



**CITY OF PALO ALTO**

**UTILITIES DEPARTMENT - ELECTRIC**

**OUTSIDE PLANT FIBER OPTIC CABLE**

**SINGLE MODE**

**STRANDED LOOSE TUBE CONSTRUCTION**

**ARMORED/NON-ARMORED**

**CPA Inventory numbers 35020, 35030 & 35032**

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**Date: March 2008**

## **1. SCOPE**

- 1.1 This specification covers multi-strand fiber optic cable intended for weather-exposed outside plant installation. Specifically it covers the cable construction known in the industry as armored or non-armored loose tubes in which bundles of fibers are enclosed in buffer tubes which are then enclosed in a larger tube. The fiber types covered by this document are single mode of both depressed and matched cladding profiles.
- 1.2 The fiber optic cable shall be designed for lashed aerial installation on wood poles owned jointly by the City of Palo Alto and Pacific Bell Company, the highest system voltage attached to the poles is 60KV. The fiber optic cable shall be designed for underground duct installation in a combination 12KV/telecommunication underground system.
- 1.3 The bidder shall, with this proposal, indicate any and all deviations from the requirements of this specification. The project manager will review any discrepancies for a determination as to their equivalency of that intended.

## **2. APPLICABLE DOCUMENTS**

- 2.1 The following documents from a part of this specification to the extent specified. Construction and performance will conform to the requirements of this document unless stated otherwise.

Document	Title and Source
EIA RS-455	EIA Standard Fiber Optic Test Procedures (FOTP)
EIA RS-359	EIA Standard codes for Color Identification and Coding
TR-TSY-000020	Bellcore Technical Reference - Generic Requirements For Optical Fiber and Optical Fiber Cable
REA PE-90	REA Specification for Totally Filled Fiber Optic Cable

## **3. GENERAL INFORMATION**

- 3.1 The proposed fiber optic cable shall be made of highest quality materials for maximum reliability and long life, shall meet all applicable standards, and shall

be acceptable by an electric utility and a telephone or CATV company.

#### **4. TECHNICAL REQUIREMENTS**

##### **4.1 General**

4.1-1 Bidders shall furnish with their bids a detailed description of the cable that is proposed. The information required on the cable shall be, as a minimum, the glass manufacturer, cable configuration, fiber grade, optical characteristics, mechanical specifications, electrical immunity characteristics, fault and lightning tolerances, and all other pertinent information required for an accurate evaluation.

4.1-2 The cable shall be a telecommunications cable, designed for the high speed transmission of voice, video, and data communication. The cable shall combine a loose tube fiber with a UV rated outer jacket and shall be designed for aerial installations on high voltage transmission poles, and underground duct systems.

##### **4.2 Optical Fiber**

4.2-1 Each cable shall have traceability of each optical fiber back to the original fiber manufacturer's serialized fiber number and measured fiber parameters.

4.2-2 Optical fibers shall conform with the parameters specified in Section 5.2 of this specification.

4.2-3 Each optical fiber shall incorporate a mechanically strippable protective coating that is applied at the time of fiber manufacture.

4.2-4 All optical fibers shall be 100% proof tested at  $0.69 \text{ GN/m}^2$  (100kpsi).

4.2-5 The optical fibers shall contain no splices.

4.2-6 All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the mechanical and environmental requirements of this specification.

##### **4.3 Loose Buffer Tubes**

4.3-1 The cable shall incorporate filled loose buffer tubes which allow the cable to expand or contract without transferring stresses onto the fibers.

4.3-2 The buffer tubes shall be filled with a soft moisture resistant gel to prevent the ingress of moisture to the fibers. The gel shall be non-toxic, non-hygroscopic, and non-nutrient to fungus, and electrical non-conducting. The compound shall act as a lubricant to permit the fibers to float inside the buffer tubes.

4.3-3 Individual buffer tubes may contain one or multiple fibers. For buffer tubes containing multiple fibers, each fiber shall be individually color coded for identification. Each buffer tube shall be color coded for identification by means of the same color coding scheme (refer to paragraph 4.11-3)

4.3-4 Depending on the number of total fibers, the number of buffer tubes shall be as follows:

<b>FIBER COUNT</b>	<b>NUMBER OF BUFFER TUBES</b>
<b>2-72</b>	<b>6</b>
<b>73-96</b>	<b>8</b>
<b>97-120</b>	<b>10</b>
<b>121-144</b>	<b>12</b>
<b>145-216</b>	<b>18</b>

4.3-5 Unless otherwise specified, each buffer tube shall be completely filled (12 fibers) before any are placed in the next tube., Empty tubes may be replaced with blank fillers, if desired. The fibers shall be placed loosely inside each buffer tube.

#### 4.4 Central Member

4.4-1 The center of the cable will consist of a fiber-reinforced plastic central member which will serve as an anti-buckling member.

4.4-2 The central member shall contain no splices.

4.4-3 The central member may be jacketed with a layer of thermoplastic material to achieve the appropriate diameter for the cable design.

#### 4.5 Stranded Core

4.5-1 The buffer tubes shall be helically stranded around the central member in a torsion free manner. Fillers may be included in the cable core to lend symmetry to the cable cross section.

4.5-2 The cable core shall be completely filled to prevent moisture entry to the cable. The filling material shall be non-toxic, non-hygroscopic, and non-nutrient to fungus.

4.5-3 The cable core shall be contained using a non-hygroscopic tape. The tape shall act as a heat barrier to prevent deformation and adhesion between buffer tubes and the inner polyethylene jacket.

4.5-4 A layer of high strength aramid yarns shall be helically applied over the cable core to

provide tensile strength. The yarns shall contain no splices.

#### 4.6 Inner Jacket

A polyethylene inner jacket with ripcord shall be extruded over the core tape. This jacket shall provide added protection against the ingress of moisture and enclose the core tape, buffer tubes and the central strength member.

#### 4.7 Outer Jacket

The entire optical cable core shall be covered with an outer high molecular weight polyethylene jacket that resists deterioration from ultraviolet rays, temperature variations, and other environmental conditions including abuse during installation. The covering provided shall be a non-corrosive, non-nutrient to fungus and an electrically non-conducting jacket. The cable jacket shall be free from holes, cracks, blisters or other imperfections and provided with ripcord for ease of cable entry.

The jacket shall contain one or two longitudinally extruded colored stripe or stripes, having a minimum width of 1/8 inch. The color and number of stripes will be specified in the purchase order.

#### 4.8 Armor

Armored cables shall consist of an inner polyethylene jacket, corrugated steel tape armor (0.006 inch thickness, plastic coated both sides) and an outer jacket as described above. The steel tape armor must be electrically continuous along the length of the cable.

#### 4.9 Ripcord

A ripcord shall be supplied under each jacket.

#### 4.10 Cable Marking

The outer cable jacket shall be marked at a two feet interval with the following information:

City of Palo Alto  
Manufacturer  
Fiber Count/Description of Cable  
Date Manufactured (Month and Year)  
Sequential footage.

Upon request, specified lengths of the cable shall also include markings, such as colored stripes, distinguishing them from other lengths of the cable.

#### 4.11 Fiber Identification

4.11-1 Fibers and buffer tubes shall be color coded for identification according to a consistent coloring scheme.

4.11-2 Fibers. Individual fibers shall be color coded. The colors shall be distinguishable after fibers are stripped and cleaned and the ends prepared for splicing. Industry standard colors shall be used with the following meaning.

FIBER NUMBER	FIBER COLOR
<b>1</b>	<b>Blue</b>
<b>2</b>	<b>Orange</b>
<b>3</b>	<b>Green</b>
<b>4</b>	<b>Brown</b>
<b>5</b>	<b>Slate</b>
<b>6</b>	<b>White</b>
<b>7</b>	<b>Red</b>
<b>8</b>	<b>Black</b>
<b>9</b>	<b>Yellow</b>
<b>10</b>	<b>Violet</b>
<b>11</b>	<b>Rose</b>
<b>12</b>	<b>Aqua</b>

4.11-3 Buffer Tubes. Buffer tubes will be colored using the same color code as for fibers with the addition that, for cables with more than twelve tubes, the sequence shall be repeated with the addition of a black dash for buffers with numbers higher than twelve. Buffer colors shall be easily distinguishable under normal field conditions.

#### 4.12 Cable Mechanical Parameters

The following mechanical parameters are the City of Palo Alto's minimum requirements. Bidders shall include with their proposals detailed specifications addressing each of the parameters listed in this section.

- a. **Tensile Strength:** The cable provided shall be designed such that the fibers do not experience any degradation during a sustained maximum operating load of 600 lbs. (2,700 N) short term, and 200 lbs. (890 N) long term.
- b. **Crush Resistance:** The cable provided shall withstand the compressive load with no detectable damage to the fibers in accordance with TIA-455-41 and TR-TSY 000020.
- c. **Impact Resistance:** The cable provided shall withstand the impact test described

in TIA-455-35A and in accordance with TR-TSY 000020.

- d. Minimum Bend Radius of Cable: Minimum Bend Radius is 20 x cable outside diameter under installation tensile load, and 10 x cable outside diameter under long term tensile load.
- e. Temperature Requirements:
  - Storage Temperature -40C to + 70C
  - Installation Temperature -30C to + 70C
  - Operating Temperature -40C to + 70C
 Qualification data shall be provided for a similar cable showing no attenuation increase at -40C and +70C, per Bellcore TSY-TR-000020 and EIA/ITA 455-3A.
- f. Electrical Tolerances: The cable provided shall exhibit tolerance to temperature rises and stresses caused by electrical faults from the power system or lightning strikes. Recommended cable attachment location shall be suggested. Recommendation shall be offered concerning track resistant jackets.
- g. Compound Flow Drip Temperature: No compounds shall flow or drip at temperature below +65°C
- h. Cable Size and Weight

The outer diameter and weight of cables shall not exceed the values in the following table.

<b>FIBER COUNT</b>	<b>OUTER DIAMETER inches (mm)</b>	<b>WEIGHT lbs/kft (kg/km)</b>
2-72	0.62 (15.75)	155(231)
73-96	0.70(17.8)	190(283)
97-120	0.78 (19.8)	230(342)
121-144	0.86 (21.9)	260(387)
145-216	0.87(22.1)	298(444)

- I. Cable Details: Each bidder with his proposal shall furnish the owner documentation showing compliance to all the specifications listed above on a similar cable type. Following is a list of other data parameters required, as a minimum:

- Nominal Cable Diameter
- Nominal Cable Weight

- Minimum Bending Radius at no load and under tension
- Cable Breaking Strength for use in specifying attachment hardware
- Shotgun Resistance.

## 5. GLASS FIBER SPECIFICATIONS

The following fiber parameters are the City of Palo Alto's minimum requirements. Bidders shall include with their proposals, detailed specifications addressing each of the parameters listed in this section.

### 5.1 Fiber Count and Type

The optical cable shall contain 144 single mode fiber and they may be either matched clad or depressed clad type. The fiber type must be specified and all cable delivered in response to a single order or contract must be of the same type unless otherwise specified in the RFQ. The glass fibers shall be manufactured by an industry-approved glass fiber manufacturer.

### 5.2 Optical Parameters:

Core Diameter	8.3 microns
Cladding Diameter	125 ± 1 micron
Protective Coating	250 ± 15 microns
Numerical Aperture	0.13
Core/Cladding Concentricity	1.0 microns
Proof Strength	100,000 psi
Max. Individual fiber loss at 1310 nm	0.35 dB/km
Max. Individual fiber loss at 1550 nm	0.25 dB/km
Mode Field Diameter (1300nm)	Matched Clad Fiber: 9.3 ± 0.5 microns Depressed Clad Fiber: 8.8 ± 0.5 microns
Chromatic Dispersion : 1285-1300nm	Matched Clad Fiber: 3.5 ps/nm - km Depressed Clad Fiber: 2.8 ps/nm - km
Chromatic Dispersion : at 1550 nm	18.0 ps/nm - km
Nominal Zero Dispersion Wavelength	1310 ± 10 nm
Polarization mode dispersion	0.5 ps/km @ 1310 nm.

### 5.3 Test Documentation

The manufacturer shall submit to the project manager test reports documenting that the following tests have been performed at the factory, either on qualification or ordered cables.

- a. Optical Test: Prior to shipping, the supplier shall test each fiber to verify that both the Bureau's and the glass fiber manufacturer's specifications are met. Each of the fibers in each of the cable reels shall be completely tested with an Optical Time Domain Reflectometer (OTDR) at 1310 and 1550 nm on a bi-directional

averaged basis and final test data attached to each reel. Also, a copy shall be sent to the City

- b.. Mechanical Tests: Documentation confirming the tensile strength, crush resistance, impact resistance and repeated bending resistance of the cable or a similar cable type. The report shall show that the specified cable load requirements will not cause fiber degradation.
- c. Vibration Characteristics: The cable shall be self -damping over the entire applicable frequency range or vibration dampening devices shall be recommended.
- d. Resistance to Shotgun Damage: Documentation depicting the cable's resistance to shotgun damage.
- e. The manufacturer shall perform all of the tests required, and send two copies of the certified reports, along with two 18-inch cable samples, to the City of Palo Alto, Utilities Department. Attention: Patrick E. Valath, Senior Power Engineer, P.O. Box 10250, Palo Alto, CA 94303, prior to cable shipment. After the City has approved the test reports and cable samples, the manufacturer will receive authorization in writing from the City to ship the cable.

## **6. INSTALLATION INFORMATION**

The manufacturer shall provide the City all the required information for installing the cable on the City's wood pole structures and in underground duct structures.

## **7. SHIPPING REELS AND LENGTHS**

7.1 All cable shall be shipped on-returnable wooden reels substantial enough to prevent damage to the cable during shipment, handling and installation.

7.2 All cable reels shall have the following maximum dimensions:

Flange dia 72", Traverse 48", Drum 36".

It is the City's intent to maximize cable lengths on reels in order to effectively reduce wasted cable during installation. Suppliers may elect to supply cable on reels that are larger than those listed above by delivering the cable on a returnable cable reel dolly, at no cost to the City. The cable reel dolly will be returned to the supplier as soon as the cable has been installed.

7.3 Cable reels shall be covered with a waterproof corrugated board or other suitable means of protection. The covering shall be secured in place in order to prevent damage to the cable during storage and handling. The cable ends shall be sealed and suitably protected in order to prevent the ingress of moisture. The fiber optic

cable reels shall be designed for outdoor storage.

7.4 Each reel shall be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

7.5 Each reel shall be stenciled or labeled on both sides in a durable and weather resistant manner with the following minimum information:

- Manufacturer's name or trademark
- Manufacturer's part number
- Actual cable length (in Feet and Meters)
- Year of manufacture
- Inner and outer end sequential length marking
- Nominal cable diameter
- Purchase Order Number
- Gross weight of reel with cable.