenum cables (OFNP) shall pass UL-910.

2.2 OPTICAL FIBER CABLE CONNECTORS

- A. Backbone optical fiber connectors shall be LC type.
- B. The terminations shall comply with the following standards:
 1. EIA/TIA-4750000B Generic Specifications for Fiber Optic Connectors
 2. EIA/TIA-455-A Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components (FOTPs)
 3. TIA/EIA-604-3 Fiber Optic Connector Intermateability Standard, FOCIS-3
- C. Connector Characteristics.
 1. Strain relief: The connector shall provide a strain relief mechanism for installation on a single fiber cable that contains strength elements. The fiber within the body of the connector shall be isolated mechanically from cable tension, bending and twisting.
 2. Intermateability: The connector shall be designed in compliance with the appropriate TIA FOCIS document.

3. Installation rate: The connector shall be installable on 900 μ m buffered fiber in 1 minute or less total time.
4. Installation polishing: The connector shall not require polishing of the endface in the field. Connectors shall have a factory-polished fiber stub in the connector ferrule.
5. Installation type: The connector installation shall not require the use of epoxies.
6. Fiber protection: The connector crimp-on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants and shall secure the fiber in the ferrule micro-hole.

2.3 INTERIOR COPPER BACKBONE CABLE

- A. Backbone copper cables shall consist of 24 AWG, groups of 25 pair thermoplastic insulated copper conductors following the ANSI/ICEA S-80-576 color code. The 25 pair groups shall be bound together and covered by a protective sheath consisting of an overall thermoplastic jacket and one layer of dielectric material applied over the core.
- B. The cable shall be listed and marked for its use as required by article 800 of the NEC. Provide plenum rated cable.
- C. Backbone cables shall be used for telephone systems only and shall be third party verified Category 6a.
- D. Transmission Characteristics:
 1. The resistance of any conductor, measured in accordance with ASTM D 4566 shall not exceed 9.38 ohms per 100m at 20 degrees C.
 2. The resistance unbalance between the two conductors of any pair shall not exceed 5%.
 3. The mutual capacitance of any pair shall not exceed 6.6 nF per 100m.
 4. The capacitance unbalance to ground at 1 kHz of any pair shall not exceed 330 pF per 100m.
 5. The characteristic impedance shall be 100 ohm +/- 15% from 1 kHz to 16 MHz.
 6. The attenuation shall meet the requirements of the horizontal cable specified in section 17160.
 7. The insulation between each conductor and the core shield shall be capable of withstanding a minimum dc potential of 5 kV for 3 seconds.
 8. The propagation delay of any pair at 10 MHz should not exceed 5.7 ns/m.

9. The Power Sum NEXT loss shall meet the following:

<u>Frequency (MHz)</u>	<u>NEXT loss (dB)</u>
0.150	53
0.772	43
1.0	41
4.0	32
8.0	27
10.0	26
16.0	23

- E. Design Make: UTP PowerSum Backbone cables

- F. Acceptable Manufacturers:

1. General Cable
2. Belden
3. AMP
4. Berk-Tek

2.4 COAXIAL CABLE

- A. Cable shall be quad shield RGII/U.
- B. Cable shall be UL listed NEC Type CLR or CATV, constructed in accordance with UL Standard 13, complying with UL 1581 vertical tray flame test.
- C. Construction:
1. 14 AWG solid bare copper conductor.
 2. .280 inch foam polyethylene insulation.
 3. 2 Aluminum polyester tapes around 100% of cable.
 4. 2 Aluminum braids covering 65% of cable.
 5. .380 inch diameter PVC plenum rated jacket.
- D. Transmission Characteristics:
1. Nominal Capacitance - 17 pf/ft.
 2. Nominal Impedance - 75ohms
 3. Nominal Attenuation:

<u>mHz</u>	<u>db/100 ft.</u>	<u>db/100m</u>
7	.31	1.0
30	.75	2.5
54	.96	3.1
100	1.6	5.2
216	2.1	6.9
470	3.3	10.8
600	4.3	14.1
890	4.6	15.1

E. Acceptable Manufacturers:

1. West Penn
2. Commscope
3. Belden
4. Berk-Tek

2.5 COAXIAL CONNECTORS

A. Backbone cable

1. Provide one piece "type F" male crimp type connectors with hex crimping on all backbone cables.
2. Connectors shall include internal reduction of the center conductor.
3. Cadmium plated brass construction.
4. Use parallel jaw type crimping tool for all connections.

B. Design Make: Thomas & Betts "PL-11QS" Series.

2.6 COAXIAL TAPS

A. Provide two and four port tap offs as required for the installation.

B. Tap offs shall be optimized for 600 MHz operation and meet CATV requirements for RF shielding.

C. Shall have a mounting bracket built-in.

D. 22dB isolation tap-tap @ 5-10 and 550-600 MHz.

E. Design Make: Blonder Tongue CRT-2A and CRT-4A

PART 3 - EXECUTION**3.1 INSTALLATION**

A. Optical Fiber Cable

1. General

- a) Interior cable installed in accessible ceilings shall be installed in open top cable hangers 4 foot on center or in cable tray. Install the cables as close to the ceiling deck as possible in a segregated pathway. Do not install with UTP or coax cables.
- b) Provide tie wraps to close top of cable hangers after installation is complete
- c) Interior cables installed in crawl spaces, basements or attics shall be installed in PVC type innerduct.

- d) Exterior cable shall be installed in multi-cell duct.
- e) Maintain polarization for entire system as described in ANSI/EIA/TIA-568-A section 12.7.1.
- f) Cable shall be continuous. Splices are not allowed.

2. Cable Pulling

- a) Adhere to all manufacturer's requirements regarding pulling tension, allowable lubricants and bending radius.
- b) Provide cable pullers designed to suit field conditions. (i.e. horizontal vault pulls, vertical pulls and 45 degree pulls)
- c) Use cable guides with aluminum adapters sized for the 1 1/4" cells. Provide extensions, sheaves and adapters as required by the installation conditions.
- d) Use directional pulling swivels as conditions require.
- e) Use Line Tension meter during cable pull to provide accurate measurements of the force exerted on a cable as it is installed. The meter shall have a programmable overload set point with an audible and visual indication of an overload condition. The meter shall have controls to disengage the cable puller if an overload occurs. Provide chart recorded documentation of the cable pull for the owners records.
- f) Provide cable racks in manholes to support cable.

B. UTP Cable:

- 1. UTP backbone cables may be installed in conduit, cable tray, or in cable hangers 4' on center.
- 2. Placement of underground cables shall conform to REA 644 Cable Standards.
- 3. Cables above drywall ceilings shall be installed in conduit. Cables in exposed areas other than communications equipment rooms shall be installed in conduit or surface raceway.
- 4. Install UTP in a separate open cable hanger segment. Do not install with, optical fiber cable or any other cable type. If cables have more than 12" of sag, install more hangers.
- 5. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.

6. Provide cable management as called for in section 17110.

7. Label MDF termination blocks, with a permanent fine point pen such as a Pilot ultra fine point - part number SC-UF. Stencil every fifth pair of each termination block with the appropriate cable count.
8. The contractor shall replace the cable if damaged during installation.
9. Test all riser cable pairs. Multi-pair cables shall be replaced if they contain more than 1% bad pairs.
10. Cross connect hardware shall be color-coded with industry standard coded fields as follows:

<u>Description</u>	<u>Color</u>
C.O. Circuits	Green
PBX Circuits	Purple
Auxiliary Circuits	Yellow
Wiring to Work Station	Blue
Back Bone Cable	White
Wiring from MUX	Orange
Concentrators, etc. on a Fiber or UTP	
Backbone	
Tie Lines	Grey

11. Unless otherwise specified, noted UTP backbone cables shall be sized based on two pairs/connected voice jack. Round up to the next audible pair sizing when doing calculations.
12. Where UTP backbone cable incorporates a campus system (i.e., multiple buildings connected to the backbone), all cable shall be installed with gas tube or solid state protection devices at both ends.

C. Coaxial Cable

1. The system supplier is responsible for calculations and design. A proposed solution is shown on the plans. Submit logical system drawings indicating cable sizes, amplifiers, tap-offs, etc., for approval.
2. Make all terminations using approved crimping tools. Crimping tools shall be approved by the manufacturer for use with connectors being used.
3. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.
4. All coaxial cable insulation and core removal shall be accomplished using an approved coaxial cable stripping tool to prevent any damage to shield or center conductor.
5. Avoid unnecessary bends in coaxial cabling, do not exceed manufacturers recommended bending radius.

6. Install coaxial cable in a separate open cable hanger segment. Do not install with category 6a, optical fiber cable or any other cable type. If cables have more than 12" of sag, install more hangers.
7. Do not tie-rape cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.
8. All tap-offs shall be fastened to building structure, cable tray or steel support using bolts, screws or toggles.

END OF SECTION